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# Driving in Early-Stage Alzheimer's Disease

## An Integrative Review of the Literature

Rebecca L. Davis, PhD, RN; and Jennifer M. Ohman, DNP, RN, AGNP-C

### ABSTRACT

One of the most difficult decisions for individuals with Alzheimer's disease (AD) is when to stop driving. Because driving is a fundamental activity linked to socialization, independent functioning, and well-being, making the decision to stop driving is not easy. Cognitive decline in older adults can lead to getting lost while driving, difficulty detecting and avoiding hazards, as well as increased errors while driving due to compromised judgment and difficulty in making decisions. The purpose of the current literature review was to synthesize evidence regarding how individuals with early-stage AD, their families, and providers make determinations about driving safety, interventions to increase driving safety, and methods to assist cessation and coping for individuals with early-stage AD. The evidence shows that changes in driving ability start early and progress throughout the trajectory of AD. Some individuals with mild cognitive impairment or early-stage AD may be safe to drive for a period of time. Support groups aimed at helping with the transition have been shown to be helpful for individuals who stop driving. Research and practice must support interventions to help individuals maintain safety while driving, as well as cope with driving cessation.

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More than 5.3 million individuals are diagnosed with Alzheimer's disease (AD) in the United States (Alzheimer's Association, 2015). AD is the most common cause of dementia, with symptoms ranging from memory loss in the early stages to severe cognitive and functional disability in the end stages of the disease. AD has been identified as

having several stages, including (a) a preclinical stage in which the disease causes damage to the brain, but there are no measurable symptoms; (b) mild cognitive impairment (MCI) due to AD, in which there are noticeable changes in cognition that are not severe enough to affect daily life (Albert et al., 2011); and (c) dementia due to AD, in which

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there are behavioral and/or cognitive symptoms that are severe enough to impact the individual's abilities to function independently (Alzheimer's Association, 2016a).

Individuals with AD and their caregivers face multiple decisions about how to maintain safety and well-being during the course of the disease. One of the most difficult decisions for many is determining when individuals with AD are unsafe to drive, and how to help them through this transition (Alzheimer's Association, 2008; Bronner, Perneczky, McCabe, Kurz, & Hamann, 2016). Because driving is a fundamental activity linked to socialization, independent functioning, and well-being (Marottoli et al., 2000), making the decision to stop driving is not easy. In addition, the health consequences of driving cessation for older adults include social isolation, health problems, institutionalization, higher mortality, and an approximately doubled risk of depression (Chihuri et al., 2016).

Because AD is a progressive disease, resulting in significant loss of cognitive and functional abilities, most individuals with the disease and/or their families may face the decision of when to stop driving. A concern is that some individuals with AD continue to drive even after they are unsafe, putting themselves and others at risk for injury or death (Snellgrove, 2009). In the United States, few laws or policies exist that help guide families or providers when making decisions about driving safety. For example, only 33 of 50 states have any restrictions on driving license renewal for mature drivers (Governor's Highway Safety Administration, 2016). Those states with restrictions often have minor ones, such as not allowing renewals of the license by mail or requiring a vision test, which may not identify individuals with cognitive problems (Governor's Highway Safety Administration, 2016). Driving examinations to identify if an individual is a safe driver are often not covered by insurance (e.g., Medicare, Medicaid) and can be cost-prohibitive, ranging from \$200 to  $\geq$ \$400 (American Medical Association, 2010). Even if insurance covered the cost of testing, with 5.3 million Americans having AD, the resources for testing would be strained.

Not knowing when individuals with AD are safe or unsafe to drive is risky for the individuals affected and society. In AD, cognitive problems, such as slowed reaction times and memory problems, can impact driving ability (National Institute on Aging, 2002). Those with cognitive impairment have difficulty reacting and making decisions while driving (Alzheimer's Association, 2016b), which can lead to getting lost while driving and difficulty detecting and avoiding hazards, as well as increased errors

while driving due to compromised judgment and ability to make decisions (Ott, 2014). Determining when individuals with dementia are not safe to drive is essential for those individuals and society.

Even more challenging is determining when individuals with dementia are still safe to drive, and if methods exist to maintain their safety for a time. If individuals with AD are safe to drive, yet have their drivers' license taken away prematurely, they can experience declines in health and well-being. Conversely, individuals with dementia may drive unsafely and cause injury to themselves and others. As argued by Warlow (2015), "A difficult balance has to be struck between the driver's autonomy and 'right for mobility' and the safety of everyone else on the road" (p. 593). Society runs the risk of being put at danger from unsafe drivers, but also of bearing the cost of expensive testing and providing transportation for individuals who can no longer provide it for themselves.

## REVIEW

### Aim

Many studies exist on driving in individuals with MCI and AD; however, there have been few syntheses of the literature that examine how individuals with AD, their families, and providers determine when an individual with MCI or early-stage dementia is safe or unsafe to drive. Most recently, Andrew, Traynor, and Iverson (2016) conducted an integrative review on driving decision making in individuals with dementia. Their review primarily contained sources prior to the current review (they ended their search in 2012), and focused on how individuals make decisions to stop driving.

No integrative reviews exist on interventions to help individuals with dementia maintain safety while driving, or interventions to help them make the decision to stop driving. Thus, the aim of the current integrative review was to synthesize evidence exploring decisions about how individuals with early-stage AD, their families, and providers make determinations about driving safety. The specific objectives were to determine (a) the types of testing that should be done to decide when individuals with dementia are safe to drive, (b) interventions to assist in driving safety, and (c) driving cessation for individuals with MCI and early-stage AD.

### Search Method

A review of the literature included articles published between January 2007 and May 2015. Databases used in the search included CINAHL, the Cochrane Database of Systematic Reviews, PubMed, PsycINFO, and Science

Direct. Articles cited in the bibliographies of articles were also explored for inclusion. Search terms used included combinations of: *dementia, early stage, Alzheimer's disease, mild cognitive impairment (MCI), driving, driving safety, driving interventions, driving performance, driving assessment, driving cessation, and testing*. Inclusion criteria were: research studies (qualitative or quantitative) addressing driving in early-stage AD (unspecified types of dementia were included) or MCI, human studies, and those written in English. Exclusion criteria were: articles primarily about other causes of dementia, studies about individuals with later stage dementia, studies primarily about caregivers, other literature reviews, or systematic reviews. Only primary sources were included.

### Search Outcome and Quality Appraisal

The initial search yielded 130 articles. The abstracts of the articles were scanned by two reviewers to determine their applicability related to the inclusion criteria. A total of 26 articles were found to meet inclusion criteria. Each study was reviewed against quality appraisal criteria established by Fisher and King (2013). The criteria included nine questions related to the methods, sample size, data collection, analysis, ethics, validity, findings, limitations, and value of the research. Most studies included in the current review were quantitative studies in which a control group of cognitively normal older adults was compared to a group of individuals with MCI and/or early-stage dementia. These studies were overall strong methodologically, with detailed descriptions of their measures, clear statements of the study findings, and some discussion of validity. The most common weaknesses were that few studies included a power analysis to determine the appropriate sample size to detect a difference between groups, some of the measures lacked reliability or validity testing, many studies did not include a discussion of research ethics, and several studies did not discuss study limitations (Table A, available in the online version of this article).

## RESULTS

After reviewing the articles, the current authors summarized the articles in tables, identifying salient themes from each. A list of categories was developed and collapsed based on commonalities to reveal four main themes: (a) *assessment of driving ability* ( $n = 6$ ), (b) *neuropsychological testing and driving performance* ( $n = 11$ ), (c) *factors associated with driving performance and cessation* ( $n = 5$ ), and (d) *interventions for driving and driving cessation* ( $n = 4$ ). A synthesis of the results is discussed.

### Assessment of Driving Ability

One problem for individuals with AD and their families is knowing when the symptoms of AD are severe enough that they should consider having a driving examination. For the past 15 years, the gold standard recommendation to assess driving ability in individuals with dementia has been to conduct an on-the-road driving test (ORDT) every 6 months after diagnosis (Dubinsky, Stein, & Lyons, 2000). However, this type of testing is costly and not often covered by insurance. Knowing when testing should begin in the disease process is important. Furthermore, the types of driving impairments must be identified to potentially address interventions to provide for safety. The current authors found two studies that explored driving ability using ORDT, three that examined naturalistic driving, and one that used driving simulation to determine driving impairments in individuals with early-stage AD and/or MCI (Table 1).

*On-the-Road Driving Test.* Several studies have examined driving ability in individuals with AD during different stages of the disease, adding insight into the progression of driving impairment in AD. Evidence exists that certain driving skills decline early in the disease. The problems exhibited by individuals with AD and MCI include left-hand turns, maintaining proper speed, and lane control (Wadley et al., 2009). In another study, individuals with a Clinical Dementia Rating (CDR) score of 0.5 (questionable dementia) were less likely to fail the driving test than those with a CDR score of 1 (mild dementia) (Ott, Heindel, et al., 2008). Thus, driving problems can begin early in the disease (during MCI), but many individuals in the early stage (CDR score = 0.5) may be able to continue driving for a time. Driving ability appears to decline over time, supporting the need for repeated driving assessment after diagnosis to detect unsafe driving.

*Naturalistic Driving Tests.* An innovative method of testing driving ability is using a naturalistic assessment that involves the use of cameras and other technology to monitor and record driving performance on a day-to-day basis. Several studies have examined driving performance in individuals with AD as compared to controls, and have shown that individuals with early-stage AD have more driving impairments than controls, are more likely to get lost, less likely to wear a seatbelt, and more likely to drive 10 mph slower (Davis et al., 2012; Eby, Silverstein, Molnar, LeBlanc, & Adler, 2012; Festa, Ott, Manning, Davis, & Heindel, 2013). However, individuals with AD have been found to limit their driving by driving fewer miles, shorter distances, and less often at night, and by staying closer to

**TABLE 1**  
**Driving Assessment Recommendations in Alzheimer's Disease**

Citation	Purpose	Sample	Measures	Findings	Comments
Davis et al. (2012)	To compare ORD and naturalistic driving	44 controls, 59 with probable AD	ORD and video recordings of naturalistic driving	Fair agreement between ORD and naturalistic driving; participants with AD scored worse on ORD and naturalistic driving.	Naturalistic driving indicated modification of driving behaviors in participants with AD.
Eby, Silverstein, Molnar, LeBlanc, & Adler (2012)	To compare driving behaviors in early-stage dementia with controls	26 controls, 17 with early-stage dementia	Analyzed driving data from video, audio, and other sensors, which were placed in vehicle	Those with dementia drove less miles, less destinations, and less distance, and more during the day. They got lost more, were less likely to wear a seatbelt, and drove slower.	No cognitive assessment of either group was reported. Type of dementia not specified.
Devlin, McGilivray, Charlton, Lowndes, & Etienne (2012)	To examine how individuals with MCI use their brakes at intersections	14 with MCI/early-stage AD, 14 controls (ages 65 to 87)	Cognitive and motor tests; used driver simulator that operated like a car	No significant differences between groups; trend for MCI to stop less at stop signs and stop-sign controlled intersections.	Small sample may have influenced nonsignificant results.
Festa, Ott, Manning, Davis, & Heindel (2013)	To identify self-regulatory driving behaviors used by older drivers and how behaviors change with cognitive impairment	20 with questionable or mild AD, 20 controls	Used composite driving assessment scale to rate the performance of naturalistic driving	Participants with AD modified driving more frequently to most optimal conditions and had much smaller driving space than controls. Few safety problems for both groups.	Only those who passed the road test could be in the study.
Frittelli et al. (2009)	To assess the effects of MCI on simulated car driving ability, and compare driving in individuals with MCI/AD to controls	19 controls, 20 with mild AD, 20 with MCI	Battery of tests and simulated driving test	Driving impaired in individuals with AD compared to those with MCI and controls. Significantly worse on length of run, mean time to collision, and number of off-road events. No differences detected in number of infractions and stops at traffic lights. Driving scores not significantly correlated with MMSE.	All participants were currently driving.
Ott, Heindel, et al. (2008)	To describe progression of driving impairment in individuals with early-stage AD compared to controls	44 controls, 84 with early-stage/probable AD	ORD, visual, motor, and cognitive testing every 6 months for 2 to 3 years; reports of crashes and driving violations	Controls and participants with AD declined in driving ability over time; those with AD declined faster. Time to failure increased with higher CDR scores. Age and education were predictors of failure.	There were relatively few motor vehicle crashes or traffic violations in both groups.
Wadley et al. (2009)	To measure driving ability in individuals with MCI	46 with MCI, 59 controls	Used a standardized road test coded on 5-point scale from 1 = evaluator took control of car to 5 = optimal	Individuals with MCI scored worse on global and discreet driving measures but were not severely impaired compared to controls.	All participants were currently driving.

Note. ORD = on-the-road driving tests; AD = Alzheimer's disease; MCI = mild cognitive impairment; MMSE = Mini-Mental State Examination; CDR = Clinical Dementia Rating.

home (Eby et al., 2012). In addition, they have been found to drive more in sunny weather versus inclement weather, more often in residential areas, and more in light traffic as compared to controls (Festa et al., 2013). The unique insight of the naturalistic driving assessment in these studies is that individuals with AD have driving problems even when not under the pressure of road testing, and compensate for their deficits by modifying their driving practices.

*Driving Simulation.* Another method of driving assessment is testing during a driving simulation, which most frequently involves driving via a computerized display (Casutt, Martin, Keller, & Jäncke, 2014). These studies support those using ORDT, showing that individuals with AD exhibit more driving errors than those with MCI and controls (Frittelli et al., 2009), and that driving errors are subtle but present in individuals with MCI (Devlin, McGilivray, Charlton, Lowndes, & Etienne, 2012). Thus, despite the method of driving testing, individuals with MCI and AD have evidence of an impaired driving performance when compared to those without cognitive disease.

### Neuropsychological Testing and Driving Performance

To drive, one must manage the mechanical demands of operating an automobile (i.e., brakes, gas, and turn signals), simultaneously processing incoming stimuli (e.g., traffic signals, other vehicular traffic) while making decisions about when to turn and where to go. Consequently, driving requires cognitive, motor, and sensory functions—all of which may be affected by AD. There have been many studies with the goal of identifying the neuropsychological tests that are most predictive of driving ability. A better understanding of the types of driving impairments demonstrated by individuals with dementia can help provide evidence for rehabilitation measures in addition to recognizing those at risk for driving safety problems. In the current literature review, 10 studies were found that examined the relationship of neuropsychological tests with driving ability (**Table 2**).

*Neuropsychological Test Batteries as Predictors of Driving Performance.* Several studies examined how a battery of neuropsychological tests can predict driving ability, as measured by an ORDT, in individuals with dementia. These studies found that combinations of tests, including measures of visual–sensory function, memory, visual spatial abilities, and speed of information processing were related to driving performance (Anderson et al., 2012; Dawson, Anderson, Uc, Dastrup, & Rizzo, 2009; Lafont et al., 2010). These studies support the proposition that driving ability is related to multiple cognitive and functional domains.

Two studies examined the ability of a test battery to correctly identify safe and unsafe drivers. These studies found that it was possible to correctly classify the driving ability of participants with dementia to some degree using neuropsychological tests (Carr, Barco, Wallendorf, Snellgrove, & Ott, 2011; Lincoln, Taylor, Vella, Bouman, & Radford, 2010). The benefit of testing in these cases is that the tests could be used (after further validation studies) to determine when to consider a driving test or counsel an individual to stop driving.

Several research teams have examined the relationship between performance on maze tests and driving performance. Mazes are thought to simulate the cognitive processes necessary for driving. Two studies found that maze tests either alone (Snellgrove, 2009) or with other cognitive tests (Ott, Festa, et al., 2008) could accurately predict driving performance via ORDT 79% to 81% of the time.

*Single Tests as Predictors of Driving Performance.* In an effort to determine an efficient way to identify individuals with AD who are at risk for driving problems, several researchers have attempted to determine if one specific test is most predictive of driving performance. Although the Clock Drawing Test has been shown to correlate with driving performance, it has been found not to be sensitive or specific enough by itself to predict driving performance results in individuals with AD (Manning, Davis, Papandonatos, & Ott, 2014).

One test that shows promise in identifying individuals at risk for driving impairment is the Wechsler Digit Symbol Substitution Test (DSST), which requires individuals to match symbols with numbers during a timed test. The DSST is a measure of “visuospatial perception, selective attention, response speed, visuomotor coordination, and incidental memory...and executive processing” (Lafont et al., 2010, p. 160). Lafont et al. (2010) found that a DSST score of <29 was useful for identifying safe and unsafe drivers.

There has been some debate in the scientific literature about whether CDR scores are sufficient for suggesting when driving cessation should occur. The CDR is a common test used to determine the stage of dementia, with scores ranging from 0 = *no dementia* to 3 = *severe dementia*. The CDR uses an interview of the patient and an informant to determine abilities in “memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care” (Morris, 2005, p. 174). Berndt, Clark, and May (2008) analyzed the relationship between CDR and ORDT scores in individuals with dementia and found that using dementia severity alone is not sufficient in assessing driving ability.

**TABLE 2**  
**Neuropsychological Tests as Predictors of On-the-Road Driving Tests (ORDT)**

Citation	Purpose	Sample	Measures	Findings	Comments
Aksan et al. (2011)	To examine effects of navigation secondary tasks to safety errors and cognitive function to driving ability	77 controls, 32 with AD, 39 with Parkinson's disease	Battery of tests and an ORDT. Had to memorize a route and navigate, and then identify landmarks while driving (secondary task).	Individuals with AD and Parkinson's disease scored worse than controls on all driving measures. Secondary tasks increased driving errors. Speed of processing predicted on-task safety errors after controlling for other factors. Visual sensory function, memory, and set shifting (TMT-B) predicted secondary task performance.	All participants were currently driving.
Anderson et al. (2012)	To evaluate neuropsychological tests in driving safety risk in individuals with and without disease	185 controls, 40 with AD, 92 with Parkinson's disease, 29 who had a stroke	Battery of tests and ORDT	Visual-sensory function, memory, visual spatial abilities, speed of processing related to ORDT scores	All participants were currently driving.
Berndt, Clark, & May (2008)	To assess dementia severity as an indicator of driving performance to determine when driving cessation should occur	117 with dementia (MMSE scores 18 to 30)	ORDT and MMSE	Those who passed ORDT had higher MMSE scores than those who failed. Drivers who failed ORDT were also older. One third of those with very mild and one half of those with early-stage dementia passed the test.	Converted MMSE scores to CDR and had no description of type of dementia.
Carr, Barco, Wallendorf, Snellgrove, & Ott (2011)	To develop a screening battery for on-road performance of drivers with dementia	99 with dementia	Host of psychological tests and then the dependent variable was a pass/fail standard road test. Used stepwise logistic regression to determine the best variables.	Using a combination of the AD-8 total score, CDT, and TMT-A or SBT time predicted accurately the majority of those who would fail the ORDT.	All participants were identified as needing a driving evaluation.
Dawson, Anderson, Uc, Dastrup, & Rizzo (2009)	To measure association of cognition, visual perception, and motor function in driving safety in AD	40 with early-stage AD (33 men, 7 women), 115 controls (60 men, 55 women)	Neuropsychological battery, motor ability, and ORDT	Those with AD only had driving and safety errors. A composite score reflecting test performances across multiple cognitive domains was best predictor of driving safety.	All participants were currently driving.
Lafont et al. (2010)	To identify cognitive tools associated with unsafe driving among older adult drivers of varying cognitive levels	23 with early-stage AD, 20 age- and gender-matched controls, 36 additional drivers without dementia	Battery of neuropsychological tests and ORDT	Individuals with AD had lower cognitive performances for all time and speed measures and scores worse on the ORDT. The Wechsler Digit-Symbol Substitution test score was the best cognitive measure to detect unsafe driving.	All participants were currently driving.

TABLE 2 (CONTINUED)

**Neuropsychological Tests as Predictors of On-the-Road Driving Tests (ORDT)**

Citation	Purpose	Sample	Measures	Findings	Comments
Lincoln, Taylor, Vella, Bouman, & Radford (2010)	To evaluate the accuracy of a test battery to predict driving ability in individuals with AD, and to assess whether it could be improved by being shortened	74 recruited, 65 completed ORDT, all had dementia except one with MCI	Standardized battery of tests and ORDT	A standardized battery of neuropsychological tests predicted driving performance with 76.2% accuracy.	All participants were currently driving.
Manning, Davis, Papandonatos, & Ott (2014)	To determine if CDT predicts driving performance	47 healthy older adults, 75 with cognitive impairment with possible or probable AD (CDR scores = 0.5 to 1)	CDT and ORDT	Findings revealed that CDT was significantly correlated with the driving score but receiver operator curve analyses showed limited clinical use of the CDT as a screening instrument for impaired on-road driving performance.	All participants were currently driving.
Ott, Festa, et al. (2008)	To determine if computerized maze performance is predictive of on-road driving performance	45 controls, 65 with probable AD, 23 with possible AD	Computerized maze tasks, other neuropsychological test battery, and ORDT	Road test scores significantly correlated with total time for five mazes. Logistic regression best model: maze total time + Hopkins verbal learning tests trial 1 + trials A + Age. Correctly classified participants 81% of the time.	12 participants who could not complete the road test and 11 who could not complete the computerized mazes withdrew.
Snellgrove (2009)	To describe the on-road driving performance of individuals with AD/MCI and validate a new maze task	23 with MCI, 92 with early-stage dementia	Maze task, interview, and ORDT	70% of participants failed the driving test. Approximately one half with MCI and 75% of those with early-stage dementia failed the road test. Maze task correlated predicted on-road driving ability. Accurately identified 79% of the drivers.	Dementia type was not specified. ORDT failure rate was higher than that in other studies perhaps due to varying types of dementia.
Yi, Lee, Parsons, & Falkmer (2015)	To determine if verbal, audio, or combination of both assisted individuals with AD in driving	28 with MCI due to AD or early-stage AD	Cognitive tests and simulated driving test using GPS in audio, audio plus visual, and visual only settings	Audio and audiovisual settings on GPS were most effective at helping individuals drive; visual attention was related to performance.	24% of participants had simulator sickness and dropped out. Conditions were not randomized. No control group.

Note: AD = Alzheimer's disease; TMT = Trail Making Test; MMSE = Mini-Mental State Examination; CDR = Clinical Dementia Rating; AD-8 = Ascertain Dementia 8-Item Informant Questionnaire; CDT = Clock Drawing Test; SBT = Short Blessed Test; MCI = mild cognitive impairment; GPS = global positioning system.



## Factors Associated With Driving Performance and Cessation

Because driving safety is a concern for many individuals with AD, research about ways to approach driving cessation and help those with AD and their families during the transition is imperative. The current authors found five studies that examined the process of decision making about driving cessation (**Table 3**).

*Provider Comfort and Involvement With Driving Cessation.* It is important that health care providers are prepared to discuss driving issues with their patients who have dementia. However, providers may not broach the problem with their patients. One study found that only 59% of physicians discussed driving with their patients with dementia and referred them for driving evaluation; physicians who addressed driving were in practice longer and stated they viewed addressing driving in their older adult population as part of their role (Adler & Rottunda, 2011). Adler and Rottunda (2011) recommended that “outreach efforts to inform and educate physicians to driving and dementia issues are needed” (p. 62).

*Driving Decision Making for Individuals With Alzheimer's Disease and Their Carers.* It is important to have an understanding of how individuals with dementia and their families make decisions about when to stop driving. Two qualitative studies found that driving cessation tends to occur in stages, ranging from noticing driving problems that affect safety to making adjustments to compensate for driving problems to finally making a decision to quit driving (Adler, 2010; Liddle et al., 2013). Surprisingly, Adler (2010) found that individuals with AD had not made plans for the future, reporting they hoped driving cessation would just happen.

Family members play a major part in determining when individuals with dementia should stop driving. Caregivers in one study rated their loved one with dementia on a survey as having *fair*, *poor*, or *unsafe* driving ability (Croston, Meuser, Berg-Weger, Grant, & Carr, 2009). Family members reported the majority of patients with dementia who stop driving do so because of encouragement from family and physicians due to declining cognitive abilities (Croston et al., 2009).

Many studies have reported barriers to driving cessation as a lack of insight to problem driving, the driver's personality, a belief that the individual with dementia was still safe on the road, concern of isolation without the ability to drive, and reluctance of the family to address driving cessation. Croston et al. (2009) found more than one half of patients retained their drivers' license although they no

longer drove; the reasons for this were not investigated. The studies reviewed indicated that there was a lack of support from the medical community when assisting patients with AD to cease driving. Few patients had a discussion or record of a discussion with their health care provider regarding this issue. Although driving screening was believed to be helpful in identifying the appropriate time to quit driving (Liddle et al., 2013), few patients were referred for driving evaluation (Adler, 2010; Croston et al., 2009). Adler (2010) found that an earlier diagnosis of dementia-related disease would have helped the dyad make long-term plans, such as when driving should cease. Liddle et al. (2013) found that dyads received conflicting advice and varying support between medical and community services.

Seiler et al. (2012) investigated the influence of cognition, function, and behavior on the decision to give up driving in participants with various types of dementia. Caregivers stated that it was their concerns about the individual's with AD driving safety that were the main impetus to stop driving. A small percentage of individuals with AD stopped driving due to accidents and the revocation of their drivers' license. One third of those with any type of dementia continued to drive. Typical neuropsychological indicators of dementia were not found to be helpful in determining driving cessation.

## Interventions for Driving and Driving Cessation

Evidence indicates that many individuals with MCI and AD continue to drive for some time after diagnosis, which places importance on interventions to improve driving safety. In addition, interventions to help individuals and their families determine how to stop driving and how to adjust to this major life change are needed. The search for interventions yielded only four studies that looked at ways to improve driving ability or help individuals with AD adjust to driving cessation (**Table 4**).

*Cholinesterase Inhibitors.* Cholinesterase inhibitors (ChEI) are frequently given to individuals with AD to delay some of the cognitive symptoms of the disease. Daiello et al. (2010) investigated the use of ChEI on visual attention and executive function in individuals with mild-to moderate-stage AD using a driving simulation test. Three groups were compared, including newly diagnosed AD participants who received ChEI at the beginning of the study, those who were already taking ChEI, and those who were not taking ChEI. The results showed several benefits of ChEI, including increased tracking ability in the simulated driving test, more accurate single-task activities, improved visual search accuracy, and faster comple-

**TABLE 3**  
**Factors Associated With Driving Performance and Cessation**

Citation	Purpose	Sample	Measures	Findings	Comments
Adler (2010)	To investigate how decisions are made about driving in individuals with dementia and their caregivers	20 drivers with dementia and their caregivers, 25 caregivers of former drivers	Focus groups	Themes included red flags noticed, compensation strategies developed, and plans to quit made. Spouses of former drivers had difficulty with the transition and were often instigators of driving cessation. Recommended that professionals should provide information and assist in conversations.	Suggestion to combine needs of patients with expertise of professionals to work together when making driving decisions.
Adler & Rottunda (2011)	To explore physicians' views on discussing driving with patients with dementia and their caregivers	239 physicians who worked with older adults	65-item questionnaire	59% of physicians surveyed discussed driving with patients and referred them for driving evaluation. Those who addressed driving were in practice longer and saw driving counseling as part of their role.	Resource available: American Medical Association's Physician's Guide to Assessing and Counseling Older Drivers
Croston, Meuser, Berg-Weger, Grant, & Carr (2009)	To understand driving status of individuals with dementia and gain insight on driving retirement	119 patient/caregiver dyads	Questionnaire	Caregivers concerned about driving ability of individuals with dementia. Driving cessation occurred due to recognition of cognitive decline and encouragement from family and providers. Barriers for driving cessation included poor insight into risks, personality and beliefs of safe driving, fear of isolation if unable to drive, hesitance of family to have a discussion, and no discussion from the provider about cessation.	One half of patients kept their license active; reasons were not investigated. Providers played a key role in driving cessation discussions.
Liddle et al. (2013)	To determine the best way to support individuals with dementia and driving cessation	4 retired drivers, 11 caregivers, 15 health care providers	Interview	Three stages of driving cessation included: early phase (driving concerns are noticed), crisis phase (high-risk driving and conflict about driving), and adjustment phase (individual with dementia adjusts to driving cessation). Participants recalled receiving conflicting advice, varying support. Sense of loss was also a prominent concern. Driving screening was reported to be helpful in identifying the appropriate time to quit driving.	Driving cessation was an individual process.
Seiler et al. (2012)	To study influences of cognition, function, behaviors, and caregiver characteristics on driving cessation	240 participants with various dementias	Questions for patients and caregivers, cognitive test battery, other measures	Approximately 60% of those with AD stopped driving. Cause of cessation for most participants was related to caregiver judgment of driving ability and not car crashes or other factors.	Confirmed 33% of patients with dementia continued to drive. No significant link between type of dementia and not driving.

**TABLE 4**  
**Interventions to Help Individuals With Alzheimer's Disease (AD) or Mild Cognitive Impairment (MCI) Adjust to Driving Cessation or Improve Driving Ability**

Citation	Purpose	Sample	Measures	Findings	Comments
Daiello et al. (2010)	To assess effects of ChEI on driving tasks	24 individuals with new diagnosis of early-stage AD, 35 with AD on ChEI, 35 with AD not on ChEI	Simulated driving test, visual search task, maze task	Benefits of ChEI included increased tracking ability in the simulated driving test, more accurate single-task activities, improved visual search accuracy, and faster completion of the mazes	11 with early-stage AD withdrew due primarily to intolerance. Any ChEI was acceptable. Simulation only, not ORDT.
Dobbs, Harper, & Wood (2009)	To test a program to help individuals with dementia and caregivers cope with the loss of driving	47 individuals with dementia who had license revoked, 30 caregivers	Measures of cognition, depression, interview data	The DCSG group had improved depression, quality of life, memory, and behavior compared to TSG. Loss of driving ability handled better in the DCSG group than in the TSG group. The DCSG group stated they were better equipped to cope with the loss of their driving privileges and were more likely to recommend the group to others.	
Stern et al. (2008)	To develop and evaluate a caregiver intervention for managing driving decisions in those with dementia	31 caregivers in the active intervention, 23 caregivers who received written information, 12 controls	Intervention with posttest	Active intervention group rated themselves significantly higher in their ability to handle driving cessation issues with the individual with dementia. They reported having an easier time accepting the circumstances, were more prepared to discuss driving cessation, and actively communicated driving cessation with care recipients with dementia.	Based off the At the Crossroads intervention (The Hartford, 2007)
Yi, Lee, Parsons, & Falkmer (2015)	To examine the effect of visual and verbal cues on simulated driving performance	28 individuals with mild/very mild AD	Battery of cognitive tests, driving simulator test	Driving performance was best in the audio-only setting, moderate in the normal setting, and lowest in the visual-only setting.	All participants currently drove at least 2 hours per week. Twenty-four percent of initial sample withdrew due to motion sickness.

Note. ChEI = cholinesterase inhibitors; ORDT = on-the-road driving test; DCSG = driving cessation support group; TSG = traditional support group.

tion of the mazes. Although the study did not directly test driving ability in an ORDT, it provided promising results supporting the possible effect of ChEI on the cognitive functions necessary for driving.

*Global Positioning Systems.* One study conducted by Yi, Lee, Parsons, and Falkmer (2015) examined the effect of visual and verbal cues plus verbal global positioning systems (GPS) on a simulated driving test in individuals with very mild to mild AD. Results showed a significant difference between the GPS conditions, with the best driving performance in the audio-only condition. The researchers hypothesized that the increased demands on visual attention with the visual GPS settings could have impaired the driving performance.

*Support Groups.* Two studies examined the effect of support groups on adjustment to driving cessation. Dobbs, Harper, and Wood (2009) investigated the benefit of two types of support groups (driving cessation-specific support group versus general AD support group) for individuals with early-stage dementia who had their drivers' license revoked. Although all participants rated the support groups as helpful, the findings supported the driving cessation-specific support group as better at equipping participants to cope with the loss of their driving privileges.

Although the current literature review is limited to studies about individuals with dementia and excluded studies about caregiving, one study with caregivers was included because it assessed the effect of an intervention involving caregiver education on addressing driving issues in individuals with AD. Stern et al. (2008) conducted a randomized controlled trial with caregivers of individuals with MCI, AD, or other dementias, in which participants were randomly assigned to either a psycho-educational intervention, written information, or control group. Results showed that caregivers in the educational intervention group scored higher in self-efficacy, communication, and ability to address driving cessation with the individual with dementia than those in the other two groups. In addition, almost all of those in the education group reported speaking with their loved ones about driving cessation during the course of the study. Thus, Stern et al. (2008) concluded that there was strong evidence that the intervention was effective in helping caregivers address the issue of driving cessation with their loved ones and that written materials alone are not as effective as intervention. Taken together, the two studies on support groups give beginning evidence that support groups aimed specifically at driving cessation strategies may be beneficial for individuals with dementia and their families.

## DISCUSSION

The current literature review focused on individuals with MCI and early-stage AD, which is a time when many of them are still driving. A consistent finding was that some individuals with MCI or early-stage AD may be able to drive safely for a time; a diagnosis of MCI or early-stage AD does not necessitate driving cessation immediately. As the disease progresses, individuals with MCI or AD are more likely to have impaired driving (Ott, Heindel, et al., 2008; Wadley et al., 2009); thus, driving assessment should be ongoing.

Findings from the current review do not completely answer the question of how to know when individuals with MCI or AD are safe to drive. A weakness of the existing literature is that most driving studies only include individuals who are still driving and who have been formally diagnosed with MCI or AD (often at a memory clinic). Because only approximately one half of individuals in the community who have AD are formally diagnosed (Alzheimer's Association, 2015), the studies are limited in their generalizability. Only one study looked longitudinally at how driving changed over time for controls and individuals with AD (Ott, Heindel, et al., 2008). However, this study also only included those who were currently driving, which is necessary when doing an ORDT to avoid injury. However, the literature does not provide an explanation for how individuals with MCI or AD who are still driving are different from those who have stopped driving.

One way to help identify individuals who need a driving assessment may be to conduct neuropsychological testing. Many neuropsychological tests show a correlation with driving performance, but no single neuropsychological test or test battery is sufficient to determine driving safety. A combination of tests, including those for visual spatial ability, memory, information processing, and executive functioning may support the clinician's decision about whether a road test is necessary (Aksan et al., 2011; Anderson et al., 2012; Carr et al., 2011). In addition, performance on these tests may eventually help provide information about future types of interventions, such as specific cognitive training exercises, that may help improve driving ability in individuals with MCI or AD.

Evidence exists that carers of individuals with dementia find driving cessation to be a long process that largely falls on them to address, yet they are not always prepared for this task or supported by health care providers (Adler, 2010; Croston et al., 2009; Seiler et al., 2012). Individuals with AD and their carers look to their providers for help with driving cessation and it is a major concern for many.

Because driving skills decline progressively and start early in the disease process, health care providers must assess driving concerns for all patients who have MCI or AD. Some individuals have significant driving safety problems even with MCI (Frittelli et al., 2009; Wadley et al., 2009). Health care providers must be cognizant of risk factors that precipitate unsafe driving and collaborate with carers to determine the safest course of action when addressing the need to cease driving. Care providers must be knowledgeable about the expected trajectory of driving ability for individuals with MCI/AD, along with the resources and referrals in the community that can help provide support for patients and their families.

Few studies examined interventions to help individuals with AD drive more safely or maintain driving ability. Only two studies were found that examined ways to help individuals with dementia drive more safely. One study examined the effect of ChEI (Daiello et al., 2010) and the other examined different types of GPS displays (Yi et al., 2015). The lack of intervention studies is possibly due to the assumption that once individuals are diagnosed with AD, they cease driving. Until 2010, the prevailing clinical recommendation was that individuals with early-stage dementia should be counseled to quit driving due to safety concerns (Lyketsos et al., 2006). Currently, the American Academy of Neurology has practice recommendations that give guidance on assessing individuals with dementia for driving safety, which state that the stage of dementia, caregiver concerns about the patient's driving, driving history, driving behaviors (e.g., reduced driving), personality characteristics, and Mini-Mental State Examination scores (<24) are indicators of potentially unsafe driving (Iverson et al., 2010). Thus, the recommendation is no longer that individuals with AD should be automatically counseled to quit driving.

Individuals with AD have a disease that affects cognitive abilities, but they are also aging. There has been substantial research on the effects of aging on driving, which is likely applicable to individuals with AD. For example, there are evidence-based occupational therapy guidelines about improving driving for older adults (Stav, 2015), in which in-class educational sessions and individualized on-the-road training are rated the highest level of evidence to reduce unsafe driving in older adults. In addition, interventions such as cognitive training, physical fitness training and exercises, simulator training, and automobile modifications are recommended to improve safe driving. These interventions could be tested in individuals with AD along with modifications to support cognitive ability.

There is beginning evidence that support groups are effective in helping individuals with dementia and their caregivers address and adjust to driving cessation. One study found that engaging in a formal driving support group after the loss of a driver's license helped individuals with AD cope with the transition (Dobbs et al., 2009). In addition, supporting caregivers with a psycho-education group class specifically focused on driving cessation may improve their ability to address and cope with driving cessation with their loved ones with dementia (Stern et al., 2008). The common feature of these two studies is that the intervention was specifically aimed at driving cessation versus a general support group for dementia.

### LIMITATIONS AND STRENGTHS

There are several limitations that must be considered in this review. The review only included English language studies, which may have limited some of the available knowledge about the topic. In addition, most studies included only participants who were still driving, thus the significant cognitive, functional, and behavioral changes that occurred prior to driving cessation were unable to be detected. A weakness of many of the studies is that they included small convenience samples of individuals with AD/MCI. These individuals, often coming from a specialty memory clinic, may be different than those who have AD/MCI but are not diagnosed early in the disease. Many studies used ORDT, but did not indicate whether the driving evaluator was blinded to the study group, which may also have induced some bias. Some studies did not clearly indicate participants' diagnoses (i.e., type of dementia and stage), and several did not use standardized criteria for diagnosis, making the interpretation of the results challenging.

A strength of the current review is that it included qualitative and quantitative studies to give a breadth and depth to the understanding of driving in dementia. According to Whitmore and Knafl (2005), an integrative review that uses different types of sources "contributes to the presence of varied perspectives on a phenomenon of concern and has been advocated as important to nursing science and nursing practice" (p. 547). The current integrative review was based on a systematic literature search, clear inclusion and exclusion criteria, evaluation of the literature (including quality), and synthesis of the studies using a thematic method. Using a clear and systematic approach to the literature review enhances rigor (Whitmore & Knafl, 2005).

## PRACTICE IMPLICATIONS

Practice implications from the current integrative review include:

- Early diagnosis of MCI and AD should be advocated to address driving abilities early in the disease (Davis et al., 2012; Frittelli et al., 2009).
- A diagnosis of MCI or early-stage AD should not automatically result in a loss of driving privileges; some individuals with MCI and early-stage AD are safe to drive for a time (Ott, Heindel, et al., 2008; Wadley et al., 2009).
- ORDT remain the gold standard for driving assessment. However, neuropsychological testing involving visual-sensory function, memory, visual spatial abilities, and speed of information processing may inform practitioners of a need for testing (Aksan et al., 2011; Anderson et al., 2012; Carr et al., 2011).
- Individuals with MCI/early-stage AD require routine assessment of driving ability (Ott, Heindel, et al., 2008).
- Health care providers may benefit from education about driving in dementia so that they have the skills necessary to counsel patients and families (Adler & Rottunda, 2011).
- Family members are almost always involved in the driving decision making, yet would value more provider input in the decision (Adler, 2010; Croston et al., 2009; Liddle et al., 2013; Seiler et al., 2012).
- Support groups aimed at driving cessation and adjustment may help individuals with dementia and their families to have the resources necessary to make appropriate driving decisions (Dobbs et al., 2009; Stern et al., 2008).

## SUGGESTIONS FOR FUTURE RESEARCH

The current authors have several suggestions for research. Researchers should use a standardized definition of MCI and AD when classifying participants. Several studies did not clearly classify the type or stage of dementia. The cause of the dementia (e.g., AD, vascular) should be identified for all participants and included in analysis. Longitudinal designs should be used to track the progression of the disease over time (before driving cessation) in relation to cognitive performance and other factors, eliminating the problem of only including existing drivers in studies. In addition, the use of driving simulators to test driving ability can be used in all individuals without having to be concerned about safety.

Because individuals with AD and MCI often continue to drive, intervention studies to help them maintain safety

are needed. Safety studies could include multicomponent interventions, such those focused on functional ability, in-car safety technology, cognitive exercises aimed at deficient cognitive mechanisms, and counseling to limit or modify driving behaviors. Because one study found that ChEI impacted the cognitive processes involved in driving (Daiello et al., 2010), this should be studied further to determine its efficacy in prolonging safe driving in individuals with AD. Further studies analyzing the effects of GPS on driving are necessary to determine if this is a feasible intervention to keep drivers with early AD safe while driving.

In terms of driving testing, research on alternatives to ORDT and/or the correct timing of an ORDT is needed. It is not known how many individuals with dementia are tested or how many barriers exist to testing, such as cost and fear of losing one's license. Policies regarding standardized driving testing in adults with AD and financial coverage of ORDT should be considered. Appropriate screening tools for primary care providers should be developed and tested for an indication for further driving assessment. Specific cutoff scores for cognitive tests should be tested to make them applicable for practice. Methods to effectively educate health care providers, patients, and families about driving safety and cessation must be studied further.

## CONCLUSION

The current literature review shows the complex nature of driving cessation in early-stage AD. There is more work to be done in this area to best support individuals with dementia and their carers. No single cognitive or physical test is a strong predictor of driving ability. Diagnosis of MCI or AD does not necessarily mean that individuals must immediately stop driving. Evidence suggests that some individuals with MCI or early-stage AD can drive safely for a time, but that as the disease progresses, driving ability declines. Families look to providers to assist with crucial driving conversations when individuals with AD become unsafe to drive. All caregivers require support from the health care team and community when making difficult decisions, such as when it is time for the individual with dementia to stop driving. Further studies are required to test new technology and other interventions for their role in driving safety.

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