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# M-CASTL 2009 SYNTHESIS REPORT: OLDER ADULT SAFETY AND MOBILITY

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16. Abstract

The purpose of the annual M-CASTL synthesis report is to identify short and long-term research needs that support M-CASTL's theme and reflect the United States (US) Department of Transportation's (DOT's) and other National organization's transportation research agendas. The intent of the report is to provide a synthesized background to help focus the Center's research program and to maintain continuity over each year of the grant. The synthesis report also serves as the background for the annual M-CASTL Transportation Research and Education (TR&E) conference. The report reviews the facts that older adults are at higher risk of a fatal crash and tend to suffer many negative consequences when driving privileges are taken away. This report conceptualizes the issues of aging and mobility as having three complementary and interdependent goals: (1) to understand and better manage the effects of medical conditions and medications on skills needed for safe driving; (2) to help those who are able to drive safely continue to do so; and (3) to identify and provide community mobility support to those who are no longer able to drive.

This report further reviews background and recent research in several areas related to the three goals: medical conditions; medication; extending safe driving; driver licensing issues; transitioning to non-driving; and alternative transportation options. The research reviewed in this report was gathered from a search of articles published in late 2007 through February, 2009 in several peer-reviewed journals and conference proceedings. This report builds upon two recent reviews of the aging and mobility literature (Eby, Molnar, & St. Louis, 2008; Eby, Molnar, & Kartje, 2009) and serves as a companion to those reports.

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## INTRODUCTION

As discussed in several recent publications, driving is a privilege but safe mobility is a basic human right (Eby, Molnar, & Kartje, 2009; Molnar & Eby, 2008a). The theme of the Michigan Center for Advancing Safe Transportation throughout the Lifespan (M-CASTL) is **Safety and Mobility throughout the Lifespan**. M-CASTL is dedicated to advancing expertise and technology in the many disciplines comprising the safety and mobility of both young people and older adults. Through its various programs and partnerships, M-CASTL works to increase understanding of and address—across the different dimensions of the roadway, vehicle, and driver—the risks and mobility issues related to the two ends of the age spectrum. The specific thrusts of the Center focus on understanding and addressing: the changing perceptual, cognitive, and psychomotor abilities of older drivers; and the transportation needs of older adults when they are unable or choose not to drive themselves; and the elevated crash risk of young drivers. This synthesis report concentrates on the older end of the age spectrum, highlighting research needs for older adult safety and mobility.

The purpose of the annual M-CASTL synthesis report is to identify short and long-term research needs that support M-CASTL's theme and reflect the United States (US) Department of Transportation's (DOT's) and other National organization's transportation research agendas. The intent of the report is to provide a synthesized background to help focus the Center's research program and to maintain continuity over each year of the grant. The synthesis report also serves as the background for the annual M-CASTL Transportation Research and Education (TR&E) conference. Because the M-CASTL 2008 synthesis report (Eby, Molnar, & St. Louis, 2008a) and a recently published book (Eby, Molnar, & Kartje, 2009) covered extensively the current state of knowledge and research needs on older adult mobility, the 2009 report focuses on newly published findings and recent published priorities of various national organizations that are interested in older adult safety and mobility. As such, this report is a companion report to the 2008 synthesis report which is available at: http://m-castl.org/node/4.

The 2008 synthesis report (Eby et al., 2008a) described the coming societal challenges for keeping older adults safely mobile. The US and many other countries are experiencing a dramatic increase in the population of people 65 years of age or older, primarily because the baby boomers are reaching older adulthood. This report also summarized data showing that older adult baby boomers are likely to take more trips and drive more miles in a motor vehicle than previous cohorts of older adults.

### Self-Regulation

Eby et al. (2008a) also discussed how driving patterns change as people age, often referred to as "self-regulation" of driving. When compared to younger drivers, older adult drivers are more likely to avoid difficult driving situations (e.g., nighttime, inclement weather, high traffic times, urban areas, and highways) and often make other adaptations to driving (e.g., driving slower, driving more often with a passenger, avoiding unprotected left turns across traffic, taking larger traffic gaps for merging, and more frequent use of a safety belt). The authors discussed how there is considerable variability in the extent and types of self-regulation reported in studies. In addition, the evidence linking self-regulation to reduced crash risk is inconclusive, due in part to the limited number of studies that have been undertaken and the reliance on retrospective data on crash involvement.

## Crash Risk

Eby et al. (2008a) discussed the various ways in which crash risk for older adult drivers has been conceptualized. The authors discussed how older adults as a group have the fewest number of fatal crashes. When these crashes are expressed as a function of population, miles driven, or number of licensed drivers, older adults have higher fatal crash rates than all other drivers except for the youngest drivers. The rates for older adults are still high even when corrected for the increased frailty associated with aging. The synthesis also discussed the "low-mileage bias;" that is, crash rates per mile driven may be biased upward for older drivers because of their tendency to self-restrict total miles driven (Alvarez & Fierro, 2008; Hakamies-Blomqvist, 2004; Hakamies-Blomqvist, Raitanen, & O'Neill, D., 2002; Langford, Fitzharris, Newstead, & Koppel, 2004; Langford, Methorst, & Hakamies-Blomqvist, 2006). This work found that only those older adult drivers who traveled less than about 3000 km per year have an elevated crash rate (about 10 percent of the population in the Langford, Methorst, and Hakamies-Blomqvist, 2006, study).

Staplin, Gish, and Joyce (2008) recommended caution in interpreting the findings of the low-mileage bias studies noting that both the crash and mileage data are self-reported in the studies. Staplin et al. (2008) presented data showing poor reliability of self-reported annual mileage estimation within subjects as well as data showing large errors in estimation of annual mileage when compared to an objective measure (odometer readings). In response to these concerns, Langford, Koppel, McCarthy, and Srinivasan (2008) reanalyzed crash data from a previously published study (Langford et al., 2006) using odometer readings instead of self-report to estimate annual distance traveled. They still found evidence for the low-mileage bias, but it was lesser in magnitude than in the previous study.

Several other studies addressing the issue of crash risk among the older adult population are in progress or have been published recently. A study in Canada (Tay, 2008) examined how the increasing number of aging baby boomer drivers may affect societal injury crashes. The study examined 14 years of crash and driver data from the Province of Alberta, Canada (1990-2004). The data showed an 82 percent increase in the number of older drivers during this time period. The author developed a Poisson regression model to separate the effects of age and other variables on injury crashes. The results showed that as the mix of drivers on the roadway became increasing older, the number of injury crashes increased. The study did not consider fatal or property-damage-only crashes.

Tefft (2008) examined the issue of what crash risks older drivers pose to themselves and others on the roadway. The author examined 5 years of crash data from the US DOT's Fatality Analysis Reporting System (FARS) and 1 year of travel data from the National Household Travel Survey (NHTS). The study examined all drivers in fatal crashes during 1999-2003 and assigned responsibility to the crash in which each driver was involved. Responsibility was assigned based on driver-related factors identified by police as contributing to the crash and other criteria. The risks that drivers of a certain age group posed to themselves or others was determined by dividing the annual average number of deaths assigned to an age group by the estimated travel exposure of that age group. Tefft found that: drivers' risk to themselves and others decreased up to age 65 and then increased, with rapid increases in risk after age 75; drivers aged 85 and older had the highest rate of death; and older drivers posed more risk to their passengers, occupants

of other vehicles, and non vehicle occupants than drivers under age 65, although the magnitude of risk was different depending on the exposure measure used (per-driver, per-trip, and per-mile).

Two recent studies examined the circumstances under which older adults are involved in fatal crashes (Awadzi, Classen, Hall, Duncan, & Garvan, in press Skyving, Berg, & Laflamme, 2009). Awadzi et al. (in press) analyzed crashes in FARS data as a function of several person, vehicle, and environmental variables. Using logistic regression analysis, the authors found that when compared to younger drivers, the fatal crash risks were greater for older drivers under the following conditions: crash impact at the passenger door behind the driver; and between 8 am and 8 pm. The Skyving et al. (2009) study examined Swedish national crash data and analyzed all crashes in which an older driver received a fatal injury. Skyving et al. (in press) identified crash patterns using cluster analysis on a subset of 12 variables related to driver and crash event characteristics. They identified five scenarios (clusters) where older drivers tended to die: driver died of natural causes (19.7 percent); men making left turns in low speed areas on weekends (30.6 percent); women making left turns on dry roads on moderate speed roadways (21.5 percent); head-on and single-vehicle crashes on dry, high speed roads (29.8 percent); and winter on high speed roads (18.2 percent). Both of these studies showed that fatal crashes involving older drivers tended to occur under good driving conditions, which is consistent with what we know about older driver self-regulation—older adults tend to restrict their driving to time, places, and situations in which they are most comfortable driving.

A study by Bao and Boyle (2009) investigated visual scanning deficits among older drivers as a possible factor in crashes at median-divided highway intersections in rural areas. The investigators conducted an on-road study of young-, middle-, and older-aged drivers using a vehicle instrumented with technology that measured a variety of driving behaviors including visual scanning. All participants executed several maneuvers at two rural intersections in Iowa: left turn; right turn; and driving through with no turns. All visual scanning behavior was measured. The study found that older drivers, when compared to middle-aged drivers: did not utilize the full scanning range; exhibited greater reductions in scanning when turning; showed significantly less scanning to the left and right; and utilized their rearview mirror significantly less. The authors concluded that because older drivers had significantly fewer glances in the direction of their turn, they may have a greater likelihood of a critical incident.

Despite the discussions of the low-mileage bias, current and on-going research is confirming that older adults, as a group, are at a higher risk for a fatal crash and that crashes for this age group tend to occur at times and places that are typically considered to be safe. It is important to remember, however, that population-level crash statistics do not predict the crash risk of any individual driver. Older adults are unique in the medical conditions they are experiencing, level of driving skills, and personality—all factors which can influence individual crash risk.

## Mobility Needs

Despite the increased crash risk for the population of drivers age 65 years and older, society needs to ensure the safe mobility of its older citizens. If society decided to revoke individuals' driver licenses at age 65, the crash risk for older adults could be reduced to zero. This "solution" ignores the fact that only some older people are unfit to drive; some older adults can improve their skills through training; and older people, like

all people, have mobility needs that still need to be satisfied if driving is no longer possible.

Eby et al. (2008a) noted that: older adults are reluctant to give up driving and consider it to be essential to independence and quality of life; driving provides an opportunity for older adults to stay engaged in their community and to participate in activities that enhance their well being, particularly in areas where alternative transportation options are limited; and driving cessation is associated with a host of negative physical and mental outcomes. Given the reliance on and preference for personal automobile travel, the decision to revoke one's license should not be made lightly. In addition, society must recognize that alternatives to the personal automobile are generally poor and unacceptable to many older adults. The mobility needs for older adults who can no longer drive still need to be met. With these facts in mind, many in the field of transportation and aging conceptualize the issues as two complementary and interdependent goals: (1) to help those who are able to drive safely continue to do so; and (2) to identify and provide community mobility support to those who are no longer able or choose not to drive (Dickerson, et al., 2007; Eby et al., 2008a, 2009; Molnar, Eby, & Dobbs, 2005). Here we add a third goal which, to an extent, underlies the first two goals: (3) to understand and better manage the effects of medical conditions and medications on skills needed for safe driving.

The remainder of this report reviews background and recent research in several areas related to the three goals: medical conditions; medication; extending safe driving; driver licensing issues; transitioning to non-driving; and alternative transportation options. The research reviewed in this report was gathered from a search of articles published in late 2007 through February, 2009 in several peer-reviewed journals and conference proceedings. Only those articles deemed by the authors to be fundamental to one of the three goals are reviewed.

## MEDICAL CONDITIONS

Eby et al. (2008a) discussed a number of medical conditions associated with increasing age in older adulthood that can increase the risk of a crash. The authors discussed how it is not the medical condition itself that raises the risk of a crash, but rather how the condition influences functional abilities—those abilities needed to execute critical driving skills. A number of medical conditions were identified including: diabetic retinopathy; congestive heart failure; abnormal blood pressure; sleep apnea; Parkinson's disease; diabetes mellitus; chronic obstructive pulmonary disease; dementia; and depression. Table 1 summarizes the findings from Eby et al. (2008a).

**Table 1: Synthesis of Research on Medical Conditions and Driving (From Eby et al., 2008a)**

| Condition | Description | Synthesis |
|---|---|---|
| **Diabetic retinopathy** | Leading cause of blindness in US | No research on driving ability or crash risk |
| **Congestive heart failure** | 10 percent of older adult population | No research on driving ability or crash risk |
| **High blood pressure** | Common in older adults; many undiagnosed | Well-managed should not affect driving and crashes |
| **Sleep apnea** | Disturbed sleep patterns | Associated with poor driving and increased crashes |
| **Parkinson's Disease** | Average age of onset is 60 | Associated with poor driving; little work on crash risk |
| **Diabetes Mellitus** | 21 percent of people age 60 and older have diabetes. | Can affect driving ability; little work on crash risk |
| **Chronic obstructive pulmonary disease** | 4th leading cause of death for age 65-84 | Little research on driving ability or crash risk |
| **Dementia** | Occurs almost exclusively in older adults | Clear evidence of increased crash risk |
| **Depression** | 4-6 percent of older adult population | Untreated: Poor driving performance; may also increase crash risk |

Marshall (2008) conducted a review of the literature to evaluate the impact of specific medical conditions and associated impairments on older driver crash risk. He found relatively high agreement on which medical conditions increased crash risk, at least to some degree. These conditions were: alcohol abuse/dependence; cardiovascular disease; cerebrovascular disease; depression; dementia; diabetes mellitus; epilepsy; use of certain medications; musculosketal disorders; schizophrenia; sleep apnea; and

vision disorders. The author clarified these findings by pointing out that determining fitness to drive for an individual based on diagnosis has significant limitations related to multiple medications use, severity of disease symptoms, and level of functional impairment. He concluded, however, that a diagnosis of certain medical conditions can serve as a warning sign for reduced fitness to drive, but many people with these conditions can still be safe drivers.

Silverstein, Splain, et al. (2008) presented preliminary data from an on-going study investigating fitness to drive in early stage dementia at the Gerontological Society of America (GSA) conference. This study is recruiting subjects with a diagnosis of memory impairment who have been cleared to drive by a certified driving rehabilitation specialist (CDRS) after clinical and on-road assessment. The subjects' own vehicles are being fitted with monitoring technology (e.g., cameras, forward radar, GPS) so that driving performance can be monitored for a period of at least 1 month. Recruited along with each subject is his or her family member and the CDRS who completed the assessment. Collectively, the three make up a triad. After the driving portion of the study, the triad meets with the research team and is presented with an objective summary of the monitored driving. This summary consists of data on specific driving skills including wayfinding, responses to traffic control devices, speed control, use of belts and signals, and many other behaviors. Pre and post surveys are being used to assess changes in how each of the triad views the dementia patient's ability to drive safely. Full results should be available in late 2009.

Researchers from the University of Iowa have also been using instrumented vehicles to better understand the effects of early stage dementia on driving (Dawson, Anderson, Uc, Dustup, & Rizzo, 2009). In their study, 40 people with early stage dementia and 115 people without cognitive impairment participated in a battery of cognitive, visual, and psychomotor tests and drove a standardized 35-mile route in an unfamiliar vehicle instrumented with technology to gather objective driving performance data. The study found that early stage dementia drivers made significantly more errors when compared to drivers with no cognitive impairment, with lane keeping errors occurring most frequently. The study, interestingly, also found that dementia drivers performed better than non-impaired older drivers at railroad crossings. Cognitive and visual scores in the clinical testing were also predictive of safety errors for early stage dementia patients. It is not clear what the implications of these findings are for actual driving safety and crash risk. It is well known that early stage dementia patients have difficulty with new surroundings, and being asked to drive an unfamiliar vehicle may have led to driving errors that they would not have committed in their own vehicle. Further, many older adults, particularly those with mild cognitive impairment, restrict their driving to familiar places. Testing driving performance in unfamiliar places does not necessarily capture an accurate picture of traffic safety for this group, as they may not make the same driving errors in a familiar area. Nevertheless, much more research is necessary to understand the relationship among early stage dementia, driving performance, and crash risk.

The literature on the effects of age-related medical conditions and driving continues to grow. For a number of reasons, determining the effect of a specific condition on crash risk is difficult. There are few clear-cut cases in which older adults with medical conditions can be ruled either safe or unsafe to drive simply on the basis of the medical condition. For older adults with a medical condition, the decision to drive should be made based on the advice of a physician, a driving professional, and possibly a family

member. As discussed elsewhere in this report, each driver is unique, and these personal variables should be taken into account when examining transportation safety and mobility issues on an individual level. Further, this report, and much of the new research, treats each condition separately, although many people have multiple (co-morbid) conditions. Very little research has considered the combined effects of co-morbid conditions or how various treatment options affect traffic safety and mobility. These issues are fertile areas for future research.

## MEDICATIONS

The M-CASTL 2008 synthesis report (Eby et al., 2008a) reviewed what is known about several classes of drugs and their effects on driving. Three drug classes were reviewed: benzodiazepines, antihistamines, and antidepressants. Eby et al. (2009) noted that the relationship among aging, medication use, and driving ability is extremely complex. Although medications can impair driving for any age group, older adults may be overly affected by medication use for several reasons: they are more likely to use multiple medications; they are more likely to use herbal and other non-regulated supplements; medications tend to metabolize more slowly as one ages; and the medications may have a greater effect on an individual as he or she ages. In addition, medications are given for specific medical conditions. Therefore, medications have both a therapeutic effect (the intended effect) and side effects (unintended effects)—both types of effects can influence driving either positively or negatively. Table 2 shows the drug classes, the therapeutic use, and the synthesis of the research on the use of the drug and driving from two previous reviews (Eby et al., 2008a, 2009).

**Table 2: Synthesis of Research on Medications and Driving (From Eby et al., 2008a, 2009)**

| Medication Class | Therapeutic Use | Synthesis |
|---|---|---|
| **Benzodiazepines** | Central nervous system depressant (e.g., tranquilizer) | Driving performance declines with increased levels of the drug. Some evidence that crash risk is elevated among older adults. |
| **Antihistamines** | Relief of allergic reactions | Affects driving performance and crash risk primarily due to the sedative/drowsiness side effect. Non drowsy antihistamines are available. |
| **Antidepressants** | Treatment for severe/clinical depression | Affects driving performance and crash risk primarily due to the sedative/drowsiness side effect. Non drowsy antidepressants are available. |
| **Opioid Analgesics** | Pain relief | Driving performance declines in early treatment phase or with increase in dosage. Once tolerance is reached, driving performance improves back to pre-drug levels. |
| **Antidiabetics** | Treatment for diabetes mellitus | No effect on driving performance or crash risk unless incorrect dose causes hypo- or hyper-glycemia. |

The US DOT's National Highway Traffic Safety Administration (NHTSA) has been interested in this topic, especially the effects of multiple medication use on crash risk, and has published two recent reports (LeRoy & Morse, 2008; Staplin, Lococo, Gish, & Martell, 2008). One study investigated the associations between multiple medication use, drug interactions, and drug-disease interactions on motor vehicle crashes (LeRoy &

Morse, 2008). The study compared data from the National Ambulatory Care Survey (NAMCS), an annual survey of use of medical care services in the US, with a pharmaceutical claims-linked, patient-level database (PharMetrics). Using a case-control analysis, the study found several outcomes for people age 50 and older:

- People using specific driver-impairing medications are more likely to be involved in a motor vehicle crash than those not taking the medications. The drug classes with at least double the likelihood of being involved in a crash were: barbiturates (Odds Ratio, OR=7.50); antihistamines (OR=3.00); non-narcotic antitussives for treating coughs (OR=2.23), narcotic analgesics (OR=2.22), antipsychotics (OR=2.20), skeletal muscle relaxants (OR=2.09), and anti-anxiety drugs (OR=2.0);
- Several drug-interaction conflicts were found to increase crash risk, even though many had too few cases to make a full assessment. Those drug conflicts that were found to increase the likelihood of a crash by at least 10 times when compared to no drug interactions were: anticonvulsants/antifungal (OR=21.0); serotonin-norepinephrine-reuptake inhibitors/quinolones (OR = 21.0); muscle relaxants/antipsychotics (OR=18.0); antidiabetics/sulfonamides (OR=15.0); serotonin-specific-reuptake inhinitors/α-2 receptor-antagonist antidepressants (OR=15.0); anticonvulsants/belladonna alkaloids (OR=12.00); and tricyclic antidepressants/antipsychotics (OR=10.5).

LeRoy and Morse (2008) described several limitations of the study including the facts that people age 50 and older were analyzed rather than those age 65 and older, prescription-filling data do not necessarily equate to actual consumption, and exposure data were lacking. Nevertheless, this study represents the most comprehensive assessment of medication use and crash risk, and highlights many of the difficulties encountered when investigating this topic.

The second NHTSA-sponsored study (Staplin et al., 2008) was, among other objectives, a pilot study to determine how driving abilities are affected by certain combinations of medications. The study recruited 44 active, community dwelling older drivers who were at least 55 years of age. All participants had to meet strict eligibility criteria regarding the amount of driving (3 days or more per week), medications use (ACH inhibitor type blood pressure medication AND medication for at least one other specified medical condition), crash history (none in past 5 years), and no presence of diseases that can cause loss of consciousness. Subjects also had to be willing to complete several tests and exercises, complete a review of their medications use with a pharmacist, and complete a behind-the-wheel evaluation with an occupational therapist. In addition, a subset of subjects had to allow instrumentation to be installed in their vehicle to record objective driving behavior for a week. Not surprisingly, the investigators had great difficulty recruiting participants. Among several other analyses, the study examined the use of potentially-driver-impairing medications on functional deficits (determined by clinical assessment) and driving performance (determined by behind-the-wheel and, for a few subjects, instrumented vehicle data). In general, the study found no significant or consistent effects of medication use on functional deficits or driving performance. The study also did not show significant effects of functional deficits on driving performance. The investigators rightly pointed out several reasons for a lack of significant findings: the study was a pilot with relatively few participants, the inclusion criteria were strict, and healthy participants were the most likely to be willing to participate in a study in which driving was assessed. The authors concluded "…results indicate that small-sample empirical investigations are not likely to be the most practical route to a better

understanding of (multiple) medications and driving impairment" (Staplin et al., 2008, pg 89).

Past and current research on the effects of medications on driving continues to highlight the difficulties of studying this topic. The new studies sponsored by NHTSA have made great strides in developing methods for addressing the effects of multiple medications on driving safety, yet more work is needed. Research has generally studied "drug classes" rather than specific medications. This is due, in part, to the constantly changing pharmacopeia--new medications are always being introduced to the medical field and older drugs are being discontinued or infrequently prescribed. In general, new drugs are not being evaluated before they are released on how they affect driving performance or crash risk, and traffic safety research lags several years behind new drug development. At the same time, drug companies should strive to develop drugs that do not produce the two side effects that clearly relate to decreased traffic safety in older adults: drowsiness and sedation.

## EXTENDING SAFE DRIVING

Given the preference for driving a personal automobile for satisfying transportation needs, and the lack of effective alternatives, there is a strong incentive for keeping older adults driving for as long as they can safely do so. Here we review the latest research and thinking on the many issues and countermeasures designed to extend safe driving for older adults.

### Screening and Assessment

The evaluation of driving fitness can be controversial and emotionally charged. As discussed in Eby et al. (2008a), decisions about driving fitness require accurate and meaningful information about the changes in driving-related abilities people may experience and how these changes affect safe driving. Eby et al. (2008a) and others (Eby et al., 2009; Molnar & Eby, 2008a; Staplin, 2008) distinguish between screening and assessment procedures. Screening represents the first step in identifying potentially at-risk drivers and is intended to identify gross and nonspecific functional impairments. The screening process may prompt self-regulation of driving or non driving actions to extend safe driving, or it may lead to in-depth assessment. Screening results, by themselves, should not be the basis for licensing actions. In-depth assessment, on the other hand, is used to determine the level and cause for an observed impairment and is needed to support decisions about whether someone should continue driving and under what conditions. Collectively, screening and assessment contribute to a comprehensive, multi-faceted approach for identifying older drivers who may be at risk.

Eby et al. (2009) presented a conceptualization of the fitness-to-drive evaluation process. According to their model, driver evaluation can take place in three venues: home/community; clinical settings; and driver license agencies. In each of these settings, there are various people who conduct the screening or assessment. The potentially unsafe older driver is generally first identified in his or her community, either through someone observing unsafe driving, an incident such as a crash, or the driver noticing a potential driving problem. In all cases, either formal or informal screening is taking place. At this point the driver may be referred to the licensing agency, or may voluntarily seek medical evaluation, participate in an education and rehabilitation program, or self-regulate his or her driving.

Assessment of driving is often triggered by a screening process that identifies potentially unsafe drivers. Assessment is a process that can take place in more than one setting and be administered by more than one person. According to the Association of Driver Rehabilitation Specialists (ADED, 2002), Carr (2004), and Wheatly and Di Stefano (2008), this assessment generally consists of a clinical evaluation, an on-road evaluation, and post-evaluation recommendations. The assessment may be conducted by an occupational therapist (OT), a physician, or other health professional.

NHTSA (2008b) is actively planning and currently funding several projects related to screening and assessment, according to its “Older Driver Traffic Safety Plan.” These projects are:

- *Validate Assessment Procedures and Tools*: The two goals of this research are to develop an evidence-based assessment tool that can detect at-risk drivers and to develop evidence-based assessment guidelines for professionals.

- *Determine Outcomes of Using Various Self-Screening Tools*: The goals of this project are to examine several existing self-screening instruments to determine if they accurately identify risk factors, lead to changes in behaviors, and impart safety benefits or costs.
- *Understanding Factors that Influence Consumers' Decisions to Continue or Discontinue Driving*: The goal of this project is to determine what can be done to encourage and foster the use of assessment and rehabilitation in the older adult population.
- *Increase Capacity to Assess Older Drivers*: The goal of this project is to promote the evidence-based findings of the previously mentioned projects and other work on screening and assessment, and promote best practices nationally.

### *Self-Screening*

The 2008 synthesis report (Eby et al., 2008a) and other recent reports (e.g., Eby et al. 2009) describe a number of available self-screening tools that range from simple paper-and-pencil to sophisticated computerized formats. There are a number of advantages of self-screening (Eby, Molnar, Shope, Vivoda, & Fordyce, 2003): (1) it is non-intrusive and less threatening than other types of screening or assessment; (2) older adult drivers may be more likely to engage in this type of screening earlier in disease onset; and (3) self-screening tools can be widely and cheaply distributed resulting in global availability. On the other hand, self-screening may not be useful to people with cognitive impairment and might even be dangerous to them if they misinterpret the feedback.

Eby et al. (2008a) briefly mentioned three tools that appeared promising: *Driving Decisions Workbook* (Eby et al., 2000, 2003); *SAFER Driving: Enhanced Driving Decisions Workbook* (Eby et al., 2008b, 2008c), and the *AAA Roadwise Review* (Staplin & Dinh-Zarr, 2006). The report concluded that while early self-awareness results are encouraging, there is clearly a need for further research to evaluate the effects of self-screening on traffic-safety-related behavior. There are several studies that have been published recently or are in progress on driver self-screening.

Myers, Blanchard, MacDonald, and Porter (2008) conducted an external process-evaluation of the *AAA Roadwise Review*. A convenience sample of 34 older drivers completed the *Roadwise Review* in pairs. (Note that even though the *Roadwise Review* is a self-screening instrument, it requires a second person to administer some of the tests.) Subjects were unobtrusively observed taking the computer-based, self-screening instrument and also participated in focus groups. Myers et al. (2008) reported that the older drivers' impressions of the *Roadwise Review* were generally favorable, but several areas of concern or improvement were noted. Many subjects had difficulty using the mouse even after completing a practice session. This was noted for both the person being screened and his or her partner. The investigators noted that the scores for some tests were inaccurate because of difficulty selecting the intended buttons with the mouse. In addition, the partners influenced the results both intentionally and unintentionally by assisting the drivers in tasks and encouraging second tries. With regard to the actual test battery in the *Roadwise Review*, most of the tasks were judged as enjoyable by the subjects. There was difficulty understanding the instructions for one task, and another task that required sustained attention and many trials was judged as frustrating, with 12 percent of subjects refusing to complete the test. Finally, the *Roadwise Review* uses cut-points to determine levels of impairment on certain tasks. Some participants were reportedly upset about being told that they had "severe

impairment" on some tasks. Collectively, these results can be used to improve the *Roadwise Review* and serve as helpful guidelines for the development of new self-screening instruments. The problems associated with the need for a partner, however, cannot be accommodated without significant changes to the instrument.

NHTSA recently released a report on a validation/evaluation of a newly developed self-screening tool called *SAFER Driving: The Enhanced Driving Decisions Workbook* (Eby, et al., 2008b, 2008c). The objective of the project was to create a valid web-based self-screening instrument to provide older drivers with individualized information to help them make better decisions about driving. The tool was intended to improve on existing tools by focusing on health concerns (the symptoms people experience from medical conditions or medications) rather than on the specific medical conditions or medications. Individuals complete the instrument by answering questions about the severity of several symptoms. The website links levels of symptoms to how they are likely to affect critical driving skills, and develops individualized feedback for the driver about which skills may be affected, strategies for maintaining safe driving given these declining skills, and suggestions for seeking further assessment.

Development of the self-screening instrument was based on a review of the literature, an expert panel, and a set of focus groups. The evaluation involved obtaining feedback from 68 older adults about the usefulness of the self-screening instrument and their intentions to make changes as a result of completing it. The validation portion of the activity involved statistically comparing participants' results from the self-screening instrument to results from an on-road driving assessment and a series of clinical tests to evaluate cognitive, visual, and psychomotor abilities. More than three-fourths of subjects reported that the self-screening instrument made them more aware of how declines in driving-related abilities can affect driving, and more than 90 percent thought the information provided by the instrument served as a useful reminder of things they already knew. More than one-third of subjects discovered a change in themselves of which they were previously unaware. A large percentage of subjects reported plans to engage in behaviors to maintain safe driving. Overall, subjects' scores on the self-screening instrument were significantly correlated with the clinical evaluation scores and on-road driving performance scores. The tool is free and in the public domain at: http://um-saferdriver.org.

### *Licensing Agencies*

Licensing agencies play an important role in the driver evaluation process—they have a unique opportunity to screen for fitness to drive because older drivers, like everyone else in the driving population, must go through a license renewal process, and it is the licensing agency that has sole authority to deny or restrict a person's driver license. As discussed in the M-CASTL 2008 synthesis report (Eby, et al., 2008a), a recent expert panel on driver licensing policy developed the following research needs based on group consensus (Molnar & Eby, 2008a):

- Design and test screening and assessment tools and/or programs using large-scale epidemiological studies across multiple jurisdictions based on objective measures;
- Translate research findings into specific recommendations for licensing agencies, clinicians, and other relevant organizations;
- Extend current focus on statistical significance to consider clinical usefulness (e.g., by identifying appropriate cutoffs and addressing sensitivity and specificity tradeoffs);

- Evaluate research outcomes within the context of how applicable and defensible they would be at the individual driver level;
- Expand the focus beyond individual measures of driving fitness to batteries of instruments;
- To determine effectiveness, expand evaluation of programs/practices to promote older driver safety and mobility.

One recently published study tested the acceptability and validity of using the *DrivingHealth*® inventory (DHI) in a licensing agency as an older driver screening tool (Edwards, Leonard, et al., 2008). The DHI is the battery of tests designed for professional administration on which the *Roadwise Review* was based. The study recruited a convenience sample of 258 drivers ranging in age from 18-87 years. All subjects completed the DHI, as well as a questionnaire on driving habits and a questionnaire on attitudes toward required screening for licensure and use of the DHI for screening purposes. Participants also self-reported their crash history over the past 2 years. The study found that older drivers performed more poorly on the DHI than younger drivers and that older drivers with crashes performed significantly worse on the DHI than older drivers with no crashes. Ninety percent of subjects thought that older drivers should be screened prior to licensure but there was little agreement on what the cutoff age should be, with 30 percent indicating all ages and 32 percent indicating those age 65 or older. Overall, both young and older subjects considered the DHI to be an appropriate screening tool that should be used as part of the licensing process.

A recent paper reviewed the literature on the efficacy of two in-office tools used to identify older drivers who have an elevated crash risk (Langford, 2008a). The paper focused on: the Useful Field of View (UFOV; Ball et al., 1993); and MaryPods (Staplin et al., 2003a, 2003b). Both of these tools are widely used in the US and abroad. According to the review, performance on these tests has been found to be consistently and significantly associated with crash risk including risk of at-fault crashes. The author cautioned, however, that the association between test scores and crash risk is only a necessary first step in the development of an in-office assessment tool. He concluded that these tests are too inaccurate to be used as a form of age-based assessment on a simple pass/fail basis. Instead, these tests may hold promise when used for pre-selecting groups of at-risk drivers and when used with a three-fold outcome—pass, fail, further assessment is needed. In other words, in his view, these tools would make good screening tools that may lead to a decision to evaluate a driver in a further detailed assessment.

Langford's (2008a) conclusions regarding the usefulness of the UFOV test were recently supported by a Canadian study (Bédard, Weaver, Dārzinš, & Porter, 2008). In this study, the researchers investigated the value of several approaches to predicting driving performance including the UFOV; Mini Mental Status Exam (MMSE); Trail Making Test A; and history of prior driving citations and crashes. The study found that each of these approaches had limited value in predicting driving performance and concluded that none should be used as the basis for making licensing decisions.

### *Health Professionals*

Physicians and other health professionals are uniquely positioned to assess driving-related problems as part general medical treatment and care. Eby et al. (2008a)

discussed how older drivers are likely to listen to a health professional regarding driving reduction and cessation, but physicians are often reluctant or uncomfortable with making fitness-to-drive decisions or lack the necessary information to do so. Many of these issues are discussed by Marottoli (2008). Fortunately, several educational sources and tools have become available to help health personnel address driving-related problems. Eby et al. (2009) review four of these resources.

One screening tool, the *Physician's Guide to Assessing and Counseling Older Drivers*, was developed by the American Medical Association (AMA) and NHTSA (Wang, Kosinski, Schwartzberg, & Shanklin, 2003). This guide was designed to provide physicians with information to address the issue of safe mobility in older adults. This report presents a model process for older driver screening and assessment in a medical setting. The first step in the process is screening to identify at-risk drivers, and involves careful observation of the patient when he or she presents to a physician. The guide recommends that physicians be alert to several visible characteristics such as poor hygiene, difficulty walking or moving, poor attention span, and memory problems. In addition, the guide suggests that physicians look for "red flags" such as any medical condition, medication, or symptom that can impair driving skills either temporarily or permanently.

If the results of this screening suggest that the patient may be at-risk as a driver, the guide recommends that the physician perform a formal assessment called the "Assessment of Driving-Related Skills" (ADReS). This assessment battery includes tests of visual acuity, visual field, walking speed, flexibility, strength, visual attention, visual search, and executive function. Research has shown that inter-rater reliability among various practitioners administering ADReS is high (Posse, McCarthy, & Mann, 2006). To date, no formal evaluation of the effectiveness of ADReS in accurately identifying crash risk has been undertaken.

Several efforts in Canada have resulted in guides and instruments to aid physicians in screening patients for fitness-to-drive. One effort is a guide developed by the Canadian Medical Association (2006) called *Determining Medical Fitness to Operate Motor Vehicles: CMA Driver's Guide*. This guide provides detailed information about several issues of interest to physicians treating older drivers, including medical conditions, medications, alcohol, and driving, as well as advice to physicians on screening and assessment of drivers.

Another effort in Canada by the Dementia Network of Ottawa resulted in the development of the *Driving and Dementia Toolkit* for primary care physicians (Byszewski et al., 2003). This toolkit consists of background information regarding the older driver and dementia, as well as a list of local resources and how to access them. The toolkit includes two sets of screening questionnaires, one for the driver and one for the driver's family member. Also included is a recommended approach to screening called SAFE DRIVE. An evaluation by the developers of the toolkit showed that after using the toolkit, physicians' had increased knowledge and confidence regarding dementia and driving, and were more likely to report that they would begin following the strategies suggested in the toolkit. However, as with other physician tools, the toolkit has been criticized for providing overly broad recommendations (Hogan, 2005), and not being evidence-based (Molnar, Byszewski, Marshall, & Man-Son-Hing, 2005).

Another approach, also developed in Canada, is CANDRIVE (Molnar et al., 2005). CANDRIVE is a pneumonic for driver screening. The CANDRIVE acronym reminds that the following areas should be screened: **C**ognition; **A**cute illness; **N**euromuskeletal disease; **D**rug use; **R**ecord (driving); **I**n-car experiences; **V**ision; and **E**thanol use. The authors pointed out that like other screening tools, CANDRIVE was not developed based on empirical evidence, but work is underway to develop evidence-based screening tools.

Finally, Dobbs (2008a) presented ongoing work on the development and validation of a screening tool for the identification of medically at-risk drivers called SIMARD© (*Screening tool for the Identification of Medically At Risk Drivers*) at a recent GSA conference. She reported that the sensitivity and specificity of the tool was studied using 181 drivers (age range 57-94), some of whom had medical conditions that could affect driving and others who were healthy. SIMARD© outcomes were compared to outcomes of a scientifically based on-road assessment. Dobbs (2008a) reported that the tool had 87 percent sensitivity and 92 percent specificity for predicting pass/fail on the on-road assessment. Dobbs concluded that the tool is valid and could be easily administered in an in-office setting.

## Education

Education plays a key role in maintaining safety and mobility throughout the lifespan. As driving laws, roadway design, and technologies change, education is necessary for drivers to stay abreast of the latest strategies for extending safe driving. Education also plays an important role in the process of transitioning from being a driver to using other community mobility options. Not only is education important for the driver, it is also important for caregivers, family members, and professionals who work with older adults.

As presented by Eby et al. (2009), there are several programs available for older drivers. These programs span a wide range of organizations and vary widely in content and format. Table 3 shows some example programs from the US and Australia. Eby et al. (2008a) examined the question of whether formal educational programs for older adult drivers are effective. The authors pointed out that few educational programs are formally evaluated making it difficult to draw conclusions about the overall effects of programs on traffic safety. They concluded that although formal educational programs have not yet been shown to improve crash risk, it is premature to give up on them, and that further research was needed.

A study presented at the annual Transportation Research Board meeting (Babka, Cooper, & Ragland, 2009) discussed the results of a program to teach older adults to use public transit. The program was designed for older adults who were thinking about using public transit, and was developed specifically for the East San Francisco Bay area public transit system. Training took place at several senior centers in the area. A convenience sample of an unreported number of older adults participated. Participants completed pre and post surveys on knowledge of public transit as well as comfort levels, attitudes, concerns, and level of familiarity with transit use. The study found that after the program, participants had an increased knowledge of transit and how to independently access information on transit. In addition, those who were current drivers were more likely to participate in the program than people who had already ceased driving.

| Table 3: Example Educational Resources Available for Older Adults (adapted from Eby et al., 2009) | | | |
|---|---|---|---|
| **Name** | **Organization** | **Web Site** | **Description** |
| **Driver Safety Program** | AARP | *http://www.aarp.org/family/housing/driver_safety_program/* | Information, articles, and news. |
| **Mature Driver Improvement Program** | National Driver Safety Services, LLC | *http://www.maturedriverco urseonline.com/* | Online paid course the covers driving environment, risk awareness, impaired driving, driving emergencies, physical conditioning and defensive driving. |
| **Safe Driving for Mature Operators** | AAA Exchange | *http://www.aaaexchange.com/Main/Default.asp?CategoryID=14&SubCategoryID=72&ContentID=325* | Hands-on course addressing specific needs of drivers age 55 and older and designed to improve everyday driving skills and knowledge. |
| **Super Seniors** | Illinois Secretary of State | *http://www.cyberdriveillinois.com/services/services_for_seniors/superseniors.html* | Hands-on training for driver license renewal for older adults. |
| **Years Ahead – Road Safety for Seniors Program** | Royal Automobile Club of Queensland | *http://www.racv.com.au/wps/wcm/connect/Internet/Primary/road+safety/road+safety+for+seniors/* | Hands-on informational course about many aspects of aging and driving. |
| **Wiser Driver Program** | Hawthorn Community Information Centre | *http://www.hcec.edu.au/WiserDriverProgram.htm* | In-person course designed for older people to upgrade their knowledge and have peer-discussions about safety and to plan for future transport options. |
| **DriveWell** | ASA | *http://www.asaging.org/asav2/drivewell/* | Informational course to promote older driver safety and community mobility. |
| **GrandDriver** | AAMVA | *www.granddriver.info/* | Information and links to several courses, tools, and other resources. |
| **Project Safe R.O.A.D.s** | Onondaga County Department for Aging and Youth | *http://www.ongov.net/Aging_and_Youth/SafeRoads/older/home.html* | Informational website covering several aspects of aging and mobility. |
| **Road Map to Driving Wellness** | ASA | *http://www.asaging.org/CDC/module4/home.cfm* | A detailed course on maintaining older adult safety and mobility. |

## Rehabilitation

According to MedicineNet (2009), rehabilitation refers to the "…process of restoration of skills by a person who has had an illness or injury so as to regain maximum self-sufficiency and function in a normal or as near normal manner as possible." Some declines experienced by older adults that impact safe driving may be reversible through rehabilitation (e.g., through fitness or cognitive training programs). Some recent work has addressed rehabilitative interventions to improve driving skills and traffic safety and is discussed here.

### *Fitness*

As discussed by Eby et al (2008a), fitness programs help older people drive more safely by improving range of motion, strength, and stamina. Past research has shown that if the fitness program is specific and intense, it will likely help older drivers extend their driving lifetime (Marottoli, et al., 2007; Ostrow, Shaffron, & McPherson, 1992). For example, Marottoli et al. (2007) investigated the effects of an exercise program on on-road driving performance. The program involved an occupational therapist visiting older drivers (age 70 and older) weekly for 3 months and guiding them through a graduated exercise program targeting stamina, flexibility, coordination, and speed of movement. Results showed that participants found the program acceptable and maintained their driving performance (as measured through an on-road driving test), while a control group declined in performance.

Recently published work from Portugal investigated the effects of an exercise program on improving abilities related to safe driving in older adults (Marmeleira, Godinho, & Fernandes, 2009), as compared to a control group who did not receive the program. The program lasted 12 weeks with 3 hours of exercise per week. The exercise activities primarily involved participants walking in an open gymnasium while doing certain visuospatial tasks (e.g., maintaining several balloons in the air). All subjects were tested on a series of functional abilities before and after the program. When compared to the control group, participants in the exercise program showed significant improvement in most of the functional areas that were measured. Inasmuch as the functional abilities are related to safe driving, the authors concluded that exercise can help improve the driving safety of older adults.

### *Cognitive*

Other programs have attempted to improve driving ability through cognitive rehabilitation, based on findings that cognitive training can improve cognitive functioning (see e.g., Ball et al., 1988, 2007; Delahunt et al., 2008). The effect of cognitive training on driving performance, however, has received little attention. Roenker, Cissel, Ball, Wadley, and Edwards (2003) investigated the effects of speed-of-processing and simulator training on driving performance as measured by an open road test. Simple and choice reaction time was the focus of the training program. The study found only moderate improvement for subjects as compared to control subjects on only two of the several driving performance measures investigated.

M-CASTL has recently sponsored a project to assess the effects of a cognitive training program on several factors including driving performance (Seidler, Jonides, Buschkuehl, Jaeggi, Bernard, Hall & Brey, 2009). This project aims to assess whether a 5-week cognitive training intervention improves measures of cognition, complex motor control, and performance in a driving simulator task for both young and older adults. Previous work by Seidler showed that the proposed type of cognitive training resulted in transfer benefits to untrained tasks. Moreover, interdependence between the cognitive and motor systems was found to increase with age. What the previous work did not explore is whether cognitive training benefits will also transfer to real-world tasks such as driving. This project is designed to determine the effects of cognitive training on driving performance as measured by a driving simulator. Results should be available in late 2009.

## Advanced Technology

One promising way to extend safe driving among older adults is to use advanced technology to help with various parts of the driving task. As discussed previously (Eby et al., 2008a), advanced technology systems for vehicles have the potential to increase the safety and mobility of older drivers but must be affordable, relatively easy to use, and work to enhance safe driving. Research shows that older drivers use ITS applications differently than younger drivers (Caird, 2004; Dingus et al., 1997; Eby & Kostyniuk, 1998; Kostyniuk, Streff, & Eby, 1997; Stamatiadis, 1998; Wochinger & Boehm-Davis, 1995). Understanding patterns of use for the various advanced technologies that are being developed is crucial for optimizing the benefits of technology for all users (Vrkljan & Polgar, 2007). Such research is lagging but some work has recently been published.

The AAA Foundation for Traffic Safety (AAAFTS, 2008) published the results of a series of surveys and interviews conducted with older and younger members of the AAA Club of Southern California (ACSC) on the use of currently available advanced in-vehicle technology (published originally in: Jenness, Lerner, Mazor, Osberg, & Tefft, 2007; 2008a, 2008b, 2008c). The advanced technology systems they investigated were: backing aids (proximity sensors/rear view cameras); adaptive cruise control; advanced high intensity discharge (HID) headlamps; and built-in navigation systems. Potential respondents were selected from the population of ACSC insurance customers who owned vehicles with one or more of these technologies installed. The study found that the majority of older adults indicated that they would want the specific technology on their next vehicle, with the percentage of respondents giving this answer varying from 98 percent for backing aids to 75 percent for adaptive cruise control. Older drivers were significantly more likely to indicate that they used the owner's manual to learn how to use the advanced technology, but also indicated greater difficulty than young drivers in understanding the owner's manual. Of the technologies investigated, the navigation system was the most difficult for people to learn how to use, particularly for older drivers. Backing aids were the easiest with no difference by age group. When asked about changes in technology use over time, about 30-40 percent indicated increased use for all technologies with most of the remaining respondents reporting no change in use. Finally, when compared to the responses of younger drivers, older drivers perceived less safety benefits for each of the technologies studied, and there was a wide range of opinion on the safety benefits among the various technologies.

## Roadway Design

As discussed elsewhere (Eby et al., 2008a, 2009), most US roadways were designed for the average driver one-half century ago, when the average US lifespan was 68 years of age. One obvious way to keep older adults safely driving for as long as possible is to make improvement to roadways that better accommodate the common functional declines associated with aging. Many organizations have recognized this fact. Indeed, the FHWA began an initiative several years ago that resulted in the 1998 publication of the *Older Driver Highway Design Handbook*, which included recommendations for geometrics, signing, and pavement markings in four major areas of roadway design – intersections, interchanges, roadway curvature and passing zones, and construction/work zones (Staplin, Lococo, & Byington, 1998). (Note that the FHWA is currently updating this document.) This publication was followed by the *Highway Design Handbook for Older Driver and Pedestrians* (Staplin, Lococo, Byington, & Harkey, 2001a), *Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians* (Staplin, Lococo, Byington, & Harkey, 2001b), *A Pocket Guide to Improve*

*Traffic Control and Mobility for Our Older Population* (FHWA, 2003), and *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan Volume 9: A Guide for Reducing Collisions Involving Older Drivers* (Potts, Stutts, Pfefer, Neuman, Slack, & Hardy, 2004).

As described in the previous synthesis report (Eby et al., 2008a), there have been many studies published that have addressed roadway design issues relevant to older drivers. The following conclusions were drawn in Eby et al. (2008a).

- Collectively, improvements in roadway design can serve to make the roadway more forgiving not only to older drivers, but also to the general population of drivers on the road. In addition, design improvements at intersections can benefit older pedestrians who are considerably more likely than younger pedestrians to be killed by automobiles (NHTSA, 2008a).
- Even with good legibility, drivers of all ages sometimes do not understand what the words used on signs mean. Educational efforts are needed to improve sign comprehension among older drivers.
- Even when pavement markings are conspicuous and legible, research has found that pavement markings are difficult for many people to understand. Public information and education programs need to be developed to improve pavement marking comprehension.
- Comprehension of signals other than the familiar three-light traffic control device is often poor. Signal comprehension should be addressed in educational programs for older drivers.
- The intersections of roadways are more dangerous for older drivers than for drivers younger than 65 years.
- Research needs to be done to help reduce the risk of intersection crashes including: advanced vehicle technology (such as collision avoidance systems); education and training programs; and intersection modifications, such as the more frequent use of roundabouts.
- Roundabouts can reduce the total number of injury crashes by up to 50 percent and fatal crashes by up to 70 percent. These safety benefits were found for drivers of all ages.
- Research should address the lack of familiarity of US drivers with roundabout design and signage.

While there is ongoing work on improving signs, pavement marking, intersections, and the like, most of this work is not addressing the needs of older drivers specifically, or if it is, it is not presenting results for older adults separately (see e.g., Carlson, Park, & Andersen, 2009; Hanscom, 2009; Hasan & Al-Bar, 2009; Hawkins, Katz, & Rigdon, 2009; Kondyli & Elefteriadou, 2009; Khattak, 2009; Schnell, Yekhshatyan, & Daiker, 2009).

Lynott and Taylor (2009) discussed research on AARP's ongoing efforts to encourage states to implement the FHWA's roadway engineering guidelines for older drivers and pedestrians. The paper reported on a series of activities to consider the FHWA guidelines from the perspective of the planning concept known as "complete streets." According to the paper, complete streets are those that are designed for the safety and comfort of all road users, regardless of age or ability. Thus, pedal cyclists, pedestrians, wheelchair users AND motor vehicle occupants are all considered users of the roadway.

The project sought to determine if the FHWA guidelines for older drivers work or hinder other roadway users. The study involved a literature review, a telephone questionnaire, an on-line questionnaire, a summit of national leaders, and a webinar. Among other results, the study found the following strengths of the FHWA Handbook guidelines: the handbook presents low-cost solutions backed by empirical data; it provides a process for prioritization of efforts; and most of the handbook recommendations satisfy the complete streets paradigm. The study also reports the following weaknesses: although the recommendations are based on empirical data, these data are for older drivers and not for other road users; the handbook does not challenge current highway design practice of designing roadways for drivers of personal vehicles at the expense of other roadway users; there are few recommendations based on different land uses; the effects of speed on various proposed roadway treatments are not addressed; and the handbook contains contradictory statements.

Heaslip, Collura, and Knodler (2009) discussed research that investigated the effectiveness of certain work-zone design guidelines for older drivers from the FHWA guidebook. The field study took place along an Interstate Highway in Massachusetts. The researchers investigated three design features: lane closure/lane transition practices; portable changeable message sign practices; and channelization and delineation of crossover/alternative travel path practices. Speed and video data were collected from several points before and in the work zone. Driver age was judged visually with drivers age 60 and older considered to be "older drivers." The following findings were reported: older drivers' speeds approaching the work zone were slower and more variable than younger drivers; older drivers' merging patterns were less uniform with frequent conservative early merging; and portable variable message signs reduced the speeds of all drivers. The authors concluded that the combination of recommended practices helped all drivers make safe merges and travel through the work zone more safely.

Kim, Ulfarsson, and Anton (2009) investigated the comprehensibility of current and experimental signs designed to indicate a photo-enforced traffic-signal ahead, with a specific focus on older drivers (age 65 or older). The study examined four intersections with photo enforcement whose old signs were replaced with the experimental ones. Three survey waves were conducted by interviewers at central locations in the city with the new signage: one survey was conducted prior to the change in signs; one was conducted about 1 month after the switchover; and one was conducted 9 months after the change. The study found that older drivers had more difficulty than younger drivers understanding both the old and new signs. Older drivers, however, showed greater improvements in understanding with the introduction of the new signs.

A study by Lord, van Schalkwyk, Chrysler, and Staplin (2007) explored strategies for reducing older driver injuries at intersections by using roundabout design practices that were more accommodating. The study involved structured interviews with older licensed drivers who drove regularly. The interviews focused on five roundabout design features: advanced warning signs; lane control signs; directional signs; yield treatments; and exit sign treatments. For each of these elements, the researchers evaluated standard design practice (base condition) and two new design countermeasures. The new countermeasures were developed from previous focus group work. The researchers developed the following recommendations based on the results:

- Advanced Warning Sign:
    - Add symbol in the center of the circular arrows to represent the center island to help clarify the context of the arrows;
    - Add the word "ROUNDABOUT" adds redundancy but would help meet the needs of the older driver.
- Roundabout Lane Control Sign:
    - Add text under the route symbol (e.g., LEFT LANE);
    - Add symbol in the center of the circular arrows to represent the center island to help clarify the context of the arrows.
- Directional Sign:
    - Add directional sign (ONE WAY) in center island;
    - Center island directional sign should be placed directly in the driver's line of sight from the yield line.
- Yield Treatment:
    - Add text "TO TRAFFIC IN CIRCLE" under yield signs at both sides of entrance to roundabout.
- Exit Sign Treatment:
    - Add arrow on exit sign;
    - Add street name on the exit sign.

The authors also concluded that education about roundabouts delivered at a broad community level is essential in order to realize the safety benefits of roundabouts for older adults.

## Older Adult Pedestrians

The pedestrian fatality rates for the oldest age groups are higher than for any other age group (NHTSA, 2008). In 2006, more than 900 pedestrians age 60 or older died in the US (NHTSA, 2008). Given what is known about age-related declines and the reality that most older adults prefer to travel in an automobile, elderly pedestrians are likely to have perceptual, cognitive, or psychomotor declines that make it difficult for them to be safe pedestrians (Langlois et al., 1997). A recent report by Mitchell (2007) discussed a number of issues related to older adult pedestrians in Europe, including pedestrian travel patterns, crashes, and several strategies for making walking trips safer.

A study in Denmark (Bernhoft & Carstensen, 2008) investigated the preferences and behaviors of older adult pedestrians using a mailed questionnaire. The study compared responses of older pedestrians (age 70 and older) to younger pedestrians (age 40-49). The study found that older pedestrians' feelings of comfort while walking were enhanced by the presence of signalized intersections, pedestrian crossings, paved walkways, long green cycles for crossing, and low curbs. In contrast, younger pedestrians favored taking the most direct and fastest route.

## Extending Safe Driving: Conclusions

It is clear that significant research effort has recently been concentrated on helping older adults remain driving for as long as they can safely do so. The work on self-screening is showing promise in helping people learn about themselves so that they can make better decisions about driving. Longer-term evaluations, however, are needed to determine the effects of self-screening on choosing appropriate self-regulatory behaviors and on improving traffic safety. The work on developing effective and easy-to-administer screening and assessment tools for licensing agencies and health professionals

continues, yet there is still controversy about using these tools for age-based driver evaluation. Some of this controversy stems from the lack of distinction many researchers and practitioners make between the screening and assessments processes. There is also widespread criticism that most driver evaluation tools were not developed based on empirical data and have not been formally evaluated. Research to disentangle these issues should continue. Fitness and cognitive retraining programs are showing promise for helping people regain some abilities needed for safe driving. Of particular interest is the recent research attempting to link improved cognitive functioning to improved driving performance. Advanced technology continues to be developed and research is needed to ensure that these technologies can be easily used by older drivers and that they do not compromise driving safety. Jurisdictions are slowly changing the roadway infrastructure following the FHWA guidelines for accommodating older drivers. Research should continue to assess whether these recommendations do indeed help older drivers (and all drivers) be safer on the roadway. Much more work is needed to better understand how to keep older adult pedestrians safe.

## DRIVER LICENSE ISSUES

The primary role of driver licensing agencies is to make sure that drivers are capable and competent to operate a motor vehicle (Snook, 2008). The public safety role of licensing agencies, however, must be carried out in an environment characterized by constraints on time, budgets, staff availability, staff expertise and training, hardware, and real estate (Staplin, 2008). In addition, licensing agencies have other roles, such as serving customers efficiently with regard to vehicle registration, that often compete with their public safety role. Licensing agencies are also being called on to prepare for the increasing number of older adults who will be driving and may eventually lose their license because of functional declines (Carr, 2008; Dobbs, 2008b). As described previously, the loss of a license can lead to many negative consequences including decreased social engagement and reduction in out-of-home activities (Marottoli, Mendes de Leon, Glass, Williams, Cooney, & Berkman, 2000), increased depressive symptoms (Ragland, Satariano, & MacLeod, 2005), increased risk of nursing home placement (Freeman, Gange, Muñoz, & West, 2006), and increased societal costs for providing transportation services to older adults who no longer drive. Because of these consequences, there are clear personal and societal benefits to expanding the role of licensing agencies beyond simply identifying at-risk drivers to include helping them maintain safe driving for as long as possible and assisting them in transitioning to non-driving when they are no longer able to drive safely (Carr, 2008; Silverstein, 2008).

To fulfill their public safety role, licensing agencies review driver history records for crashes and citations, and referrals from health professionals (e.g., physicians, occupational and physical therapists, social workers, and vision specialists), law enforcement officers, courts, and families and friends of older drivers, to alert them to cases in which a driver may not be safe to drive. Those who are flagged are generally required to report to the agency for an evaluation, such as described in the screening and assessment section of this paper. Based on the outcomes, licensing agencies have several choices: they can allow a driver to keep his or her license with no restrictions; they can refuse to renew the license, suspend, or revoke the license; they can place restrictions on the license (e.g., prohibit night driving, require vehicle adaptive equipment, restrict driving to specific times or distances from home); or they can shorten the renewal cycle. In making these choices, licensing agencies consider each individual's abilities and circumstances, options for rehabilitation, and the options available for driving compensation.

Issues related to driver license holding among older adults have received a fair amount of research efforts in the past few years. Much of this work was presented in a special issue of *Traffic Injury Prevention* that was guest edited by Langford (2008b). The papers for the special issue grew out of a 2007 TRB workshop titled: "Licensing Authorities' Options for Managing Older Driver Safety—Practical Advice from the Researchers." Langford, Braitman, Charlton, Eberhard, O'Neill, Staplin, and Stutts (2008) summarized the outcomes from the workshop in the form of five messages:

- Older drivers as a group are not at heightened crash risk solely because of functional decline, whether the result of normal aging or of disease/pathology;

- A minority of older drivers justify further identification and assessment, with early research suggesting that self-reported low annual driving distances may be a possible indicator for this group;
- Assessment of all older drivers reaching a threshold age is not an efficient means to identify those who are unfit to drive;
- A minority of older drivers need to cease driving as a result of their heightened crash risk;
- To keep abreast of new developments, licensing authorities and researchers need to continue to work closely to ensure that older driver license policies and practice are guided by the latest empirical evidence.

The Iowa Office of Driver Services and the American Association of Motor Vehicle Administrators also provided their perspectives on the workshop (Snook & Cohen, 2008).

Adler and Silverstein (2008) addressed several issues about how licensing authorities should respond to drivers with dementia. The study was based on a review of the driving and dementia literature. The study found that: drivers with dementia have unique impairments that should be recognized by licensing authorities; these drivers should be responded to with sensitivity and respect early in the disease progression; and drivers and their family/caregivers could benefit from "resource referrals" from the licensing agency that provide information about mobility options and support services. The researchers concluded that licensing authorities should be concerned about drivers with dementia as these authorities are important partners in maintaining safe mobility for people with dementia.

### Driver License Renewal

As discussed by Eby et al. (2009), driver license renewal policies in the US vary widely from state-to-state in terms of the length of the renewal cycle, requirements for accelerated renewal for older drivers, and other renewal provisions. Renewal cycles for older adults are generally every 4-5 years, but 8 to 10 year cycles are in place in six states. Arizona has no renewal cycle until people turn age 65. Some states require accelerated renewal for older drivers. The beginning age for accelerated renewal ranges from 61-years-old (Colorado) to 81-years-old (Illinois), and the length of the accelerated renewal cycle ranges from 1 year (Illinois for age 87 and older) to 5 years (Arizona, Colorado, South Carolina). One state (Tennessee), surprisingly, has *decelerated* renewal, with no renewal required after age 65. Some states have other special renewal provisions for older drivers, including requirements for in-person renewal, vision tests, or other testing/certification (e.g., written and road tests, certification of fitness.

The wide range of renewal policies, unfortunately, reflects the political will, or lack thereof, in states rather than empirically-based policy to maintain public safety and well-being. Research on the effects of older driver license renewal provisions has been limited. There is some evidence that vision testing at renewal may be associated with reduced motor vehicle deaths among older drivers (e.g., see Levy, Vernick, & Howard, 1995). However, a recent examination of renewal provisions in the contiguous US found that only in-person renewal was related to reduced fatalities, and only among the oldest old (age 85 and older; Grabowski, Campbell, & Morrisey, 2004). Vision tests, road tests, and accelerated license renewal did not result in additional benefits. Recent work in

Australia has also failed to demonstrate safety benefits associated with mandatory testing of older drivers (Langford, Fitzharris, Koppel, & Newstead, 2004; Langford & Koppel, 2006). Further research on the effects of license renewal provisions for older drivers is warranted.

A recent study by Bohensky, Charlton, Odell, & Keefe (2008) investigated whether current licensing guidelines were consistent with the empirical data on vision impairment and driving, with a focus on older adults. The study reviewed the licensing guidelines for vision impairments in five countries and the European Union, and the research literature on vision impairment and driving performance. The study found that the predictive value of the vision tests commonly used for decision making by licensing authorities in the countries investigated were inconclusive. The authors concluded that: the visual abilities currently assessed for renewing a license do not adequately explain unsafe driving; setting thresholds for these vision tests is problematic; and decisions about vision for safe driving need to be considered in the context of the driver's overall health.

A recent Australian study investigated the issue of whether age-based mandatory assessments reduce older drivers' risk to other road users (Langford, Bohensky, Koppel, & Newstead, 2008). The researchers compared older driver fatality rates from two Australian states, one that had age-based mandatory assessment (Victoria) and one that required special testing for relicensing at age 80 (New South Wales, NSW). When the fatality rates for drivers age 80 or older were compared, overall fatality rates and fatality rates for other road users were slightly higher in Victoria, but not significantly so. The authors conclude that age-based mandatory assessment programs do not have demonstrable safety benefits, based on their findings.

### Physician Reporting of At-Risk Drivers

Given that functional declines resulting from medical conditions and medications are what lead to declines in the functional abilities needed to drive safely, physicians play a fundamental role in the process of determining a person's fitness-to-drive. In the course of normal patient care, physicians are often faced with patients whose physical, perceptual, or mental conditions may impact their ability to drive safely. Should the physician report these patients to the driver licensing agency?

The issue of physician reporting has both ethical and legal implications. From an ethical standpoint, the American Medical Association recommends that physicians notify the licensing agency when a patient's condition may affect safe driving. From a legal perspective, few states require physicians or other health professionals to report at-risk drivers to licensing agencies (Carr, 2008). Instead, most states rely on a voluntary referral process whereby potentially at-risk drivers can be reported to licensing agencies by health professionals, law enforcement, or family members (Meuser, Carr, Berg-Weger, Niewoehner, & Morris, 2006; Morrisey & Grabowski, 2005). A small number of states require that physicians report patients with specific health conditions (e.g., Alzheimer's disease, epilepsy) so that ongoing driving fitness can be assessed (Wang et al., 2003). In addition, drivers themselves are also encouraged to report to the licensing agency if they feel they are not safe to drive (Meuser, 2008).

As recently reviewed by Meuser (2008), specific requirements of voluntary reporting laws vary across jurisdictions. Some states keep the identity of the person filing the referral paperwork confidential while others do not. Some states, like Michigan, keep the identity of private citizen reporters confidential but not law or health professionals. Some

states provide civil immunity to reporters from prosecution for breach of confidentiality. Meuser (2008) points out that little is known about how such provisions impact both physician behavior and public safely. On the other hand, if a patient is involved in a crash and determined to be at fault, physicians can be held liable – even in states with voluntary reporting. Carr (2008) suggests that the key for physicians to protect themselves from liability is to document all concerns, recommendations, and referrals to outside sources and keep them in the patient's file.

A study in Missouri examined the traffic crashes of drivers voluntarily reported as medically impaired to the licensing authorities, as well as the resulting licensing outcome (Meuser, Carr, & Ulfarsson, 2009). The study compared the records of reported drivers with a control group of drivers who were not reported. The study found that reports came from a variety of sources: law enforcement (30 percent); license office staff (27 percent); physicians (20 percent); family members (16 percent); and others (7 percent). The average age of reported drivers was 80 and 55 percent were male. During the 5 years studied, 38 percent of reported drivers had subsequently died. Crash involvement was significantly higher for reported drivers when compared to controls (9.3 percent vs. 2.2 percent). Of the 4,100 reported drivers investigated, only 3.5 percent retained their driver license after the reassessment process, with most (96.5 percent) not completing the assessment. The authors conclude that the Missouri voluntary reporting law does enhance public safety, but caution that some reported drivers who were still safe to drive may have stopped driving prematurely rather than go through the assessment process.

### Driver Licensing Issues: Conclusions

The past few years have seen an abundance of research on older driver license issues. This is appropriate given the primary role the driver license plays in maintaining safe mobility in an aging society. While there is still much research to complete, some preliminary conclusions are:

- In depth assessment should be triggered by one of the following: a failed screening; a referral from a health professional, law enforcement, family members, or other person; or an unacceptable crash or violation history.
- Driver assessment should involve a team of professionals;
- Driver license renewal policies should be developed based on empirical data, not politics;
- Physician's should be encouraged or required to report individuals who exhibit declines in abilities that can compromise driving safety and these physicians should have immunity from prosecution and their identities kept confidential from the patient;
- States need to be encouraged to adopt policies that have been shown to improve public safety and well-being;
- Drivers with dementia need special attention and perhaps, a special approach, to licensing.

## TRANSITIONING TO NON-DRIVING

Despite large individual differences in the functional abilities of older adults, most older people will eventually be faced with difficult decisions about whether they will need to reduce or stop driving, and if they do, how they can maintain mobility and well-being. Research has estimated that once individuals stop driving, most will be dependent on other community mobility options for several years – for men, about 6 years and for women, about 10 years—before death (Foley, Heimovitz, Guralnik, & Brock, 2002). Hakamies-Blomqvist and Wahlström, (1998) discussed the fact that the process of transitioning from being a driver to a non-driver is a complex one, and many factors such as the availability of personal and environmental resources, are important. The transition has been described as a spontaneous, gradual process, with many older drivers becoming increasingly more vulnerable to difficulties in traffic, limiting their driving under certain conditions, and driving progressively less than before. It is also known that there is considerable variation in how older drivers respond to driving-related problems, what steps they take to continue driving safely, and how well they adapt if they are forced to stop driving. Eby et al. (2008a) concluded that there has been limited research on how the driving cessation process affects well being and what role driving restrictions play in the process, as well as what factors might lessen the adverse outcomes that can result from stopping driving. There is clearly a need to better understand the process of driving cessation among older adults and to identify factors that allow older drivers to successfully manage the transition from driving to other transportation options (Dickerson et al., 2007).

The topic of transitioning from being a driver to using other options to maintain mobility was the focus of a special issue of *Topics in Geriatric Rehabilitation* edited by McCarthy (2009). The issue contained seven papers from authors representing three continents and six countries. Siren and Hakamies-Blomqvist (2009) presented data from focus groups held with older drivers and former drivers in Finland. The focus groups explored how older adults talk about mobility and adapting to restricted mobility due to functional declines. The study found that: older adults connect mobility with physical health and functional capabilities; independent mobility was tied to everyday life practices and personal lifestyle; and the obstacles to independent mobility were overcome by both mental (readjustment of attitudes and perceived needs) and material (technical aides) strategies.

A study from Canada (Friedland & Rudman, 2009) explored the role of family and physician advice (interpersonal factors) in older driver self-regulation. The study utilized data from focus groups conducted by the authors in a previous study. The groups in that study included preseniors (age 55-64), senior drivers (age 66-92), senior former drivers (age 65-94), and family physicians. The study found that in general: older adults expected to hear driving self-regulation advice from others (either family or physician); older drivers were open to constructive advice to reevaluate driving practices; older drivers wanted to hear the advice gradually rather than being suddenly confronted with advice to stop driving; all participants described a reluctance to discuss driving at all; and older adults expected to hear about their driving problems from their family, but families tended to not have these conversations. The authors conclude that a more proactive approach is needed to ease the transition from driving to other mobility options.

Kostyniuk, Molnar, and Eby (2009) explored the conditions under which family members did or did not talk with older adults regarding driving problems. The researchers analyzed data from a statewide telephone survey of older adults in Michigan who had a valid driver license or one that had recently expired. The study used categorical analysis to determine differences between family members reported by the older drivers in the survey to have expressed concerns about their, and family members reported not to have expressed concerns. The study found that family members were more likely to express concerns if the older adult: had been involved in a crash in the past year; was uncomfortable merging onto freeways in heavy traffic; was uncomfortable driving 200 miles in a familiar area; avoided driving in inclement weather; showed declines in physical functioning; or was male. The authors concluded that further research is needed on older adults and their families to more objectively examine the interactions and dynamics of adult children and their aging parents with respect to driving.

A study from Massachusetts (D'Ambrosio, Coughlin, Mohyde, Carruth, Hunter, & Stern, 2009), examined the issue of communication about driving problems among caregivers and drivers with dementia. The authors correctly noted that older adults with dementia may lack the insight to evaluate their own driving abilities or the typical arguments that a caregiver might use with a cognitively intact older adult. The authors analyzed data from a baseline questionnaire administered to a random sample of caregivers attending a session to educate caregivers on how to cope with drivers with dementia. The study found: about two-thirds of caregivers had spoken to the driver with dementia about driving; about one-third thought that the dementia patients would know when to stop driving; one-half thought the family member would decide when the driver should stop driving; and about 10 percent had either taken away keys or disabled a vehicle to prevent the driver from driving. When asked about reasons why the caregiver had not talked with the driver with dementia, about one-half did not think that his or her driving was a problem, and 19 percent did not want to upset the driver. Thus, fear about family conflict was an important barrier to having this conversation. Finally, when asked about plans to address the driving issue with the driver with dementia, about 20 percent of caregivers indicated that they would eventually talk with the driver; 9 percent said they would sell the car; and small percentages of others said they would use other strategies. The authors concluded that there was a need to educate and support caregivers to provide them with the information they need to be better informed about driving and dementia.

While the transition to non-driving can be traumatic and devastating, some people are able to manage the transition without a loss in well-being. An Australian study (Oxley & Charlton, 2009) examined differences in attitudes toward driving cessation, life satisfaction, and mobility between current (n = 1,700) and former drivers (n = 133) age 60 and older. The study found that among current older drivers: most maintained good levels of mobility and were satisfied with these levels; most had thought about the fact that they would eventually have to stop driving one day; a large majority indicated that they did not want to have to make the decision to stop driving; and most feared the consequences of driving cessation including the loss of freedom and independence, difficulty using public transport, and reliance on others for transportation. Former drivers reported that they took fewer trips than current drivers but were satisfied with their mobility. The study found: 70 percent made the decision to stop driving themselves; those who made the driving cessation decision themselves were more satisfied with their current mobility than those who stopped driving because of someone else's decision; and 60 percent thought they stopped driving at the right time (30 percent thought they

stopped too early). Numerous reasons were reported for stopping driving, with availability of other transport options, lack of enjoyment of driving, and concerns about safe driving being reported most frequently. The authors concluded that the transition process can be improved by raising the awareness of the benefits of planning ahead for driving retirement and by providing new and different kinds of transport options and mobility services.

Another Australian study (Di Stefano, Lovell, Stone, Oh, & Cockfield, 2009) developed and evaluated a community mobility program to help older adults make better decisions about their driving, with the overarching goal of helping people maintain dignity and independence as they age. The program development process built on data from the literature, involvement of many key stakeholders, piloting of the program with older drivers, and revisions. The objectives of the program were to educate participants to: have an understanding of the impact of aging and health on driving and mobility; appreciate the relationship between health and safe mobility behaviors; encourage participants to plan for driving self-regulation and cessation; appreciate the role of health professionals in the transition process; increase awareness of licensing and vehicle modification issues; increase awareness of available community mobility options; and encourage participants to engage in safer community mobility options. The evaluation involved 94 people participating in the program and completing pre and post surveys. Some participants also completed a telephone interview 6-8 weeks after the program. The evaluation results were positive: the program reached the target population of older adults (90 percent were age 60 or older); people remembered the community mobility information that was presented; participants were satisfied with the content and resources; and many participants reported that they changed their behavior based on knowledge gained in the program and had encouraged others to do so also. The authors concluded that education about community mobility can influence both personal behavior change and the use of acquired knowledge and resources to influence the behavior of others.

Dobbs, Harper, and Wood (2009) explored the value of specialized driving cessation support groups for individuals with dementia in the process of transitioning to non-driving. The authors compared participants in a traditional Alzheimer's support group (TSG) presented by employees of the Alzheimer's Society to participants in an Alzheimer's driving cessation support group (DCSG) developed by the authors and administered by a clinical psychologist. The DCSG was developed using empirical data from the literature. The outcome measures were several well-documented tests measuring mental status, depression, quality of life, behavior and memory problems, pleasant events, and emotional effects related to loss of driving privileges. Feedback on the efficacy of the support groups was also collected. The study found that the DCSGs were effective in reducing many of the negative consequences associated with loss of driving privileges for those with dementia. The authors concluded that the positive outcomes of the DCSGs, combined with the expanding scope of the problem of driving cessation among those with dementia, underscore the need to translate research findings into practice.

Several research reports on the transition from being a driver to using non-driving mobility options were presented on this topic at the 2008 Annual GSA conference. One paper showed that when compared to older adults who are still driving, adults who have stopped driving score lower on several measures of health (Edwards, Reynolds, Popa, Lunsman, & Rebok, 2008). Several papers examined various aspects of driving self-

regulation and cessation. Winter, Morgan, Classen, and McCarthy (2008) reported the results of two literature reviews on the difference between men and women in self-regulation and driving cessation. The study found that men and women differed in how they self regulate driving; their attitudes toward driving cessation; reasons for driving cessation; and the length of dependence on community mobility options. The authors concluded that greater attention should be paid to gender differences in older adult driving self-regulation and cessation. Along the same lines, Bédard and Kafka (2008) administered a set of questionnaires to current and former older adult drivers in Canada to investigate possible gender differences in driving cessation. The study found that former drivers were older, had poorer health status, and were more depressed than current drivers, with no gender differences on these factors. In addition, men who had stopped driving scored significantly lower on scales of happiness and life satisfaction than other respondents. The authors concluded that strategies are needed to minimize the negative impact of driving cessation, particularly among men.

Ackerman, Okonkwo, Ball, and Crowe (2008) explored the relationship between cognitive impairment and self-regulation through a questionnaire of older drivers. They found that several specific self-regulatory practices were associated with specific declines in cognitive function. Baggett and Neal (2008) conducted a statewide survey of current and former older drivers in Oregon to determine factors that influenced self-regulation and driving cessation. They found that: those who had voluntarily ceased driving had made significant voluntary changes in their driving in the year or two prior to cessation; those who had ceased driving relied mainly on their family for transportation; there was a lack of alternative transportation options available; and older adults would make personal vehicle trips for emergencies even if they had already stopped driving. The authors noted that the lack of transportation options could lead to continued driving even when physical or mental changes in a person would suggest they could no longer drive safely. Blanchard, Myers, and Porter (2008) compared older adults' reports of self-regulation to measures of driving comfort and actual driving as determined by in-vehicle monitoring. They found that self-regulation was related to driving comfort in certain situations as well as objective measures of driving.

Three GSA papers were related to improving the conversations about transitioning among the older adult and his or her family member/caregiver. Berg-Weger, Niewoehner, and King (2008) presented a new mobility counseling paradigm for older adults designed to ease the transitioning process. The paradigm was based on early planning and a holistic approach to communication that includes the person, his or her family, and community. Gibson, Horowitz, Reinhardt, and Boerner (2008) investigated the factors that influence family/friend conversations with older adults who are faced with vision loss. The study analyzed data from a longitudinal study of drivers age 55 or older with vision loss. The study found that family/friends were more likely to initiate driving conversations with an older driver with vision loss if: they experienced stress related to the older adult's driving; were worried about the older adult's driving; or knew about near crashes. Many family/friends were reluctant to discuss driving unless they perceived serious risk for the older adult. The authors concluded that conversations should take place before serious risk develops. Kostyniuk, Molnar, and Eby (2008) examined the conditions under which adult children express concern about their parents' driving, based on the parents' self-reports. They analyzed data from a statewide survey of older drivers in Michigan. They compared responses from adult children who had and who had not expressed concerns about driving. The study found that children were more likely to raise concerns if their parent: was involved in a crash in past year; was not able

to climb two flights of stairs; walk one-half mile; or was male. The authors conclude that there is consistent evidence that driving discussions between older adults and their children are difficult and too often the discussion does not take place until there is a serious incident, such as a crash.

In line with the explosion of research on transitioning in the past few years, several journal articles have been published and there are several ongoing projects related to this issue. Donorfio, D'Ambrosio, Coughlin, and Mohyde (2008) published the results of a study that examined the impact of age and health on patterns of driving and self-regulation among older adults who still drive. The researchers analyzed data from a nationwide survey of drivers age 50 or older. The study found that: as driver age increases so does the frequency of self-regulation, especially after age 70; reported confidence in and enjoyment of driving decrease with age; and poorer health status decreases confidence and enjoyment of driving and increases the frequency of self-regulation. The authors concluded that age alone is not the best predictor of self-regulation.

Investigators at the University of Michigan Transportation Research Institute (UMTRI) and M-CASTL have been actively engaged in researching self-regulation and the driving transition process. Kostyniuk and Molnar (2008) presented the results of a study designed to better understand how older adults self-regulate driving and any differences in this process by age, sex, and health status. The authors' analyzed data from a statewide survey of older drivers in Michigan (n = 961). In addition to health and functioning questions, the survey asked about how the respondent would travel to an appointment under several types of scenarios, such as inclement weather, or travel in an unfamiliar area. For each scenario the respondent could select "drive as usual," "drive with modifications," or "not drive." The study found that sex had a greater effect on self-regulation than age or health status. Molnar and Eby (2008b) investigated the relationship between self-regulation and driving-related abilities as measured in an on-road evaluation. The study found that: one-quarter of older adults in the study reported engaging in self-regulation; the majority of self-regulators were women; the most common practice was avoiding night driving; and self-regulation of night driving was directly related to performance on the on-road driving assessment. The authors concluded that future studies should focus on objectively measuring self-regulation, possibly through instrumented vehicle studies, and comparing these measures with clinically determined functional abilities and driving performance.

Michigan researchers are also involved in ongoing research sponsored by M-CASTL. Kostyniuk, Connell, and Carow (2009) are developing a model of driving reduction and cessation guided by the Stress and Coping and the Precaution Adoption Process models. Eby, Molnar, Roberts, and Bubar (2009) are developing a new approach to assessing self-regulation by older drivers. In this study they are developing and testing a questionnaire instrument for use by jurisdictions in the US and elsewhere to measure the self-regulatory practices employed by older drivers. The results of both studies should be available in late 2009.

### Livable Communities

One approach that holds promise for helping older adults transition from driving has to do with how we can make our communities more livable. As defined by Silverstein, Johns, and Griffin (2008), an elder livable community refers to "…the features of a local community that support residents who wish to age in place" (pg. 19). Livable

communities enhance transportation by bringing goods and services needed by older adults in closer proximity and they support community mobility options by increasing the density of users and, therefore, the feasibility and profitability of transport options. Eby et al. (2008a) suggested the following research needs related to livable communities: determine how communities can facilitate driving by older adults by improving the travel environment; support driver education; promote safe driving throughout the lifespan; and determine how communities can take positive steps to enhance mobility options, including public transportation, walking and bicycling, and specialized transportation for individuals with varied functional capabilities and mobility preferences. Several studies on this topic have recently been published or are in progress.

Nagel, Carlson, Bosworth, and Michael (2008) examined the relationship between the characteristics of the built environment and walking activity among older adults in Portland, Oregon. Measures of the built environment include percentage of high-medium- and low-volume streets, percentage of sidewalk coverage, number of intersections, number of bus lines, number of commercial establishments, and straight-line distance to nearest park. Multilevel regression analysis found no relationship between walking activity and the built environment, suggesting that in this community, the characteristics of the built environment did not play a significant role in whether older adults walked.

In a similar vein, Kemperman and Timmermans (2009) examined the effects of the built environment on walking and bicycling activity among older adults in the Netherlands. The study correlated travel diary data with objectively defined environmental attributes. The study found that walking trips were more frequent in areas of higher urbanization, with the opposite effect found for bicycling trips. The study also found that both walking and bicycling were less frequent in areas of with relatively low levels of recreation and in green areas. The authors concluded that compact, high density neighborhoods may not be a good urban design concept for promoting walking and bicycling.

Dumbaugh (2008) presented a synthesis of current knowledge of designing communities to enhance the safety and mobility of older adults. The article suggested that the current practices of driver assessment, providing senior-oriented paratransit, and moving non-driving older adults into senior care facilities effectively segregates older adults from the larger community. Based on his synthesis of the literature, Dumbaugh presented four strategies that can be used to design communities and transportation systems to address the safety and mobility of older adults: compliment the arterial roadway system with a network of lower-speed, two-lane through-routes; enhance the connectivity of the local street network within communities, while ensuring that vehicle speeds remain low; balance system capacity with opportunities for protected left turns and safe pedestrian crossings; and encourage household-serving retail and services to locate in community-oriented centers rather than in strip developments along arterial roadways. The author concluded that these strategies will not only enhance the safety of older adults who continue to drive, but will also be broadly beneficial for those experiencing mobility impairments or other disabilities.

Several papers related to livable communities were presented at the 2008 GSA conference. Scharlach, Lehning, and Dal Santo (2008) presented the results of an online survey that addressed the importance of several factors for a community to be considered “aging friendly.” Several characteristics were deemed to be absolutely essential: adequate public transportation; walkable neighborhoods; mixed-use

neighborhoods; community-based support services; and health and wellness programs. Walker and Finkelstein (2008) presented information on an initiative to make New York City a better place in which to grow old.

M-CASTL is sponsoring a project titled*: Youth, Age, and Transportation Accessibility: An Intermetropolitan Comparison* (Levine, Grengs, Kostyniuk, & Wargelin, 2009). Broadly accepted across the transportation field is the idea that the purpose of transportation is not movement per se, but access to activities at one's destination. The implication of this is that transportation outcomes are most appropriately evaluated in terms of accessibility, rather than mobility. This project is developing and comparing accessibility metrics among 30 of the largest 50 metropolitan areas in the US. The project is designed to add to previous research the dimension of the accessibility characteristics and travel behavior of both younger and older travelers. The researchers are analyzing the place-based accessibility indicators developed in previous work and household- and person-level characteristics that can be gleaned from metropolitan household travel surveys. Because the surveys represent a snapshot of the population, they will enable the researchers to analyze and compare accessibility characteristics of older and younger travelers in different land-use and transportation environments: between metropolitan regions, in different locations within a single metropolitan region, and with varying levels of access to transportation alternatives. The results of this study should be available in late 2009.

## Transitioning to Non-Driving: Conclusions

Although many researchers recognize that transitioning from being a driver to a non-driver is a difficult and stressful process for most older adults, very little work had investigated this topic until recently. It is gratifying to see the wide range of research to better understand the transitioning process and to find ways to ease the transition. There is a need to continue and expand this research. Based on the work reviewed here, there is a clear need to better understand how the "conversation" about transitioning takes place and to identify successful strategies for having these conversations. Work is needed to better understand and facilitate the roles of the various people involved in the transitioning process. Recent work has begun to investigate the role of self-regulation in the transitioning process. This work still needs to establish objectively the frequency and extent of self-regulation and its relationship to improved safety and mobility. Finally, work is proceeding on how to develop communities that facilitate transitioning. This important work should also be expanded to better understand how livable communities influence safety and mobility in older adulthood.

## ALTERNATIVE TRANSPORTATION OPTIONS

As discussed previously, many older drivers are able to compensate for declines in functional abilities and continue to drive safely for some time, while others stop driving, often suddenly, because of health conditions, medical problems, involvement in a crash, or recognition that they are no longer safe drivers. Currently, about one in five adults age 65 and older do not drive, with those least likely to drive being the oldest old (age 85 and older), women, non-whites, the poor, and individuals with disabilities (Rosenbloom, 2004). Older adults who are no longer able or choose not to drive must still be able to meet their transportation needs to retain their mobility and, hence, quality of life.

Among the alternative transportation options for older adults are traditional public transit (e.g., buses, light rail, trains, and subways), paratransit (demand response services including ADA transit services), specialized transit services (e.g., those operated by health and human service providers), supplemental transportation programs (e.g., operated by private sector transit services, community groups, and volunteer groups), and other alternatives such as walking or bicycling (Suen & Sen, 2004). The extent to which these options are available varies by community. There is also considerable variation among the various services in terms of how aware people are of the services, how difficult the services are to use, and how much they cost.

The Beverly Foundation (2001) measures the effectiveness of transportation services by the extent to which they are available, accessible, acceptable, adaptable, and affordable. First, transportation must be available and in operation when people need it. Accessibility has to do with whether people can get to and physically use the service. Acceptability has to do with how well the service meets the personal standards of users relative to such things as cleanliness of the vehicle, safety of the waiting area if there is one, and politeness of the driver. Adaptability has to do with whether the service is flexible enough to be responsive to the special needs of individual users. Affordability is the cost of the service and if there are options for reducing out-of-pocket costs. Although these are effective measures of customer satisfaction, they do not provide guidelines for best practices among community mobility options.

A recent paper by the Transportation and Aging Interest Group of GSA (Dickerson et al., 2007) noted several research needs related to alternative transportation:

- A definitive methodology is needed to predict the future number of people who will be limiting or giving up driving;
- Research is needed to better understand how to map older adult functional declines to transportation services;
- There is a need to develop and evaluate community models that demonstrate the continuum of services that are friendly to older adults;
- There is a need to develop transportation alternatives that are responsive to the special needs of the person with dementia;
- Research is needed on the development and testing of a transportation transitions model that links the driver safety and transportation options to help support older adults and their families as they make the transition from driving to dependence on non-driving options for mobility.

## CONCLUSIONS

This report updates that literature reviewed in the M-CASTL 2008 Synthesis Report (Eby et al., 2008a) and defines additional areas where further research is needed. Judging by the volume of research reviewed in the present report, the issues of older adult safety and mobility are receiving much needed attention and funding. When considered in the context of pressing societal issues--generation of motor-vehicle produced greenhouse gases and dependence on foreign oil--research into maintaining safe mobility for our aging society will positively impact these issues. As discussed in this report, one cannot think about older adult transportation safety without also considering how mobility will be maintained once an older person can no longer, or chooses not to drive. The development of community mobility options to help maintain older adult mobility options that are available, accessible, acceptable, adaptable, and affordable will have the added benefits of reduced fuel use and greenhouse gas emissions. Such synergies make sponsorship of aging and mobility research a fiscally responsible choice for society.

Finally, as echoed in the previous report (Eby et al., 2008b), there are several themes that thread through the current report. First, mobility is needed by all people. If mobility needs are not met by driving, then they must be met by other means. Second, older adults are not a homogeneous group. Older adults vary greatly in: the functional declines they may be experiencing; their ability to compensate for declines; their financial and social resources; and their personalities. All of these characteristics interact with the factors influencing safe mobility. Third, older adults, as well as all drivers, need lifelong education to maintain safe mobility. For the older adult, learning about roadway design changes, how to use advanced technology, and the transportation options available when driving is no longer possible is an important component in safe mobility. Fourth, research to help older adults stay mobile will also help younger drivers. Fifth, developing alternatives to automobile use for personal travel will have a wide range of positive societal impact beyond helping older adults stay safely mobile. Finally, meeting the mobility needs of an aging population is complex and will require the expertise and collaboration of several academic and applied disciplines. M-CASTL will continue to provide these collaborative opportunities.

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