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Feasibility and Results of a Computer-Based Driver Safety Assessment

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Feasibility and Results of a Computer-Based Driver Safety Assessment

Program for Older Adults

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MS, Fordham University, 1981
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A Thesis

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Feasibility and Results of a Computer-Based Driver Safety Assessment

Program for Older Adults

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Introduction

Driving represents freedom, control and competence. It allows us to go places such as work, social gatherings, houses of worship and shopping. Driving has been linked to independence and quality of life especially for older drivers.¹

Motor vehicle safety among older drivers (65 years and older) is an important public health issue. Older people represent an increasing proportion of the United States population² and this trend is escalating as baby boomers age. By 2030, nearly one in five U.S. residents is expected to be 65 years old or older.² This will result in an elderly population of more than 70 million people.³ As they age, older people are keeping their driver's licenses longer than in past years and are driving more miles.⁴ Motor vehicles allow older adults to maintain mobility and independence, but as their age increases, so does the older adults' risk of being injured or killed in a motor vehicle crash.^{4, 5} Research shows that age is not the sole predictor of driving ability and safety.⁶ But, there is ample evidence to show that most drivers experience age-related declines in physical and mental abilities or declines that result from medical conditions. Such declines can signal a greater crash risk potential.^{5, 6}

The purpose of this paper is to examine motor vehicle safety among older drivers (65 years and older) in the United States. We will present a statement of this public health problem, elaborate on its public health impact, discuss interventions that address older driver safety, and report on the results of a pilot study conducted to determine the feasibility of a computer-based driver safety assessment program developed by the American Automobile Association.

Public Health Approach

Motor vehicle safety is a public health issue and, like many diseases, motor vehicle injuries are preventable.^{7, 8} To address this growing public health issue agencies such as the Centers for Disease Control and Prevention (CDC) utilize a systematic process called the public health or systems approach.⁸ This approach has four steps: define the problem, identify risk and protective factors, develop and test prevention strategies, and assure widespread adoption of effective injury prevention principles and strategies.⁸ The first step involves surveillance or the gathering and analyzing of data. The data will help indicate the magnitude of the problem among older drivers. Step two involves finding out why older drivers are involved in car crashes, what their risk factors are, and what factors could protect them from crashing. In step three, knowledge is put into action. Using data collected in the research, public health professionals design strategies to help prevent or reduce motor vehicle crashes among older drivers. The strategies are tested in communities that are experiencing the problem to determine the effectiveness of the intervention. Modifications, if needed, are made to eliminate difficulties or increase effectiveness. In step four, the information is shared with other groups so that communities can replicate the successful intervention.

Successful public health efforts to reduce motor vehicle related injuries and improve motor vehicle safety include graduated licensing for teens, increased use of seat belts, and enforcement of laws regarding speeding, and drinking and driving.⁹

Statement of Problem

There were 31 million licensed older drivers in the United States in 2007 – which is a 19 percent increase from 1997.¹⁰ More than 183,000 older adults were injured as

occupants in motor vehicle crashes in 2008.¹⁰ On a daily basis, 500 older adults are injured in a crash and almost 7,000 die annually in motor vehicle crashes.^{10, 11} In Connecticut, in 2006, there were 5,895 accidents among older drivers with 2,384 injuries and 31 deaths.¹² Per mile traveled, fatal crash rates increase starting at age 75 and increase markedly after age 80.¹³ In Connecticut, among persons 70 years and older the fatal crash rate is 20.7 per 100,000 licensed drivers and the injury crash rate is 824 per 100,000 licensed drivers.¹⁴

The high fatality rate among older drivers is due largely to increased susceptibility to injury, particularly chest injuries, and medical complications among older drivers.¹⁵ Risk factors that may lead to fatal crashes include the gradual deterioration of the senses, diminished cognitive processing capabilities and decreased mobility and flexibility that make it more difficult for older drivers to gather and process information.¹⁶ In a June 2010 release, the Insurance Institute for Highway Safety reported that contrary to expectations, the rate of fatal crashes per licensed driver 70 and older declined from 1997 to 2008.¹⁷ No particular reason was cited for the decline, but a partial explanation may be that older drivers are reducing driving time themselves.¹⁷ While the numbers have been declining nationwide for years, from 7,468 deaths in 1999 to 6,632 in 2007,¹¹ measures to maximize older driver safety are still needed if the Healthy People 2010 national objective of 9.2 deaths per 100,000 population is to be met.¹⁸

Economic Costs of Motor Vehicle Crashes

Motor vehicle crashes are the leading cause of death from unintentional injury for persons of all ages in the United States.¹⁹ And motor vehicle crashes costs the United States billions of dollars each year.^{19, 20, 21, 22}

For the year 1990, the Centers for Disease Control and Prevention reported that motor vehicle crashes accounted for 44,532 fatalities, 5.4 million non-fatal injuries, and 28 million damaged vehicles at an estimated cost of \$137.5 billion.²¹ The economic or human capital costs include direct and indirect costs to individuals and society from the decline in the general health status of those injured or killed in motor vehicle crashes.²² Major sources for costs were property damage (\$45.7 billion), productivity losses in the workplace (\$39.8 billion), medical-care expenses (\$13.9 billion), and losses related to household productivity (\$10.8 billion).²¹ The National Highway and Traffic Safety Administration (NHTSA) reported that motor vehicle crashes cost \$230.6 billion in the United States for the year 2000.²² In addition to the costs listed in the CDC study, NHTSA's report included costs for emergency services, travel delay and legal and court costs.²² The \$230.6 billion is equal to approximately \$820 for every person living in the United States.²² Another study estimated that motor vehicle crashes in 2005 cost the United States more than \$99 billion.²³ Costs considered in this study were limited to medical care, rehabilitation and productive life years lost due to premature death or long-term disability. The economic burden was estimated to be \$336 for every person in the United States or \$500 for each licensed driver in the US.²³ In terms of lifetime injury costs, older drivers had the lowest.²³ Men 65 and older had per capita costs of \$118

versus \$1,249 for men 20-24 years old and \$901 for boys 15-19.²³ The substantial economic and human costs associated with motor vehicle crashes reinforce the need to implement proven interventions.

Risk Factors

Unlike crashes among young drivers, which often result from risk taking, older driver crashes appear to result from age-related declines in driving abilities.^{24, 25}

Research has established that as drivers age, their physical, cognitive and visual abilities decline and the declines are associated with an increased risk of crash involvement.^{26, 27}

This section considers how age, vision, hearing, musculoskeletal impairments, chronic medical conditions, and medication could affect driving ability in later life.

Age

Age, by itself, is often one of the factors mentioned in the discussion to restrict a senior's opportunities to drive.²⁸ However, it is misleading to consider age-based driving restrictions as people age differently.^{26, 28, 29} Older age per se does not lead to higher crash rates.²⁹ Two 75 year-old drivers can have vastly different abilities to drive safely due to differences in fitness and health. The onset and degree of decline will vary from person to person.^{25, 29} Safe driving is about skills and ability, not age.²⁸

While the number of accidents involving older drivers decreases as age increases, the risk of being involved in a car crash increases after age 75 for every mile driven and the rate almost equals that of younger drivers age 16 to 24.^{30, 31, 32, 33}

Vision

Vision is the primary sense used in driving and it has been estimated that 90 percent of information used while driving is visual.^{25, 29} The leading cause of vision impairment in the United States is age-related eye diseases.³⁴ Beginning in the 40's there are changes that occur in the eyes that are a normal part of aging.^{35, 36} These changes can lead to vision loss and even blindness if left untreated. Many older drivers adapt their driving when they recognize the changes.³⁷ The changes affect:

Dynamic visual acuity – the ability to see a moving object – particularly under low light conditions at dusk and dawn.

Depth perception – the ability to determine the distance of objects. With age, changes in the eye's lens decrease the ability to accurately determine distances between two objects.

Useful Field of View – refers to the area that one can see and cognitively process and interpret. When drivers are in complex driving situations, their attention is restricted to the area immediately in front of them. Drivers with decreased visual attention can only see the car directly in front of them and not the pedestrian stepping from the curb.

Contrast Sensitivity – the capacity to see the difference between two similarly colored objects, thus indicating one's ability to perceive contrast. The inability to see the difference in contrast affects distance judgment. Drivers may have difficulty in determining distance of an object, resulting in "tailgating" or hitting a curb.

Peripheral Vision – the ability to see objects to the side when the eyes are focused forward. Reduced peripheral vision results in "blind spots" around the vehicle causing older drivers to be surprised when an object comes into their narrow field of view.

Light/Dark Adaptation – the ease with which the eye can adjust to changes from dark or dim lighting to bright areas. The older driver may have difficulty seeing when entering or leaving a tunnel.³⁷

The four major eye diseases among people aged 40 and older are age-related.^{34, 36} The first of these, age-related macular degeneration is an eye disorder that results in damaging sharp and central vision. Central vision is needed for seeing objects clearly and for common tasks such as reading and driving.^{35, 36} Macular degeneration or AMD affects the macula, the part of the eye that allows people to see fine detail, but causes no pain. In some cases, AMD advances so slowly that people notice little change in their vision. In others, the disease progresses faster and may lead to a loss of vision in both eyes.³⁸

Common symptoms include a gradual loss of ability to see objects clearly, distorted vision, a gradual loss of color vision, and a dark or empty area appearing in the center of vision.³⁹ The condition can make it difficult to see road signs, traffic, and people walking.³⁵ It is a leading cause of vision loss in Americans 60 years of age and older.^{35, 36}

Cataract is a clouding of the eye's lens and the leading cause of vision loss in the United States.³⁶ The amount of cloudiness within the lens can vary and if not occurring near the center, it may not be noticed.⁴⁰ The lens is a clear part of the eye that helps to focus light or an image on the retina. When the image or light reaches the retina, it is changed into nerve signals that are sent to the brain.⁴¹ Cataract makes it harder to see the road, street signs, other cars, and people walking. Objects look blurry, things are more

difficult to see in bright light, headlight glare is more intense, colors look faded, night vision is worse and double vision may be present.⁴⁰ Treatment for cataracts could be in the form of eyeglasses when vision is slightly blurry or surgery when eyeglasses are no longer effective.^{40, 41}

Glaucoma is a disease that causes gradual degeneration of cells that make up the optic nerve, which carries information from the eye to the brain.³⁴ As the nerve cells die, peripheral or side vision is lost first, typically slowly, which makes it hard to notice. Then it can progress to central vision loss, causing blindness.⁴² Glaucoma cannot be prevented, but if diagnosed early, it can usually be slowed or controlled with treatment.^{34,}
⁴² Since glaucoma usually affects peripheral vision, drivers may not see other cars, bicyclists, or pedestrians that are outside of their central vision.⁴³

Diabetic retinopathy is a common condition occurring in persons with diabetes.^{34,}
³⁶ Diabetes is a disease that interferes with the body's ability to use and store sugar and can cause many health problems. Diabetes affects the blood vessels of the retina, the light-sensitive tissue at the back of the eye that is necessary for good vision.^{34, 36} Over time, diabetes affects the circulatory system of the eye. Diabetic retinopathy is the result of damage to the tiny blood vessels that nourish the retina. They leak blood and other fluids, causing swelling of the retinal tissue and clouding of vision.⁴⁴ Symptoms of diabetic retinopathy include seeing spots or floaters in the field of vision, blurred vision, having a dark or empty spot in the center of the vision field, and difficulty seeing at night.⁴⁴ To reduce the chances of diabetic retinopathy, diabetics can control blood sugar,

blood pressure, and cholesterol levels, exercise regularly, maintain a healthy diet, and avoid alcohol and smoking.^{34, 44}

Hearing

It would appear logical that hearing or the processing of auditory information (horn honking, road noise, mechanical failure) would be a critical element of safe driving. However, there are few data to indicate that hearing impairment affects driving ability.^{25, 29, 45} Of those that are available, none has shown a significant relationship between hearing impairment and risk of motor vehicle crash.^{25, 45} As a result, there are no restrictions for drivers with hearing impairments.^{25, 29, 45}

Physical Impairments

Physical conditions associated with aging affect head and neck mobility, muscle strength, endurance, and flexibility necessary for driving a car and turning to view traffic.³⁷ Drivers must be able to perform complex muscular movements swiftly, accurately, repeatedly and without undue pain.^{25, 29} Driving a car requires strength and agility to depress the brake and gas pedals, turn the steering wheel, shift gears, and enter and exit the vehicle.³⁷ There are physical impairments that could diminish an older person's safe driving capabilities. These include sleep apnea, cerebrovascular conditions (strokes), diabetes, arthritis, and Parkinson's disease.⁴⁶

Arthritis can make joints swollen and stiff, thus limiting how far drivers can bend or move their shoulders, hands, head and neck, hips, knees, ankles and feet.⁴⁷ This can make it harder to grasp or turn the steering wheel, press the gas and brake pedals, fasten a seat belt, look over one's shoulder, and get in and out of a car.^{37, 47}

Diabetes can cause a driver to feel sleepy or dizzy, be confused, have a seizure, and lose consciousness, and can affect nerve endings in hands, legs, and feet.⁴⁸ Diabetes can affect an older driver's ability to make good decisions, hold onto a steering wheel, or operate gas and brake pedals.³⁷

Sleep apnea is a condition in which breathing is interrupted during sleep.⁴⁹ The body reacts by partially or completely awakening each time it stops breathing.⁵⁰ People with untreated sleep apnea stop breathing repeatedly during their sleep, sometimes hundreds of times during the night and often for a minute or longer.⁵⁰ The lack of sleep can affect alertness when driving and cause drivers to fall asleep at the wheel.³⁷

Stroke or "brain attack" occurs when a blood clot blocks an artery or a blood vessel breaks, interrupting blood flow to an area of the brain.⁵¹ When either of these things happen, brain cells begin to die and brain damage occurs.⁵¹

When brain cells die during a stroke, abilities controlled by that area of the brain are lost.⁴⁸ These abilities include speech, movement and memory.⁵² Stroke can affect drivers' ability to turn the steering wheel and press the gas and brake pedals, cause confusion or frustration while driving, make it difficult to stay in one lane and not drift, and inhibit the ability to think clearly about the traffic around the driver.⁵²

Parkinson's Disease is a progressive disorder of the central nervous system characterized by a decrease in spontaneous movements, gait difficulty, postural instability, rigidity and tremor.⁵³ Since Parkinson's causes arms, hands, or legs to shake, drivers may not be able to react quickly to a road hazard, turn the steering wheel, or press on the gas and brake pedals.⁵⁴

Medication

Many older adults have chronic medical conditions which often results in their taking medication, prescribed and over-the-counter, to cope with their conditions.^{55, 56} Many of the medications they consume are known as potentially driver-impairing (PDI) medications. These medications have been associated with increased crash risk especially when multiple PDI drugs are prescribed.²⁵ National surveys of non-institutionalized adults indicate that more than 90% of people 65 and older use at least one medication per week. More than 40% of this population uses five or more different medications per week and 12% use 10 or more different medications per week.^{45, 55, 56} Medications commonly used by the ambulatory elderly include analgesics, antidepressants, antihistamines, antihypertensives, benzodiazepines, hypoglycemics, and tranquilizers.^{25, 45} These PDI medications may cause sleepiness, fatigue, lightheadedness, dizziness, low blood pressure, blackouts or syncope, loss of coordination, blurred vision, impaired visual field, and impaired night vision.^{25, 45} While medication and driving studies often establish a correlation and suggest an increase risk for crashes, causation has not been established.^{25, 45} The cause of the crash may be due to the medication(s), or the condition for which it was prescribed, or the presence of other conditions, or a combination of these issues.^{25, 45} It is important for drivers to be educated about the effect medication could have on their ability to drive safely.²⁵ In a study by the American Automobile Association (AAA), researchers suggest that health professionals are not sufficiently informing their patients of the risks posed by PDI medications.⁵⁶

Chronic Medical Conditions

Chronic medical conditions, in addition to the ones already noted, that could affect driving include dementia, multiple sclerosis and peripheral arterial disease.⁵⁷

Dementia is the loss of intellectual ability, also known as cognitive function, which interferes with daily activities.⁵⁸ Persons with dementia may be confused, not able to remember things, or lose skills they once had, including performing normal daily activities.⁵⁸ A diagnosis of dementia is not, on its own, a sufficient reason to stop driving privileges as many drivers with dementia are found to be competent to drive in the early stages of their illness.²⁵ Signs that driving may be getting more dangerous for the older driver include:

- Getting lost on familiar roads
- Reacting more slowly in traffic
- Driving too slowly or stopping for no reason
- Not paying attention to traffic signs
- Taking chances on the road
- Drifting into other lanes
- Having trouble parking
- Getting scrapes or dents on the car⁵⁵

Alzheimer disease is the most common cause of dementia.⁵⁸

Multiple sclerosis is a disease of the central nervous system – the brain, optic nerves and spinal chord - and is thought to be an autoimmune disorder.⁶⁰ Multiple sclerosis can affect vision (blurred or double), cognition (problem solving, attention, and memory) sensation, speech (slurred) and physical strength.^{60, 61} Individuals with multiple sclerosis may have difficulty visually interpreting the driving environment, remembering where they are going, getting in and out of a vehicle, turning the key in the

ignition, feeling the gas and brake pedals, or rotating the steering wheel with enough force to turn the vehicle.⁶¹

Peripheral arterial disease reduces blood flow to the legs (and sometimes the arms) due to a narrowing of the arteries caused by a buildup of plaque – a mixture of fat, cholesterol, blood platelets, and blood vessel wall damage.⁶² The reduced blood flow causes the legs to cramp or feel numb.⁶³ It can also cause sores on the legs or feet.⁶² Reduced sensation would affect the driver's ability to operate gas and brake pedals.⁵⁷

Lifestyles and Family Issues in Dealing with a Senior Driver

The changes that impact an older driver can affect family members and caregivers. It is important to consider the challenges families and other caregivers face as they try to understand the age related changes and offer support to their older driver.

The important role of family members in discussing driving safety with older relatives is well-recognized. The National Highway Traffic Safety Administration (NHTSA), the Hartford Financial Services Group, Inc, collaborating with the Massachusetts Institute of Technology (MIT) AgeLab and the American Automobile Association, encourage concerned family members to have a conversation with older drivers about their driving. In the ideal world, the conversation will occur long before the older driver begins to exhibit signs of declining skills. All four organizations acknowledge that the conversation can be difficult and challenging. Almost 25 percent of older drivers reported feeling sad or depressed as a result of the conversation and about 10 percent were angry.³² Older adults understand the implications of driving cessation:

- Loss of their car keys
- Fewer trips outside the home
- Increased and permanent dependency on others for transportation

- Becoming a burden to others
- Fewer social opportunities ^{31, 32}

In its report “How To Understand and Influence Older Drivers,” NHTSA recommends developing a plan before initiating the conversation. The plan has three steps:

- Collect information
- Develop a Plan of Action
- Follow through on the Plan ³²

Collecting information means that family members observe the older driver for signs of risky behavior. Research from focus groups indicates that older drivers are more willing to listen to those who have driven with them.³² Driving behaviors to observe include:

- Does the driver stop at all stop signs and look both ways to check for cross-traffic?
- Does the driver stop at red lights?
- Does the driver appropriately yield the right-of-way?
- Does the driver respond appropriately to other vehicles?
- Can the driver merge and change lanes safely?
- Does the driver stay in the lane when turning and driving straight?
- Does the driver have trouble working the pedals?
- Does the driver stop or slow down for no apparent reason, such as at green lights?
- Does the driver go too fast for the road conditions?
- Does the driver go so slow as to impede the flow of traffic?
- Does the driver get lost on familiar routes? ^{31, 32, 33, 64}

Observations are to be tracked over time with the family member(s) keeping notes to determine if a pattern of risky behavior emerges. Non-driving observations are also important as they may indicate a problem that could affect an older driver’s skills. Such observations may include:

- Forgetfulness (frequent)
- Unusual or excessive agitation
- Confusion and disorientation
- Loss of coordination and trouble with stiffness in joints
- Trouble walking
- Trouble hearing or following verbal instructions and giving inappropriate responses to those instructions
- Shortness of breath and general fatigue³¹

Another element NTHSA includes in this step is for family members to encourage the older driver to utilize a free self-assessment tool – such as Roadwise Review - with the idea that it may prompt the older driver to be more open to a conversation about driving skills.³¹

The last element in this step is to collect information from local agencies that could provide assistance with the action plan. Resources might include:

- A driver rehabilitation specialist who may offer interventions such as physical therapy or suggest installing specialized equipment
- Area Agency on Aging which could provide information about transportation choices
- The Department of Motor Vehicles address in case a letter needs to be written by a family member with specific examples of unsafe driving
- Address and phone of organizations that provide educational and refresher courses
- Local Alzheimer’s group to help with the driving issue⁶¹

Step two is Develop a Plan of Action. In this step, the family member has a conversation with the older driver and together they develop a written action plan. The goal is to preserve the independence and freedom of older drivers while keeping them connected to the activities that give meaning to and enhance the quality of their life.^{31, 32} Action plans range from the simple to the complex. They may include a self-assessment, an assessment with a driver rehabilitation specialist, a discussion with the drivers’

physician, plans to limit driving times and driving distances, learning about and using alternative transportation, and alternate ways of staying connected socially.^{31, 32} Family members that live nearby may need to provide rides for the older driver, coordinate transportation services or provide financial support.^{31, 32}

Step three is Follow Through on the Plan. Over time, changes in the older drivers' abilities could mean adjustments will be needed for the plan. A regular review of the transportation plan is important to ensure that it still works for older drivers who have reduced or stopped their driving.³¹

With regard to who should initiate the conversation with older drivers, a survey from The Hartford/MIT AgeLab indicates that older drivers have specific preferences.

- Among married drivers, 50 percent prefer to hear about driving concerns from their spouses
- Twenty-seven percent prefer their physician
- Forty percent of drivers living alone prefer to hear from their doctors
- Thirty-three percent of drivers living alone prefer their adult children
- Adult children appear to have more influence with parents over 70
- Older drivers tend to be more open to children who live nearby
- Women are generally more receptive than men to listening to adult children
- Men are slightly more inclined to choose sons over daughters
- Women are slightly more inclined to choose daughters over sons
- Fifteen percent of married drivers said their spouse was the last choice
- Fifteen percent of drivers living alone said hearing from their children was the last choice
- Older drivers strongly prefer not to hear about driving concerns from police officers.³²

The drivers most at-risk for unsafe driving behavior are older males with medical conditions such as dementia or declining vision, who are not aware of or do not recognize their disabilities, and who have little contact with family members or friends.⁶⁴ Male

drivers are more reluctant than females to modify or stop driving due to the independence driving provides.⁶⁴

Motivations and Barriers to Intervention

In the NHTSA report, “Family and Friends Concerned About An Older Driver,” four key factors were associated with a willingness of family members to intervene with the older driver.⁶⁴ These factors include characteristics of the older driver, family and friends most likely to intervene, professionals who might serve as advisors or intermediaries, and social norms that support driving modification and cessation efforts.

The key factors are summarized below:⁶⁴

Problem Older Drivers More Likely to Modify Unsafe Driving	Problem Older Drivers Less Likely to Modify Unsafe Driving
Will self-regulate	Will not self-regulate
Recognizes problem driving	Denies problem driving
Female	Male
Not cognitively impaired	Cognitively impaired
Has caregiver/confidant	Has no caregiver/confidant
Has access to alternative transportation	Has no access to alternative transportation
Is ready to change	Is not ready to change

Family Members More Likely to Help Problem Older Drivers	Family Members Less Likely to Help Problem Older Drivers
<i>Sociodemographic/Structural Variables</i>	
Close family member	Not close family member
Primary/secondary caregiver	Not primary/secondary caregiver
Spouse or daughter	Son/son-in-law
Mother is care recipient	Father is care recipient
Father is still married to mother	Parents are divorced/separated
Lives within one hour's drive from older driver	Lives more than one hour's drive from older driver
Frequent contact with older driver	Infrequent contact with older driver
Not employed	Employed
Euro-American	African-American
Higher income	Lower income
<i>Social/Psychological Variables</i>	
Aware of declines	Denies declines
Not stressed	Highly stressed
Helping relationships	Independent relationships
Emotionally close	Emotionally distant
In family unit able to make decisions about elder	In family unit unable to make decisions about elder
Able to provide help and support for elder's change	Unable to provide help and support for elder's change

Professionals More Likely to Help Concerned Family Members and Problem Older Drivers	Professionals Less Likely to Help Concerned Family Members and Problem Older Drivers
Understands issues	Does not understand issues
Sympathetic ethical stance	Unsympathetic ethical stance
Not fearful of lawsuit	Fearful of lawsuit
Risk of problem driving outweighs confidentiality	Risk of problem driving does not outweigh confidentiality
Will report to DMV	Will not report to DMV
Able to give patients and family information	Unable to give patients and family information

Social Norms Organized Around Safe Driving by Older Drivers	Social Norms Not Organized Around Safe Driving by Older Drivers
Social norms support driving cessation without stigma	Social norms support continued driving as a marker of independence
State regs support input of family/friends and professionals	State regs do not support input of family/friends and professionals
Public policy supports public or other alternative transportation	Public policy does not support public or other alternative transportation

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Alternative Transportation

When older drivers consider relinquishing their car keys, alternative transportation options are important to help preserve their independence and freedom while keeping them connected to the activities that give meaning to and enhance the quality of their lives.⁶⁵ Options include local public resources such as bus, subway, train, and taxi. Other options could be provided by such community organizations as the Red Cross, local senior center, and volunteer organizations. Family and friends are potential

options, too. Resources to consult include the Florida Senior Safety Resource Center (<http://fssrc.php.ufl.edu/>) and the AAA Foundation for Traffic Safety (www.seniordrivers.org/notdriving).^{65, 66} Both organizations have extensive transportation ideas as well as information on how to use mass transit. They focus on helping older drivers maintain their independence without sacrificing safety.

Social Marketing

Social marketing is a process for influencing human behavior on a large scale, using marketing principles for the purpose of societal benefit rather than commercial profit.⁶⁷ The Centers for Disease Control and Prevention expands the definition of social marketing, indicating it is designed to influence voluntary behavior of target audiences in order to improve their personal welfare and that of society.⁶⁸ Similar to commercial marketing, the primary focus is on the consumer – on learning what people want and need rather than attempting to persuade them to purchase a product.⁶⁹ This process requires public health officials to listen to the needs and desires of the target audience and build a program from the bottom-up. For the older driver and those concerned about their safety, a social marketing campaign would focus on older driver safety and encourage the transition from driving to using alternative transportation options.⁷⁰

In “Family and Friends Concerned About An Older Driver,” NHTSA outlines a framework for developing a social marketing campaign, similar to Mothers Against Drunk Driving (MADD) and national seat belt campaigns, that includes the following steps:

- Develop multimedia presentations that specify indicators and consequences of unsafe driving with specific examples of interventions
- Educate family members that age alone is not a predictor of driving ability

- Provide information about the signs of unsafe driving and related functional declines
- Encourage families and friends to seek official assistance from healthcare professionals and Department of Motor Vehicles in re-evaluating a driver
- Develop strategies to involve the healthcare community and law enforcement personnel to help them be more responsive to families who need assistance
- Identify unsafe driving as a public health risk and make intervention socially acceptable and responsible (e.g., “Friends don’t let friends drive unsafely”)⁶⁴

National organizations such as the AAA and the American Association of Retired Persons (AARP) have mass media and public information campaigns addressing older driver safety. These programs, in general, offer educational material and promote older driver safety courses. The American Occupational Therapy Association (AOTA) for two consecutive years, 2009 and 2010, sponsored a national Older Driver Safety Awareness Week for consumers and practitioners.⁷¹ None of these organizations or the National Highway Transportation Safety Administration has developed a social marketing campaign addressing older driver safety. A review of NHTSA’s website and marketing calendars for 2010 and 2011 failed to identify a month when it would promote older driver safety.⁷²

The Three E’s of Injury Prevention

Motor vehicle injuries are the leading cause of death from unintentional injury for persons of all ages in the United States.⁷³ And the injuries cost the United States billions of dollars each year in lost productivity, medical care and rehabilitation, court costs, and emergency response.^{73, 74, 75} Fortunately, motor vehicle injuries are preventable.^{76, 77} There are numerous models available to assist practitioners with the design of interventions that could help prevent motor-vehicle injuries and deaths.^{78, 79} One such

model is the Three E's of Injury Prevention which consist of education, engineering and enforcement.^{78, 79, 80, 81}

Educational Approaches to Injury Prevention for Older Drivers

Education in injury prevention seeks to influence stakeholders (individuals, communities, health professionals, policy makers, the media) by increasing their knowledge, changing their attitudes and altering their behavior.^{78, 79, 80, 81} People learn that wearing seatbelts can save lives. For this intervention to work, drivers and passengers must change their attitude towards seatbelts, and then wear them on a consistent basis when they are in a motor vehicle. This is known as an active intervention as it requires action by the stakeholder.⁸² Education alone will not necessarily result in behavioral change.^{78, 80}

Five educational interventions are outlined below that could help reduce motor vehicle injuries among older drivers.

Florida Senior Safety Resource Center: The Florida Safety Resource Center (FSRC) is a website developed and maintained by the University of Florida, Department of Occupational Therapy, and funded by the Florida Department of Transportation's Elderly Drivers Statewide Safety Resource Centers.⁸³ The purpose of FSRC is to provide older drivers, seniors, and family members with information and resources on alternative forms of transportation and driving knowledge and skills, and links to national organizations that address transportation issues so older drivers can remain independent within their communities.⁸³ The website has three primary headings – Find Transportation, Assess Road Knowledge, and National Resources. Find Transportation helps older Florida drivers locate alternative transportation resources in their community.

The site identifies agencies that could provide transportation, the populations they serve and the types of vehicles in the fleet. The Assess Road Knowledge section provides drivers with an opportunity to assess their current driving behaviors and knowledge of Florida motor vehicle laws. National Resources provides links to national driving resources for alternative transportation, research and information to consider when retiring from driving.

The University of Florida clearly states that the content of its website is intended for informational purposes only and is not intended to:

- Serve as a replacement for in-office medical assessment or advice, or
- Determine driver eligibility or ineligibility⁸³

Physician's Role: The American Medical Association (AMA) believes physicians can play an important role in the safe mobility of their older patients and encourages physicians to make driver safety a routine part of their geriatric medical services.⁸⁴ To this end, the AMA, with support from the National Highway Traffic and Safety Administration, created a *Physician's Guide to Assessing and Counseling Older Drivers* to help physicians address the issue of older driver safety.⁸⁴ The AMA's guide can assist physicians in their effort to evaluate the ability of their older patients to operate motor vehicles safely as a part of their everyday activities.⁸⁵ Topics covered in the guide include screening, assessing functional abilities, handling evaluations and referrals, conditions and medications that may impact driving, addressing safer driving, and counseling those who are no longer able to drive.⁸⁵ Physicians are in a leading position to address this public health issue with their patients by adopting preventive practices that include assessment and counseling, identifying drivers at risk for crashes,

modifying medication, and easing the transition to driving cessation if and when it becomes necessary.⁸⁵

DriveSharp: DriveSharp, developed by Posit Science, is a software program designed to increase the brain's processing of visual information. This intervention stems from research conducted by Ball et al. who reported that impaired visual function, mental status, or a combination of both can result in a decline in useful field of view (UFOV).⁸⁶ Useful field of view is the area in which information can be acquired without eye and head movements (i.e., within one eye fixation).⁸⁷ Ball's research focused on how well a driver can simultaneously see stimuli in front and to the periphery. Ball had shown that older drivers with a 40 percent or more impairment of UFOV were about twice as likely to be in a motor vehicle crash in the next three years compared with older drivers who were not similarly impaired.⁸⁷ Posit Science, which produces brain-training programs, claims that DriveSharp can train an individual's brain to think and react faster on the road by putting a user through brief repetitive exercises aimed at improving a driver's visual-processing ability.⁸⁸ The company states that the exercises have been created to increase processing speed (to react quicker), enlarge a driver's field of view (to see dangers sooner), and improve the users' ability to keep track of multiple moving objects (e.g., cars, trucks, pedestrians, and bicycles).⁸⁸

Posit Science asserts that drivers who use the program as directed (at least three times a week for 20 minutes at a time) can cut their "crash risk" by 50% and stop their cars 22 feet sooner at 55 miles per hour. It further states users can expand by 200% their "useful field of view," the area within which one can take in details with a single glance. The company also claims if drivers use DriveSharp as instructed for a total of 10 hours,

its positive effects can last for several years.⁸⁸ DriveSharp is endorsed by the AAA Foundation for Traffic Safety, and The Hartford.^{89, 90} Yet, one of The Hartford's collaborators, the MIT AgeLab, is investigating DriveSharp's claims as the AgeLab has not found evidence that DriveSharp helps drivers in the real world.⁹¹

AAA Mature Driver Program: AAA's Mature Driver Program is for experienced drivers over 55 years of age. The program is a refresher course to enhance an older drivers' knowledge of driving. Focusing on three key areas - visual scanning techniques, risk reduction and handling of emergencies - the curriculum consists of eight hours of classroom presentations and discussions. Effects of the aging process on driving are also discussed. Some insurance companies offer a discount for drivers who successfully complete the course.⁹²

Roadwise Review: Roadwise Review is a self-assessment tool designed by the American Automobile Association to help older drivers identify cognitive and physical skills important for safe driving.⁹³ A computer based screening tool, Roadwise Review uses videos and games to assess eight functional abilities believed to be the strongest predictors of crash risk among older drivers.⁹³ The abilities assessed by Roadwise Review are:

1. Leg Strength and General Mobility – allows driver to accelerate and brake under regular conditions and to respond quickly in emergencies.
2. Head/Neck Flexibility - allows driver to check blind spots when they back up, change lanes, or merge into traffic.
3. High Contrast Visual Acuity - helps driver detect pavement markings, read road signs and spot hazards in or near the road.
4. Low Visual Acuity - enables driver to maintain lane position and drive safely in rain, dusk, haze and fog.
5. Working Memory - helps driver follow directions, remember traffic rules and regulations, and make good decisions as they drive.

6. Visualization of Missing Information - enables driver to recognize and anticipate a threat or hazard even when part of it is hidden from view.
7. Visual Search - enables driver to scan the driving environment and recognize traffic signs, signals, navigational landmarks and hazards.
8. Visual Information Processing Speed - allows driver to pay attention to what is in front of them while also detecting threats at the edge of their field of view.⁹³

Roadwise Review provides confidential screening results and assesses the level of impairment for each ability – no impairment, mild impairment or serious impairment. It also provides recommendations to address the identified mild and/or serious impairments.

The American Automobile Association states that Roadwise Review was developed based on research sponsored by the National Highway Traffic Safety Administration, the Maryland Motor Vehicle Administration, and the National Institute on Aging. Promotional material developed by the AAA indicates that individuals who exceed measured levels of decline in key safe driving predictors are two to five times more likely to be involved in a motor vehicle crash.⁹³

Scialfa et al. did not find Roadwise Review to be a useful tool for assessing older drivers.⁹⁴ They reported the acuity tests and useful field of view exhibited substantial ceiling effects that limit predictive utility, and there was a high failure rate on the head and neck flexibility test.⁹⁴ Additionally, they reported that Roadwise Review did not predict collision risk.⁹⁴

Engineering Interventions for Injury Prevention in Older Drivers

Engineering in injury prevention occurs when a product or environment is designed or modified to ensure it is safer for people to use or live in.^{79, 80, 81} This approach makes behavior change unnecessary by providing automatic protection.⁸²

Airbags in motor vehicles is a design modification. This is a passive intervention as it does not require cooperation by the stakeholder.⁸² Three environmental modifications for older drivers are discussed below.

Engineering advances are based on the already-reviewed risk factors associated with advancing age—declines in physical, cognitive, and visual abilities.⁹⁵ For older drivers who may have visual impairments, increasing the size of road sign letters can be important.⁹⁶ Older drivers in focus groups stated that larger street signs with bigger lettering and standardization of sign placement overhead would make driving an easier task.⁹⁶ Guidelines for size, dimension and style can be found in the Manual on Uniform Traffic Control Devices (MUTCD).⁹⁷ For conventional roads in rural districts on major routes, letters are to be at least 6 inches in height. On low-volume roads and urban streets with speeds of 25 mph, letters are to be at least 4 inches high. On street name signs, letters should be at least 6 inches high. An accepted “rule-of-thumb” to follow for signs other than those on the Interstate is to have 1 inch of letter height for every 40 feet of desired legibility.⁹⁷

Other challenges for older drivers that might be remedied by engineering solutions include negotiating left turns and intersections.^{98, 99} Several studies indicate that older drivers are overrepresented in collisions at intersections.¹⁰⁰ Forty percent of fatal collisions involving drivers 70 and older, compared with 23% of crashes for 35-54 year olds, occur at intersections and involve other vehicles.¹⁰⁰ A NHTSA report that analyzed crash data from 2002-2006 involving drivers over 60 indicated that left turns proved risky for older drivers.¹⁰¹ In two-vehicle crashes, drivers 60 and older were more

likely to be the struck (as opposed to the striking) vehicle, to be involved in angle crashes, and to have received citations for failure to yield.¹⁰¹ One study found that each advancing year of age after 65 increases by 8% the odds of getting into a crash that involves turning left.¹⁰⁰

An engineering solution that could reduce the frequency and severity of intersection accidents for older drivers is to include left-turn arrows at intersections controlled by signal lights. Older drivers would then not have to judge the speed of oncoming traffic and decide if there is time to make a turn.^{99, 100} Another engineering intervention would be to construct a roundabout in place of stop signs and traffic lights.^{99, 102} A roundabout is a circular intersection with design features that promote safe and efficient traffic flow.¹⁰² In the United States, vehicles travel counterclockwise around a raised center island, with entering traffic yielding the right-of-way to circulating traffic.^{99,102} Slow speeds aid in the smooth movement of vehicles into, around, and out of a roundabout.¹⁰² A 2001 Insurance Institute for Highway Safety (IIHS) study of 23 intersections reported that converting from traffic signals or stop signs to roundabouts reduced injury crashes by 80 percent and all crashes by 40 percent.^{99,102} The safety effects for older drivers are unknown.¹⁰² The 2001 IIHS study reported the average age of crash-involved drivers did not increase following the installation of roundabouts, suggesting roundabouts may not pose a problem for older drivers.¹⁰²

Enforcement Approaches for Injury Prevention in Older Drivers

Enforcement in injury prevention uses the force of law, often combined with penalties, to influence the actions of stakeholders when there is poor compliance.^{80, 81}

Non-compliant drivers may be fined for not wearing seatbelts, for driving above the posted speed limit, and fined and/or lose their license for driving while under the influence of alcohol or other drugs. The next section considers the role of enforcement by states as they impose restrictions on older drivers when they renew their license.

License renewal practices for older drivers vary among the states, but do not differ significantly.^{103, 104, 105, 106} Renewal provisions typically include shortening the renewal cycle, requiring renewal in person rather than by mail, and mandating testing that is not routinely required of younger drivers – vision or road or written tests, a medical or psychological certification of fitness, or some combination of these.^{103,104} Eighteen states shorten the license renewal period beginning at a specified age. Georgia initiates the shortened renewal for drivers at age 60 with renewal every five years; Colorado, at age 61, with renewal every five years; Kansas and Maine, at age 65 with renewal every four years; Hawaii, at 72 with renewal every two years; Florida, at age 80 with renewal every six years; and Texas, at age 85 with renewal every two years.^{103, 104, 105, 106} Vision tests are required for older drivers at every renewal in nine states – Colorado, Florida, Georgia, Maine, Maryland, Oregon, South Carolina, Utah, Virginia, and Washington D.C. Road tests are required when drivers reach age 75 in two states – Illinois and New Hampshire.^{103, 104, 105} At age 70 the District of Columbia requires a medical report from a physician certifying that the applicant is physically and mentally competent while Nevada, for drivers at age 70, requires a medical report.^{103, 104, 105}

When older drivers renew in person, licensing officials may require them to undergo physical or mental exams or retake the standard licensing tests – vision, written and/or road if their physical or mental abilities to drive are in doubt due to their

appearance or demeanor or because of a history of crashes or violations, or reports from physicians or police.^{103,109} The results of the exams and tests could cause the licensing officials to revoke, suspend or restrict the older drivers' license.^{103, 109} Typical restrictions prohibit nighttime driving or restrict driving to specified places or a limited radius from the driver's home.^{103, 109}

Connecticut has no special renewal requirements for older drivers.^{103, 104, 105, 107} Drivers 65 and older may choose either a 2-year or 6-year renewal cycle.^{103, 107}

Levy et al. assessed the relationship between state driver's license renewal policies (vision, knowledge, and road tests) and fatal crashes involving drivers aged 70 years and older.¹⁰⁸ They found that state license renewal policies mandating vision tests are associated with fewer fatal crashes for older drivers.¹⁰⁸ Their results also provided weak evidence that knowledge tests given to older drivers were associated with fewer fatal crashes for seniors.¹⁰⁸ Grabowski et al. also assessed the relationship between state driver's license renewal policies (in-person renewal, vision tests, road tests and shorter renewal cycles) and fatal crashes for drivers 65 years and older.¹⁰⁹ They concluded that in-person renewal was related to a significantly lower fatality rate among drivers 85 years or older.¹⁰⁹ They found that state laws mandating vision and road tests were not associated with a lower fatality rate among older drivers.¹⁰⁹

Grabowski's hypothesis is that in-person renewal affords an opportunity for licensing officials to refuse to grant licenses to obviously impaired drivers or to refer such drivers for medical evaluation prior to granting them a new license.¹⁰⁹ Thus, it may be

that greater numbers of potentially unsafe older drivers are detected and refused a license during the in-person renewal process.¹⁰⁹

Effective prevention strategies combine tactics from each of the Three E's of Injury Prevention.^{78, 79, 80, 81}

Pilot Educational Intervention: AAA Roadwise Review

Developed by the American Automobile Association (AAA) in 2005, Roadwise Review (RWR) is a 30 minute computer program designed to be used in the privacy of one's home as a self-screening instrument to identify physiological changes that could affect driving.¹¹⁰ A process evaluation of the Roadwise Review revealed that, although impressions were generally favorable, researcher observations and participant feedback raised a number of concerns: computer mouse proficiency, adherence to instructions, partner assistance, accuracy and interpretation of results.¹¹¹ Although AAA reports widespread distribution of the RWR-CD-ROM, its rate of use is unknown because it is designed to be used in-home.

From a public health perspective we thought it was important to publicize the issue of older driver safety in a community setting and offer a community based intervention. Despite Scialfa's criticism, the Roadwise Review program was selected because the tool could be easily adapted both to utilize an administrator for screening, and to make the screenings available in the community. To date, there are no published reports of adapting Roadwise Review in this way and testing the feasibility of this approach. We hypothesized that this approach would: 1) provide documentation of Roadwise Review completion and results, and 2) allow for in-person explanation and counseling of results, and referrals to be made.

Pilot Study Purpose and Methods

The purpose of this study, which was approved by the University of Connecticut Health Center Institutional Review Board, was to test the feasibility of implementing a pilot community senior driver screening program.

Thirty older drivers (age 65+) were recruited in the spring and early summer of 2010 from two local churches and a senior community center in Greenwich, Connecticut. Recruitment flyers were posted at the recruiting sites requesting volunteers for the study. Criteria on the flyer stipulated that participants had to be 65 years old or older, possess a valid drivers' license and be current drivers. To volunteer for, or inquire about the study, prospective participants called the study coordinator at his office in the Greenwich Department of Health. Volunteers were screened over the phone to make certain they met the study criteria. When accepted for the study, volunteers were given an appointment to complete Roadwise Review at the department of health. Volunteers remained anonymous to protect their confidentiality and were assigned an appointment using an eight-digit code. The code consisted of two numbers for the month, two for the day and four for the time. Thus, June 21 at 10:00 am was 06211000. The only information collected from volunteer drivers was sex and age. For data purposes, drivers were divided into two age groups, 65-74 and 75+, with 15 volunteers in each group. Thirty-three volunteers were accepted for the study with 30 keeping their appointment. All 30 participants completed the 30-minute computer program and received a copy of their results.

The Roadwise Review program provides a report to the participant for each assessed skill (no impairment, mild impairment, serious impairment) with recommendations on how to address deficiencies. Although Roadwise Review does not

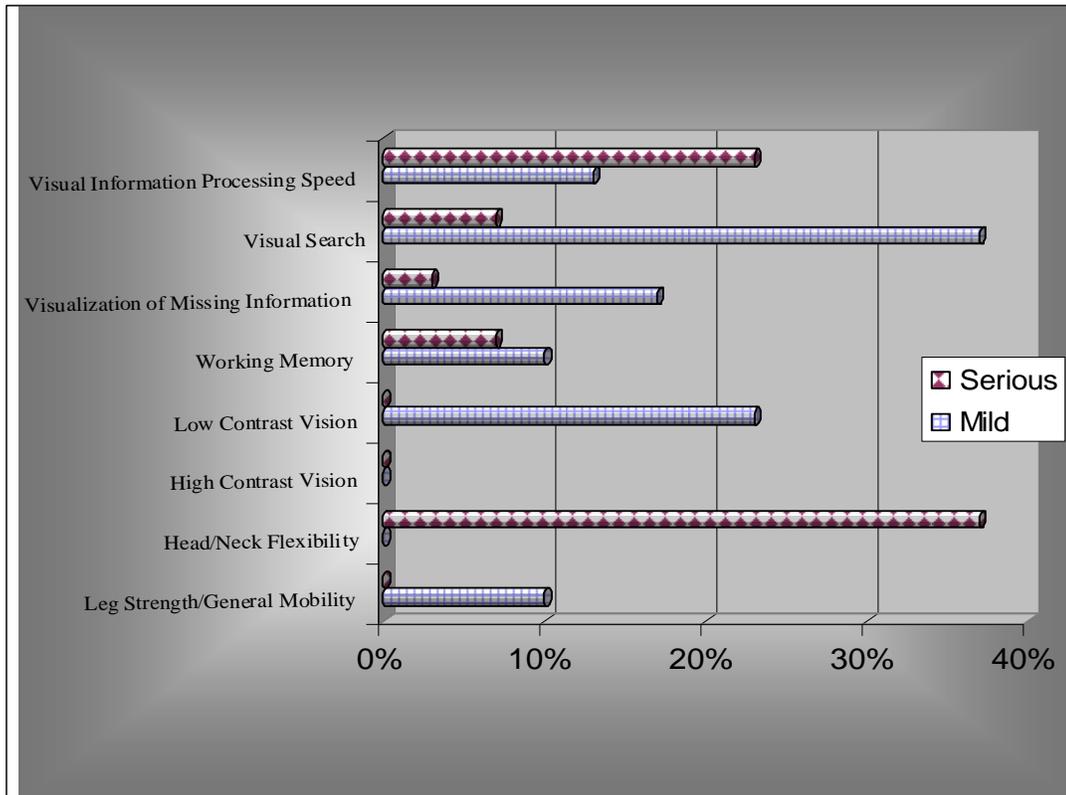
explicitly define impairments, which has been noted in previous research,¹¹¹ it does provide an explanation page for each task's result, with a comparison range of results. The study compared the level of impairment for each assessed skill between the two age groups as well as between males and females.

Results

All thirty participants were white and 53% were female, with a mean age of 74. Overall, the Roadwise Review assessment program identified 23% of participants with no impairments, 27% with at least one mild impairment, and 50% with at least one serious impairment (Figure 1). Mild and serious impairments were identified in leg strength/general mobility (10% and 0%), head and neck flexibility (0% and 37%), low contrast visual acuity (23% and 0%), visualizing missing information (17% and 3%), visual information processing speed (13% and 23%), visual search (37% and 7%), and working memory (10% and 7%). No impairments were identified in high contrast vision. When the two age groups were compared (15 individuals in each age group), there were more drivers in the younger group without an impairment (6 vs 1), more drivers in the older group with at least one mild impairment (12 vs 8) and more in the older group with at least one serious impairment (11 vs 4). The skill that recorded the most serious impairments was head/neck flexibility, with 9 in the older group and 2 in the younger group.

When females were compared to males, 75% of women and 78.5% of men had one or more impairments. In the 75+ group, 88% of women and 100% of men had one or

Figure 1 Impairment Levels



more impairments, whereas in the 65-74 age group, 57% of women and 62.5% of men had one or more impairments. For women, the top two impairments were head/neck flexibility (37.5%) and visual search (31%) whereas for men it was visual search (57%) and head/neck flexibility (35%). When drivers with three or more impairments were considered, the percentage was greater for women 44% compared to 21% for men. This was particularly true in the 75+ age group 78% of the women versus 33% of the men. The significant difference here may be due to age as all nine female drivers were over 80 (mean age 80.6) and none of the six male drivers was older than 79 (mean age 76.8).

Discussion

Motor vehicle safety among older drivers is a public health issue as the United States experiences an increase in the aging of the baby boomer population. The human and economic cost of car crashes among older drivers is enormous. Older drivers are

retaining their licenses longer and driving more miles. As their age increases so does their risk of being injured or killed in a motor vehicle crash. While there has been a welcome decline in car crashes among older drivers in recent years, the United States has not achieved the Healthy People 2010 national objective of 9.2 deaths per 100,000 population. Finding proven interventions to reduce the risk of motor vehicle crashes among older drivers remains a goal of public health.

The purpose of this study was to determine the feasibility of implementing a computer-based driver safety assessment program for older adults. This pilot study was easy to implement due to the support of the Greenwich Department of Health, which provided meeting space to conduct the study, and the cooperation and collaboration of the Greenwich Commission on Aging, Round Hill Community Church and First Congregational Church. The three community groups promoted the pilot study to their membership and helped recruit participants. In a span of five weeks, thirty-three participants were screened for the study and assigned an appointment to meet with the study coordinator. Overall satisfaction by the 30 volunteers that completed the assessment was very high.

Twenty-seven of the 30 participants indicated they would like to repeat the assessment in one or two years to monitor their skills. This appears to indicate that they gained some knowledge about aging and its potential impact on driving abilities. Thirteen additional older drivers contacted the study coordinator for an assessment after hearing about Roadwise Review from a participant. Several participants invited the study coordinator to discuss Roadwise Review and older driver safety at a local senior center, a community church and on a local radio talk show. These community forums resulted in

ten additional presentations for a total of thirteen. One participant asked to purchase the Roadwise Review CD at the completion of the study to utilize with older drivers at a senior provider agency.

Roadwise Review identified one or more impairments in 76% of the participants. What this meant to individual volunteer drivers remains unknown. Since the study was designed to maintain the anonymity of the volunteers, we could not contact them to determine if they followed up on the recommendations provided by Roadwise Review when an impairment was identified. If they had trouble with their vision or head/neck flexibility, did they make an appointment with an eye care provider or physical therapist to discuss and address the impairment? Additionally, we do not know if the Roadwise Review assessment changed the driving behavior of the volunteers.

A concern addressed by 66% of the volunteers during the phone interview was the ability of the study coordinator to take their license or report the results of the assessment to the department of motor vehicles. Volunteers were informed results would remain confidential, easy to do with an anonymous test, and they would retain their driver's license at the completion of the assessment.

Conclusion and Recommendations

The small study showed that it is feasible to conduct an older driver screening program in a community setting with a public health agency as the lead organization. Roadwise Review as an educational intervention appears to enhance older driver's awareness of the skills needed to maintain driver safety and mobility. However, a larger study is recommended with a more diverse pool of older drivers and the collection of additional risk data to determine the wider applicability of the intervention. An

additional recommendation is to convene a broad based older driver traffic safety advocacy group to develop a social marketing campaign to promote awareness of the issues and solutions.

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