

A Crash Reduction Strategy: Training Transportation Professionals in Alabama About How to Manage Drivers with Diminished Capabilities

by

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16. Abstract Alabama has the fourth highest injury and fatality rate from vehicle crashes among all states. Prior research has indicated that diminished capabilities (e.g., visual, cognitive, and/or physical impairments) elevate crash risk, increasing the rates of serious injury and death from involvement in motor vehicle collisions. Alabama has no mandatory re-screening policy to identify drivers with diminished capabilities after a license is issued. In addition, there is no statewide effort to educate transportation and safety professionals in Alabama about how to identify high-risk drivers or the procedures for referral once they are identified. The purpose of this project was to examine the current system for dealing with drivers with diminished capabilities in Alabama, to determine how these guidelines are implemented and enforced by the Alabama Department of Public Safety (DPS) and law enforcement agencies, and to identify specific ways that the current system could be optimized in order to reduce Alabama's high injury and fatality rate. To enhance the ability of the DPS Medical Unit staff and law enforcement officers to manage drivers with diminished capabilities, two resource guides were developed to educate these professional about strategies for identifying and processing high-risk drivers with diminished capabilities. The first one is designed for staff members in the Medical Unit who process the many referral reports and documents from law enforcement, physicians and other citizens about drivers with potentially diminished capabilities. The second one is a pamphlet and accompanying pocket guide educating law enforcement officers in the field about what sorts of functional impairments and medical conditions could impact driving and how these problems could be manifest on the road as unsafe driving. Meetings with the Alabama Department Public Safety also allowed project staffers to identify other ways that the process of managing drivers with diminished capabilities could be facilitated (e.g., better form design). A key step for the future is to evaluate what sort of impact these education resource guides have on the process of managing drivers with functional impairments and whether they are ultimately effective in enhancing driver safety in the state.					
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Executive Summary

Alabama has the fourth highest injury and fatality rate from vehicle crashes among all states. Prior research has indicated that diminished capabilities (e.g., visual, cognitive, and/or physical impairments) elevate crash risk, increasing the rates of serious injury and death from involvement in motor vehicle collisions. Alabama has no mandatory re-screening policy to identify drivers with diminished capabilities after a license is issued. In addition, there is no statewide effort to educate transportation and safety professionals in Alabama about how to identify high-risk drivers or the procedures for referral once they are identified.

Therefore, the purpose of this project is three-fold: 1) To examine the current system for dealing with drivers with diminished capabilities in Alabama, 2) To determine how these guidelines are implemented and enforced by the Alabama Department of Public Safety and law enforcement agencies, and 3) To identify specific ways that the current system could be optimized in order to reduce Alabama's high injury and fatality rate.

The goal was to develop resource guides designed to educate transportation and safety professionals about strategies for identifying high-risk drivers with diminished capabilities. The target user groups for this project were staff members who work in the Medical Unit of the Alabama Department of Public Safety and law enforcement officers. The project personnel consisted of an interdisciplinary team of experts including a researcher experienced in the study of risk factors for crash involvement among drivers with functional impairments, a health educator specializing in the area of driver education and training, and a certified driving rehabilitation specialist who oversees a driving assessment clinic.

After a series of meetings with the Medical Unit and the Public Information Office of the Alabama Department of Public Safety, the research team determined that staffers working in these offices as well as law enforcement officers felt that there was a need for resource information about drivers with functional impairments – what types of impairments and medical conditions are likely to occur among drivers, how these problems can be detected, and what implications these impairments have for safe driving potential. As a result of this identified need, two educational resources were developed. The first one was designed for staff members in the Medical Unit who process the many referral reports and documents from law enforcement officers, physicians and other citizens about drivers with potentially diminished capabilities. The second one was a pamphlet and accompanying pocket guide educating law enforcement officers in the field about what sorts of functional impairments and medical conditions could impact driving and how these problems could be manifest on the road as unsafe driving. Meetings also allowed staffers to identify other ways that the process of managing drivers with diminished capabilities could be facilitated (e.g., better form design). A key step for the future is to evaluate what sort of impact the education resource guides have on the process of managing drivers with functional impairments and whether they are ultimately effective in enhancing driver safety in the state.

Section 1

Introduction, Problem Statement, Overall Project Approach

Introduction

In order to enhance safety, the National Highway Traffic Safety Administration (NHTSA) has recognized the need to identify and deal with drivers with diminished performance capabilities. By diminished capabilities, NHTSA is referring to drivers who suffer from visual, cognitive, and/or physical impairments and the medical conditions that engender these impairments. A growing body of research has indicated that these diminished capabilities elevate crash risk (Owsley, in press 2001), including increasing the rates of serious injury and death from involvement in motor vehicle collisions.

Problem Statement

Alabama has the fourth highest injury and fatality rate from vehicle crashes among all states. The strategies for identifying drivers with diminished capabilities vary across states. Driver's license re-screening is one method used by other states for identifying these drivers. However, in Alabama, there is no mandatory re-screening policy for the identification of high-risk drivers once a driver is licensed for the first time. Furthermore, there is no coordinated and comprehensive effort to educate transportation and safety professionals in Alabama about how to identify high-risk drivers, and also what they should do about them once they are identified. For the purposes of this project, the transportation and safety professionals we are focusing on are of two types -- police officers (e.g., state troopers, county deputies, city police) and the personnel in the Medical Unit of the Licensing Division of the Alabama Department of Public Safety. A strategy to educate these professionals about the management of high-risk drivers could go far in reducing crashes and injuries on Alabama roadways.

Overall Project Approach

We set out to address three questions so that we could identify concrete ways to improve the system for identifying and managing drivers with diminished capabilities in our state:

- (1) What is the system for dealing with drivers with diminished capabilities in the State of Alabama?
- (2) How are these guidelines implemented? That is, what are the actual practices?
- (3) What specific educational aids could enhance the identification of drivers with diminished capabilities?

Section 2

Background

Safe driving relies on a number of key skills that involve visual, cognitive, and physical capabilities. Impairments in these functional capabilities can occur at any age. However, they are more prevalent in the older adult population. A growing body of research over the past decade has demonstrated that certain types of functional impairment in drivers elevate crash risk and have a negative impact on driving performance. A clear understanding about how diminished capabilities contribute to crash risk in drivers greatly facilitates society's efforts to develop strategies to reduce crash rates in this population and to enhance driving mobility. The presence of certain medical conditions also affects driving via the functional problems they engender and also through the medications used to treat these conditions. The section summarizes the major advances in our understanding over the past decade concerning how diminished capabilities impact driver safety and performance, and underscores why this issue must be addressed among those professionals who deal with driver licensing and the enforcement of safe driving statutes and laws.

Vision Impairment

The literature addressing the relationship between visual impairment and driving is substantial, with one recent review listing about 200 published articles on the topic, many from the past decade (Owsley & McGwin 1999). Probably the most common type of study involves examining associations between visual acuity and driving performance, since acuity is the most ubiquitous visual screening test used by licensing agencies for the determination of driving fitness. Some of the most quoted work in this area was done by Burg in the 1960s based on data collected from 17,500 California drivers (Burg, 1967, 1968) and later reanalyzed by Hills and Burg (1977). With respect to older drivers, visual acuity demonstrated a significant association with crash rate. However, the authors note that, despite statistical significance, the magnitude of the correlation was low and cautioned that the relationships found should not be interpreted as meaning that poor acuity is a strong causal factor in automobile crashes among older drivers, or furthermore, that acuity tests are good screeners for high-risk older drivers. More recent studies have reported positive, weak associations between visual acuity and crash involvement (Ball *et al.* 1993; Davison 1985; Henderson & Burg 1974; Hofstetter 1976; Humphriss 1987; Marottoli *et al.* 1998), or no associations at all (Decina & Staplin 1993; Gresset & Meyer 1994; Johansson *et al.* 1996; Marottoli *et al.* 1994; McCloskey *et al.* 1994; Owsley *et al.* 1991; Ivers *et al.* 1999; Owsley *et al.* 1998). Combining the older work with the more recent studies, there is little support from the literature that a strong association exists between visual acuity and unsafe driving.

However, visual acuity is related to the performance of certain driving tasks. For example, simulated acuity impairment (from induced optical blur) is related to decrements in road sign recognition and road hazard avoidance (Higgins *et al.* 1998). In general, though, studies relying on simulation of vision impairment in normally sighted persons, rather than studying actual drivers with visual impairment, must be interpreted with caution. Simulations are abrupt onsets

of reduced vision, whereas in actual visually impaired drivers, reductions in vision typically emerge gradually, affording the person the opportunity to develop compensatory strategies and coping mechanisms for driving.

Given that visual acuity is the most common vision screening test for licensure, it seems paradoxical at first glance that research generally does not support the conclusion that acuity tests can effectively identify high-risk drivers. There are several possible reasons why studies have generally failed to find strong associations between visual acuity and crash risk, as summarized here and discussed in detail elsewhere (Owsley & McGwin 1999; Shinar & Schieber 1991; Ball & Owsley 1991). Letter acuity tests were originally designed for the clinical diagnosis and monitoring of eye disease, but not for the evaluation of visual performance skills in complex tasks such as driving. Guiding a vehicle along a roadway and through intersections involves the simultaneous use of central and peripheral vision and requires monitoring of primary and secondary visual tasks, all in the midst of a visually cluttered array whose elements are in motion. Severe visual acuity impairment (e.g., worse than 20/70-20/100) most likely engenders driving performance problems and even decreases safety; however, other types of visual processing impairments even in the presence of good acuity also jeopardize safe driving, as discussed below. An acuity screener would fail to identify these individuals as high risk.

Another potential reason studies have not found strong links between acuity impairment and driver safety is that drivers with severe visual acuity impairments may not be on the road because of state licensing requirements. In this sense, driving license restrictions based on acuity deficits may be in fact increasing public safety. Therefore, it would be impossible in many states to conduct the proper study to evaluate whether and to what extent visual acuity was associated with automobile collisions. Some states do not require vision re-screening and therefore are likely to have drivers with visual acuity impairment on the road. Such situations in certain states represent unique opportunities to evaluate the impact of severe acuity impairment on crash risk. Research also suggests that individuals with visual acuity and other vision impairments, especially older drivers, may elect to give up driving or simply limit their driving to familiar and low-risk situations (Ball *et al.* 1998; Campbell *et al.* 1993; Forrest *et al.* 1997; Marottoli *et al.* 1993; Stutts *et al.* 1998), thus removing or minimizing exposure to the possibility of a crash. All of these factors would mitigate against finding an association between acuity and crash involvement, even if one exists.

Several studies have examined the role of deficits in peripheral vision in driver safety and performance. One of the most quoted studies is a California study (Johnson & Keltner 1983) finding that crash and violation rates were twice as high among those with severe binocular field loss compared to those without any loss, adjusting for annual mileage. More recently a study reported a similar finding in that those older drivers with impaired peripheral vision in the better functioning eye were two times more likely to be crash involved compared to those with good peripheral vision in the better eye (Ball *et al.* 1993). However, a number of other studies (Burg 1967; Hills & Burg 1977; Decina & Staplin 1993; Owsley *et al.* 1998; Burg 1968) have not reported elevated crash rates for those with visual field impairments. An important consideration in comparing these results is that the definition of impairment differs across the studies. The California study (Johnson & Keltner 1983) defined impairment as severe binocular field loss, whereas most other studies defined it in a less impaired fashion.

Visual field impairment also impacts certain aspects of driving performance. In a series of studies from Australia (Wood & Troutbeck 1992; Wood *et al.* 1993; Wood & Troutbeck 1995), the impact of simulated visual field restriction on driving performance on a closed course was evaluated. Visual field impairment compromised some (e.g., identification of road signs, avoid obstacles, reaction time) but not all (e.g., speed estimation, stopping distance) aspects of driving performance. A driving simulator study also demonstrated that field restriction impaired the detection of important targets in the affected area (Lovsund *et al.* 1991). The relevance of the findings from these studies to real world driving is not clear. As discussed earlier, it is likely that the impact of sudden, simulated visual field restriction is different from that of naturally occurring restriction from eye disease, such that the persons with the latter may develop compensatory mechanisms over time. Further, closed course or simulator driving is likely to be less complex and demanding than actual driving and may not allow for the observation of critical driving problems (e.g., crashes). In several studies wherein real world driving performance was assessed, drivers with visual field impairment did not reveal an increased tendency for driving performance problems (Marottoli *et al.* 1998; Cashell 1970; Council & Allen 1974; Danielson 1957).

When interpreting the literature on visual fields and driving, an important issue to consider is visual field measurement procedures. For example, in some studies only the extreme limits of the visual field were determined. Such screening techniques provide little information about the type or severity of visual field impairment (e.g., scotomas, central field defects). Another possible explanation for the differences among study results is behavioral adaptation and compensatory strategies. Drivers with visual field defects may partly overcome them by eye and head movement, reduced driving exposure, or both. In the future, studies should attempt to not only better quantify the extent of visual field defect but also the extent to which drivers adjust and compensate. Drivers with visual field defects who successfully modify their driving behavior so that their ability to drive safely is not compromised may provide a rationale for screening drivers for visual field defects, since the negative ramifications of their field impairment on driving may actually be remediable. Such an approach could identify impaired drivers, assist them in adopting accommodative strategies, and enhance their driving mobility and safety.

There are comparatively fewer studies on the role of contrast sensitivity in driving, as compared to the literature on acuity and visual fields. A few studies have reported associations between contrast sensitivity and crash involvement. Greater impairment in contrast sensitivity has been linked to a higher number of at-fault crashes in the prior five years (Ball *et al.* 1993), and in the subsequent three years (Owsley 1994), although these associations were not adjusted for confounding factors. Marottoli *et al.* (1998) also reported a positive univariate association between adverse driving events among older drivers and impaired contrast sensitivity. Wood *et al.* (1992; 1993) has examined the impact of simulated contrast sensitivity on driving performance on a closed road course. Better contrast sensitivity was associated with better driving skills. Along these lines, Rubin *et al.* (1994) reported that older drivers reporting difficulties with day and evening driving had worse contrast sensitivity. Contrast sensitivity, as well as acuity, are linked to road sign recognition (Evans & Ginsburg 1985; Kline 1990).

A common cause of contrast sensitivity loss in older adults is cataract, a prevalent eye condition in the elderly that involves an opacification of the crystalline lens. Almost half of adults exhibit early cataract by age 75, and approximately one-quarter with more advanced cataract (Kahn *et al.* 1977; Klein *et al.* 1992). A recent study (Owsley *et al.* in press 2001) evaluated the role of contrast sensitivity impairment in elevating crash risk in a large sample of older adults with clinically significant cataract (20/40 or worse in at least one eye). Those older drivers with a history of recent crash involvement were eight times more likely to have severe contrast sensitivity impairment as compared to those older drivers who were crash-free. Impaired acuity was unrelated to crash involvement in cataractous drivers when contrast sensitivity deficits were adjusted for. Given the importance of image contrast in pattern vision and evidence that contrast sensitivity deficits underlie driving problems in older drivers with cataract, this is an area deserving of further study.

There are a number of other aspects of visual function that have been considered with respect to driving. It is well established that older adults typically experience impairments in color discrimination (Knoblauch *et al.* 1987), primarily along the tritan or “blue-yellow” axis, so the question of how this impacts their driving is relevant. The underlying rationale for color vision testing in both personal and commercial driver licensing is not the belief that color deficiency is a major risk factor for crash involvement; rather, color vision screening is simply a way to insure that drivers can obey color traffic control devices. The critical cues on the road usually can be obtained through multiple sources of information (e.g., luminance, position, pattern), so drivers with color vision anomalies do not experience serious difficulty in traffic signal recognition. Vingrys and Cole’s comprehensive review (1988) of this literature indicates that the vast majority of studies on color vision and road safety support this conclusion, finding no association between color deficiencies and vehicle crash involvement or impaired driving performance. Owing to this overwhelming wealth of evidence, it is reasonable to conclude that color deficiency by itself does not elevate crash risk in personal or commercial drivers, or for older drivers with modest color discrimination problems.

The visual world of the driver is in motion, and in this sense, stationary test targets in driving assessment tests are not very representative of the visual scene. Studies from the 1960s and 1970s, which included both static and dynamic acuity measurements, have generally found that dynamic targets had stronger univariate associations with crash involvement than did static targets (Burg 1967; 1968; Shinar 1977). However the associations between dynamic visual acuity and driver safety were still weak. It has been noted that dynamic acuity deteriorates more rapidly with age. Furthermore, individuals with the same static acuity can have widely divergent dynamic acuity. At the very least, tests of sensitivity for dynamic visual events require a closer look in terms of their association to driver safety and performance.

Disability glare problems are discussed as a serious threat to the safety of older road users (Wolbarsht 1977), but one is hard-pressed to identify actual studies that scientifically confirm this notion. This failure to find an association between glare and road safety may be due to methodological difficulties in defining “glare” and in measuring a multi-faceted phenomenon, as well as to a poor understanding of what people mean when they say they have “glare” problems.

The role of eye movement disorders in driving is largely an untouched research area. Prior research on normally-sighted drivers indicates that experienced drivers continuously scan the road scene for useful information (Mourant & Rockwell 1972). Older drivers with restrictions in the ability to turn their heads experience a restriction in the distances at which approaching traffic could be brought into the central visual field for visual inspection (Isler *et al.* 1997). Motion perception and optical flow phenomena such as “heading” have a great deal of face validity to the driving task, but little work has addressed how impairments in motion processing may affect driving performance and safety. Three decades ago a study (Shinar 1977) showed that performance in a motion perception task was one of the best correlates of self-reported crash involvement among a large battery of vision tests, but the relationship was still weak. This study also found that acuity under low illumination was related to nighttime crash involvement, but again the link was weak. It has been suggested that drivers’ errors and crashes at night may stem from their lack of awareness of perceptual limitations that occur in low light (Leibowitz *et al.* 1982; 1998).

Most vision-threatening eye conditions that occur in middle-aged and older adults are bilateral in nature, i.e. affecting both eyes (e.g., cataract, age-related macular degeneration, glaucoma, diabetic retinopathy). However, the severity and rate of progression of the condition can vary greatly between the two eyes, allowing for situations where one eye retains good function while the other eye is seriously impaired. This issue may be highly relevant in understanding crash risk given the results of a recent study on older drivers with cataract (Owsley *et al.* in press 2001). The study showed that vision impairment need only be present in one eye to substantially elevate crash risk. A handful of studies have specifically examined the safety and driving performance capabilities of “monocular” drivers. In these studies, monocularity has been defined in a variety of ways. Although in these studies one eye has good acuity or good peripheral vision (often not precisely defined), the fellow eye can vary across studies from no vision at all, to acuity worse than 20/200 or significant scotomas in the visual field, to no definition of monocularity given whatsoever. Thus, interpreting study results and summarizing across studies can be difficult. With respect to actual driving performance, simulated monocular vision, by occluding one eye, did not impact driving maneuvers on a closed-road course (Wood & Troutbeck, 1991; Wood *et al.* 1992). With respect to safety, those drivers with monocular field loss did not have an elevated crash rate compared to a control group of drivers with normal visual fields in both eyes (Johnson & Keltner 1983). Not all studies are consistent with these findings however (Liesmaa 1973; Keeney 1968), finding higher rates of violations and mishaps among monocular drivers as compared to those with normal vision in both eyes. A growing body of evidence suggests that monocularity, particularly visual acuity impairment worse than 20/200 in one eye, elevates crash risk among commercial drivers who are exposed to high levels of driving often in intense traffic situations (Maag *et al.* 1997; Laberge *et al.* 1996; Roger *et al.* 1987). A study performed by the California Department of Motor Vehicles (Roger *et al.* 1987) on the safety of heavy-vehicle truck drivers found that those who were monocular (acuity worse than 20/200 in one eye) had more total convictions and crashes than did non-visually-impaired drivers. Yet this topic remains controversial. For example, a recent study (McKnight *et al.* 1991) that assessed driving performance in both monocular and binocular commercial drivers reported there were no group differences in the safety with which most day-to-day driving maneuvers were performed.

Cognitive Impairment

Because driving is a complex visual/cognitive task, it is unlikely that an assessment of visual sensory impairment and the diagnosis of eye disease would alone be sufficient to identify those at elevated risk for crash involvement. Visual information processing skills, not only visual sensory thresholds, have a great deal of face validity to the execution of safe driving practices. One such skill that appears to be relevant is visual attention. It is interesting that several studies from the early 1970s implied that impaired visual attentional abilities were linked to crash involvement (Barrett *et al.* 1977; Kahneman *et al.* 1973; Mihal & Barrett 1976), but this finding was not further explored until recently.

During the late 1980's, a task called the Useful Field of View test was developed which assesses the visual field area over which one can use rapidly presented information (Ball *et al.* 1990; Ball *et al.* 1988; Sekuler & Ball 1986; Sanders 1970). Unlike conventional measures of visual field, which assess visual sensory sensitivity, the Useful Field of View test additionally relies on higher-order processing skills such as selective and divided attention and rapid visual processing speed. Over the past decade, in excess of 50 published articles have evaluated this measure in the context of driving competence (Ball *et al.* under review). For example, reduction in the useful field of view in older drivers is associated with a history of at-fault crash involvement (Ball *et al.* 1993; Owsley *et al.* 1991) [5, 16] and injurious crash involvement (Owsley *et al.* 1998). Those drivers with the most severe restrictions tended to have the highest number of crashes during the prior five years (Ball *et al.* 1993). In a prospective study (Owsley *et al.* 1998) older drivers with a 40% or greater impairment in the useful field of view were two times more likely to incur a crash during the three years of follow-up, after adjusting for age, sex, race, chronic medical conditions, mental status, and driving exposure. This association was primarily mediated by difficulty in dividing attention under brief target durations. It is noteworthy that in this study useful field of view impairment was the only type of visual deficit that was related to future crash involvement; deficits in acuity, contrast sensitivity, and visual field sensitivity were unrelated to future crashes.

The Useful Field of View test has also been used to study crash proneness in the Alzheimer's disease (AD) population. Studies indicate that in drivers with AD, the useful field of view reduction is one of the best predictors of crash-involvement in a simulator and poor on-road performance in a driving test, when compared to other cognitive tests (Duchek *et al.* 1998; Cushman 1996; Rizzo *et al.* 1997). These studies imply that visual attention and visual processing speed are critical considerations when evaluating safe driving skills and may be better screening tests for detecting high-risk older drivers than visual sensory tests, a practical issue worthy of focused investigation.

Impaired performance on other tests of higher order visual processing abilities have also been related to crash involvement and impaired driving performance, underscoring the importance of assessing visual skills beyond basic sensory capabilities. Studies have reported associations between unsafe driving and deficits in visual search and sequencing abilities (Duchek *et al.* 1998; Goode *et al.* 1998), selective attention tasks (Marottoli *et al.* 1998; Cushman 1996), spatial memory (Rizzo *et al.* 1997; Odenheimer *et al.* 1994), the perception of three-dimensional structure from motion (Rizzo *et al.* 1997), and Trails (Ball *et al.* 1993; Cushman 1996; Tarawneh *et al.* 1993; Cooper *et al.* 1993; Stutts *et al.* 1996). The strength of the association between the

visual/cognitive measures and driving competence is consistently much stronger than with visual sensory function alone.

Since higher-order visual processing abilities which rely on intact cognitive function have been discussed above, further discussion of cognitive impairment will focus on studies relating mental status and Alzheimer's disease to driving competence. Several studies have identified cognitive impairment as a risk factor for unsafe driving among older adults. Older drivers with cognitive impairment, regardless of etiology, are at least twice as likely to be crash involved, depending upon the study one cites (Ball *et al.* 1993; Johansson *et al.* 1996; Marottoli *et al.* 1994; Owsley *et al.* 1991; Cooper *et al.* 1993). On face validity, this is not surprising. Control of a vehicle during a typical drive involves many cognitive skills, such as visual attention, memory, and reasoning. Prior work has documented this link. Older drivers with general cognitive impairment (e.g., as assessed by short mental status screening tests such as the Mini-Mental State Exam) exhibit on-road driving problems (Goode *et al.* 1998; Hunt *et al.* 1993; Fox *et al.* 1997; Fitten *et al.* 1995) as well as an elevated crash risk (Johansson *et al.* 1996; Marottoli *et al.* 1994). Furthermore, studies focusing on specific cognitive domains have found that crash involvement and poor on-road or simulated driving performance are linked to attention problems (Ball *et al.* 1993; Marottoli *et al.* 1998; Owsley *et al.* 1991; Owsley *et al.* 1998; Owsley 1994) and impairments in visual search (Duchek *et al.* 1998) and spatial memory (Rizzo *et al.* 1997).

While most experts agree that driving is unsafe and therefore unwarranted in the moderate to severe stages of dementia (as summarized in Lundberg *et al.* 1997), with Alzheimer's disease (AD) being the most common diagnosis. There is a great deal of controversy about whether those with the mild dementia should be behind the wheel. One of the hotly debated issues is what to do about the driving privileges of an individual once he or she is diagnosed with a dementing disease (Drachman 1988; Reuben 1991; Freedman & Freedman 1996; Friedland *et al.* 1988; Lucas-Blaustein *et al.* 1988). This issue stems from a sincere concern for the safety of both the elderly driver with dementing disease and of the other road users. Several studies have focused on the diagnosis of AD per se as a risk factor for crash involvement. A number of these studies have reported that older drivers diagnosed with AD are more likely to be crash-involved than are drivers without this diagnosis in the same age range (Lundberg *et al.* 1997; Friedland *et al.* 1988; Lucas-Blaustein *et al.* 1988; Tuokko *et al.* 1995; Dubinsky *et al.* 1992). For example, several studies have implied that between 30 - 40% of drivers with AD are likely to be involved in a motor vehicle crash after the onset of symptoms (Friedland *et al.* 1988; Lucas-Blaustein *et al.* 1988; Gilley *et al.* 1991). One study found that although older drivers with AD had a slightly higher annual rate of crash occurrence as compared to non-AD drivers, the crash rate among the AD drivers was still within the range deemed acceptable for other age groups, especially young drivers (Drachman *et al.* 1993). Thus, the authors of this study argued that older drivers with AD are no more a hazard on the road than are some other segments of the driving population, and thus may be unfairly targeted.

Only one study has suggested no differences in crash involvement between drivers with AD and normal controls (Trobe *et al.* 1996). This study reported that the frequency of crashes within a group of drivers with AD, compared to a group of non-demented controls, was no different for either pre-diagnosis or post-diagnosis periods of driving. These authors also reported that the drivers with AD drove significantly less (i.e., had less driving exposure) than did the controls,

and thus this reduced exposure may have mediated the similar crash rates of the two groups of drivers in this study. In summary, then, most studies imply that older drivers with AD are more likely to be crash involved, than are non-demented controls.

Rather than stereotyping older drivers with presumed AD as having a high crash risk, many have argued that functional evaluation of driving skills, using assessment tools with proven validity, is the only fair way to decide for or against licensure in an individual driver (Drachman 1988; Owsley 1997). An international panel of experts (Lundberg *et al.* 1997) recently agreed that decisions on the fitness of "at risk" drivers to continue to drive should be based on empirical observations of performance, because age or medical diagnosis alone are often unreliable criteria. In the absence of objective criteria, physicians and other caregivers must often rely on intuition to restrict driving. Such decisions may unfairly restrict mobility or unwisely sanction driving in the crash-prone. As earlier discussed, driving is tied to personal independence and self-worth, and removal of the license from a person with presumed AD without objective evidence of impaired skills is viewed by many as unreasonable. However, there seems to be little consensus among health professionals and driving experts on how to advise dementia patients in the early stages of the disease on whether or not to drive. These issues highlight a serious public health problem that cannot be ignored (O'Neill 1992). Further efforts to address the critical questions are clearly needed. The challenge is that a functional-evaluation approach is difficult to implement because there are no accepted and standard protocols for evaluating skills important for safe driving in drivers with dementia. Many authors have remarked on the need for prospective studies to evaluate cognitive abilities and driving performance and the ultimate development of a cognitive battery that could be used in conjunction with an on-road evaluation (Carr *et al.* 1990; Carr *et al.* 1991; Carr 1993; Mitchell *et al.* 1995; Logsdon 1992; Rees *et al.* 1995).

Physical Impairment

Controlling a vehicle in a safe fashion obviously depends on the successful execution and continuous monitoring of physical behaviors. Several aspects of motor ability that on face validity appear to be important for the driving task are strength, coordination (both gross and fine), range of motion of head/neck, arms, and legs including the overall flexibility of the extremities, and balance and gait (e.g., in getting in and out of a vehicle, sitting in a stable fashion behind the wheel). As summarized by Marottoli *et al.* (1993), what is most striking about the area of physical function and driving in older adults is that relatively little is known about how physical function deficits impact their driving safety and driving behavior. There is little to no information available about what minimum levels of physical functioning are necessary for safe driving. Reductions in strength could theoretically be a problem when turning the steering wheel or shifting the gear lever, however, most new vehicles' controls are designed now to accommodate a wide range of driver strength to facilitate ease of operation. Retchin *et al.* (1988) found a bivariate association between grip strength and driving frequency among older veterans, suggesting that some older adults with impaired strength may avoid driving. Range of motion with respect to the head and neck is especially important for checking for vehicles, pedestrians, and other obstacles in the roadway environment. It has been shown that older drivers with restricted ability to turn their heads (e.g., from arthritis) are limited in the distances at which approaching traffic can be brought into the central visual field for visual inspection, and that limited neck rotation is a risk factor for future crash involvement (Marottoli *et al.* 1998).

Gait and balance problems may be especially a problem when getting in and out of vehicles, which may hamper the use of one's vehicle, even though the person may be safe behind the wheel, an issue worthy of study. In terms of lower extremity problems, foot abnormalities in older adults have been associated with the occurrence of crashes and moving violations in older drivers (Marottoli et al. 1994), implying that these problems may hamper the ability to maneuver between the accelerator and the brake. Capabilities associated with physical activity have also been related to older adults' driving safety. Crash- or violation-involved older drivers walked fewer blocks on the average day (Marottoli *et al.* 1994) and reported difficulty with physical activities such as walking a mile, opening a jar and doing yardwork or light housework and were more likely to have a history of falls (Sims *et al.* 1998; Sims *et al.* 1999), compared to those who were not crash- or violation-involved. This implies that physical difficulties with other instrumental activities of daily living may serve as markers or warning signs that a person may also be having problems with driving. It has long been known that reaction time to a visual stimulus is increased on average in older adults compared to younger adults when measured in a laboratory setting, however, slow reaction time has not been consistently identified as a risk factor for older adults' crash involvement. This may be because of compensatory behaviors like driving more slowly and avoiding heavy traffic areas, although these potential coping strategies deserve further investigation in terms of their role in minimizing crash risk.

Section 3

Methodology

Our methodology had three parts. Our first task was to comprehensively review the published scientific literature on functional impairments as it relates to driving. We focused on the three most common impairments that threaten safe driving – visual, cognitive, and physical impairments. Literature for this review was based on a MED-LINE search using the terms vision, ocular, vision impairment, cognitive impairment, physical impairment, driving, accident, and crash for the period of 1966 to the present. Additionally, references contained within those articles and not listed in MED-LINE were gathered. Article and reports from the first author’s reprint collection were also included.

Our second task was to contact and arrange several meetings with the Medical Unit of the Alabama Department of Public Safety and also the Public Information Office of the Alabama Department of Public Safety. These meetings were conducted in person, by conference call, and by regular telephone conversations. The purpose of these meetings was to gather information with respect to Questions 1 and 2 as listed in Section 1 under Overall Project Approach, i.e. to learn what the current system is for identifying drivers with diminished capabilities and how this system is followed at a practical level within the Department of Public Safety.

Our third task consisted of developing educational aids and curriculum materials to enhance the process of managing these drivers within the current Alabama system. We based the content and structure for these materials on our discussions with the Medical Unit and the Public Information Office, in terms of what would be most practical and most useful from their own standpoint.

Section 4

Project Findings and Products

The main project findings are summarized in the following paragraphs. In addition, two draft prototype products that were developed in the project are introduced.

DPS License Examiners

The Department of Public Safety (DPS) license examiners (i.e., the DPS staffers that accept applications for driver's licenses and process these applicants at the counters) are rarely in a position to identify drivers with diminished capabilities. Since Alabama now recognizes licenses from almost all states, many applicants coming from other states are not re-tested. Similarly, there is no re-screening process for those who maintain an Alabama license. Therefore, many individuals tested are novice drivers who are very unlikely to have diminished visual, cognitive, or physical impairments. If someone is wearing glasses at the time of licensure, a restriction is placed on the license. No eye examination is required. If a driver fails the visual acuity test at license examination, they are referred to the Medical Unit who asks them to complete a comprehensive visual examination form. Therefore, there is no opportunity for an educational program to intervene in an effective fashion at the level of the DPS license examiners.

Medical Unit Staff

The Medical Unit reviews cases as they are referred to the Unit by law enforcement officers, private citizens or physicians. A driver behavior and condition report is submitted citing the need for a specific driver to be re-examined. A letter is sent to the driver telling him or her of the need to have a visual examination or physical examination. The physician is the primary source of referral. The Medical Unit reviews the form completed by the physician and usually makes decisions based on the physician recommendation (as indicated on referral form "should this person be driving"). In other words, if the physician indicates that the driver should be driving, then this is what is typically recommended, and if the physician says the person should not drive, then that recommendation is typically made. The Medical Advisory Board is called to assist in questionable cases (which is rare because the Medical Unit typically follows the advice of the physician).

After conducting interviews with all members of the Medical Unit (six members), their greatest need was information about medical conditions that are outlined by state law. The staff felt that they were at the mercy of the physician since they often did not understand the medical conditions reported on the examination form. Staff members requested information on common eye diseases, cognitive impairments such as dementia and Alzheimer's disease and physical impairments. The Medical Unit also expressed a need for resource information to assist with the many phone calls they receive from drivers and families regarding eye care specialists, places to find adaptive equipment, or resources providing alternative transportation to those who lost driving privileges. They expressed a need for information from the literature that they could provide to physicians on the Medical Advisory Board. For these reasons, we developed a notebook which provides 1) information on common functional impairments that impact driving,

2) a list of state resources that assist individuals with these impairments and 3) articles from the research literature to guide the Medical Unit staff and physicians on the medical advisory board in making the best decision about driver abilities.

Department of Public Safety

Interviews with key personnel at the DPS (e.g., Captain McCall in the Public Information Office and Lieutenant Burns and Sgt. Chapman in the Medical Unit) revealed that many officers were not well versed in how to identify drivers with diminished visual, cognitive and/or physical impairments (consistent with prior research). It also came to our attention throughout interviews with Captain McCall and with the Medical Unit staff that many officers did not complete the driver condition and behavior report accurately. As a result, the Medical Unit was often forced to throw the referral out. Therefore, the educational needs identified were to provide law enforcement officers with information that would assist them in identifying potentially unsafe drivers at the roadside. It was also necessary to encourage officers to complete the citation cards more appropriately. State law enforcement officers indicated that the best way to communicate this information was through a pocket guide that officers could use at the scene while in contact with the driver. Therefore, we developed a pamphlet and pocket guide that could be distributed to law enforcement officers (state police, county deputies, city police) statewide.

Challenges

Many individuals at the state level recognize the problem of identifying drivers with diminished capabilities that continue to drive. However, these professionals are restricted by the Alabama legislation which in some cases needs modifying, a process that is time-consuming and difficult to achieve. For example, the need for mandatory re-screening and having more tests done at the license examination level was often mentioned. The Medical Unit expressed a frustration with legislation that is not consistent with current medical knowledge (e.g., oral insulin and its impact on driving). There may be new research demonstrating an effect of a medical condition on driving, yet the Medical Unit is bound by current law and the prospects of changing the law to reflect the new findings are not promising.

Professionals at both the Medical Unit and Public Information Unit cited lack of financial resources to publish updated information on how to identify and process these individuals with diminished capabilities. Also, a lack of staff and manpower to pursue these cases in an ideal manner was also discussed.

Professionals at the state level wish they could do more. For example, the Medical Unit sees cases where the physician may make the incorrect recommendation about driving abilities. However, since the physician has the medical training and the official state licensure to practice medicine, the Medical Unit is bound by state law and the judicial system to comply. For example, the Medical Unit does not appear to have the power to override the decision of the referring doctor, despite repeated reports of unsafe incidents from law enforcement (e.g., driving wrong way down the interstate) and close calls reported by family members and people in the community.

After meetings with the Medical Unit and the Public Information Office, it was determined that distance learning courses would be premature at this time. These transportation professionals

needed background information first and needed the information in a format that could be quickly implemented. The final products produced by this project serve the needs expressed by the transportation professionals themselves. After determining the efficacy of these tools, perhaps the next step would be to develop a distance learning program that could be presented at the training academy and continuing education.

Products

Two draft prototype products were developed as a result of this project. The first product, as mentioned above, is a notebook that was developed in response to the Medical Unit's need and the Medical Advisory Board's need to have a resource guide readily accessible, as they make decisions and recommendations about drivers with diminished capabilities. As discussed earlier, this resource notebook has three major types of content: 1) information on common functional impairments that impact driving, 2) a list of state resources that assist individuals with these impairments and 3) articles from the research literature to guide the Medical Unit staff and physicians on the Medical Advisory Board in making the best decision about driver abilities. These resources were gathered in the following ways. With respect to the information about functional impairments and driving, a medline search was performed in order to identify articles on this topic. The major findings from these articles were used as a guide in putting together the notebook's informational summaries on medical, visual, cognitive, and physical problems that are known to impact driving performance. With respect to state resources that assist individuals with functional impairments, we compiled a list of resources about rehabilitation, eye care, and public and private agencies that provide alternative transportation options for those who can no longer safely drive. Finally, we selected a subset of articles for inclusion in the booklet that we felt were particularly good overviews and/or presented important information about medical conditions and driving in a cogent fashion.

The second draft prototype was a pamphlet and pocket guide intended for use by law enforcement officers. This pamphlet and pocket guide offers law enforcement officers easy-to-understand tips on how to manage drivers suspected of having diminished capabilities while on the road. These tips are based on scientific findings from the literature and are presented in an easily understood form to facilitate their implementation for officers "at the scene". The pocket guide is a short, "to the point" version of the pamphlet that can be easily accommodated into the officer's pocket binder or citation case.

For more information about these products, please contact Dr. Cynthia Owsley at the Department of Ophthalmology, University of Alabama at Birmingham, 700 S. 18th Street, Suite 609, Birmingham, AL 35294-0009 or by e-mail at owsley@eyes.uab.edu or phone (205) 325-8635.

Section 5

Project Conclusions and Recommendations

1. Both the Department of Public Safety (DPS) Medical Unit staff and the Public Information Office, speaking on behalf of law enforcement officers, are professionally committed to enhancing driver safety in Alabama, and specifically, to taking all appropriate steps to manage drivers with diminished capabilities so that all road users are safe.
2. They believe that there is a need for educational resource materials, such as the two prototype products developed as part of this project (a resource notebook, and a pamphlet/pocket guide), that can help them process drivers with functional impairments through the system. They also felt these resources would be routinely used if made available on a more widespread basis within the Driver Licensing Division of DPS and within law enforcement.
3. The Medical Unit staff expressed an interest in modifying the referral forms so they can more reliably and validly obtain the information needed to make decisions about licensure. They would like assistance from driver safety experts and from medical experts in proposing design modifications.
4. The Medical Unit staff expressed frustration about receiving reports they cannot read and have discussed the possibility of providing referral forms and examination reports on-line so physicians can fill them out from their office computers.
5. The DPS, through the Public Information Office, expressed an interest in highlighting the issues in the pocket guide during the training of law enforcement officials at the state academy and also at continuing education programs.
6. Both the resource book and the pocket guide need to be formally evaluated. For example, how many officers utilize the pocket guide? Has the quality of the information on the driver behavior and condition report improved? With respect to the Medical Unit, has there been an increase in the identification and assessment of drivers with potential visual, cognitive, and physical impairments identified? Has there been an increase or decrease in the license revocation of those drivers with impairments so severe that road safety is threatened? These and similar questions are suitable topics for future research.

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