Evidence-Based Review of Interventions for Medically At-Risk Older Drivers

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MeSH TERMS

- aged
- automobile driving
- evidence-based practice
- health status indicators
- outcome and process assessment (health care)
- risk factors

OBJECTIVE. To conduct an evidence-based review of intervention studies of older drivers with medical conditions.

METHOD. We used the American Occupational Therapy Association's classification criteria (Levels I–V, I = highest level of evidence) to identify driving interventions. We classified studies using letters to represent the strength of recommendations: A = strongly recommend the intervention; B = recommend intervention is provided routinely; C = weak evidence that the intervention can improve outcomes; D = recommend not to provide the intervention; I = insufficient evidence to recommend for or against the intervention.

RESULTS. For clients with stroke, we recommend a graded simulator intervention (A) and multimodal training in traffic theory knowledge and on-road interventions (B); we make no recommendation for or against Dynavision, Useful Field of View, or visual–perceptual interventions (I). For clients with visual deficits, we recommend educational intervention (A) and bioptic training (B); we make no recommendation for or against prism lenses (I). For clients with dementia, we recommend driving restriction interventions (C) and make no recommendation for or against use of compensatory driving strategies (I).

CONCLUSION. Level I studies are needed to identify effective interventions for medically at-risk older drivers.

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Funded through a cooperative agreement between the American Occupational Therapy Association (AOTA) and the National Highway Traffic Safety Administration, the Gaps and Pathways Project will provide expanded guidance to occupational therapy practitioners in helping clients with instrumental activities of daily living, specifically driving and community mobility (Schold Davis & Dickerson, 2012). Project priorities are guided by a panel of expert researchers and clinicians. The panel has identified the importance of finding evidence to identify at-risk drivers and to develop evidence-guided intervention strategies and recommendations.

The first author of this project (Classen) addressed this gap by conducting an evidence-based review to determine the effectiveness or efficacy of driving interventions for medically at-risk drivers. This article offers practitioners a review of current evidence with translation to clinically applicable recommendations and intervention strategies where evidence exists. Acknowledging that evidence in driving interventions is limited, our project focused on studies targeting medically at-risk drivers with stroke, visual deficits, or cognitive decline.

Significance and Purpose

With the increased growth in the U.S. population of older adults (i.e., those age 65 or older), effective driving interventions will be important to help older drivers stay on the road longer and more safely. The literature addressing driving

performance issues in older drivers who are medically at risk, however, has not yet been classified in a systematic way. To overcome this gap, we asked the following research question: What is the level of evidence supporting the efficacy or effectiveness of driving rehabilitation interventions targeted at medically at-risk older drivers (≥ 65 yr)? To advance the clinical practice and science pertaining to medically at-risk older drivers, we used AOTA's classification criteria (Stav, Arbesman, & Lieberman, 2008) to provide an evidence-based review of rehabilitation interventions and make recommendations to occupational therapy practitioners, researchers, and policymakers.

Method

Procedure

A doctoral-level researcher, an occupational therapy certified driving rehabilitation specialist (OT-CDRS), a health sciences reference librarian, and a trained graduate assistant conducted the review. A search strategy was developed, and the search identified literature published in the past 16 yr (January 1, 1997–January 31, 2013) addressing rehabilitation interventions (interventions provided by but not limited to rehabilitation professionals, including occupational therapists, physical therapists, and visual specialists) for medically at-risk older drivers. Searches included the databases listed in Figure 1. Controlled vocabularies, such as MeSH terms and CINAHL headings, were used in addition to key words matching the study's descriptors (see Figure 1).

We included studies if they met all of the following criteria:

- Published from January 1, 1997, to January 31, 2013, because rehabilitation intervention studies for medically at-risk drivers emerged during the past 16 yr
- Located from searches in databases indexing systematic reviews, psychological and social science, medicine, and health science (i.e., Cochrane Library, PsycINFO, Age Line, PubMed, CINAHL, Sociological Abstracts, Web of Science) and from experts in the field
- Published in the English language literature
- Contained key word–controlled vocabulary terms (MeSH, etc.) or were retrieved from “footnote chasing” (i.e., finding additional citations in the reference list of selected articles)
- Addressed outcomes of a comprehensive driving evaluation, which uses evidence-based clinical tests and an on-road assessment administered by an occupational therapist (or medically trained) CDRS

- Had outcomes of driving simulation, crashes, citations or violations, and self-report.

Studies were excluded if they were medication or surgical intervention studies, duplicates, not primary studies, dissertations or theses, qualitative or descriptive, or used psychometric designs.

Our search yielded 128 study citations with abstracts. The research team reviewed the abstracts of all the primary studies. From the 106 abstracts reviewed with a rater reliability of 98.88%, we excluded 89 (84%) because 56 (53%) were not intervention studies, 8 (8%) were either not medically at-risk or intervention studies, 9 (8%) had no driving outcome, 12 (11%) had no rehabilitation interventions, and 4 (4%) did not meet the criteria for the population–sample. Of the 17 remaining studies, 1 (Lamoureux et al., 2007) did not address driving, and another, a systematic review, had a mixed population (Strong, Jutai, Russell-Minda, & Evans, 2008); both were excluded from the full review. The remaining 15 studies met the study's criteria, and we appraised, classified, and synthesized them. We discussed, classified, and rated all the studies together, and all conflicts were resolved through consensus to achieve 100% agreement.

Evidence-Based Ratings, Strength, and Recommendations

Using AOTA criteria (Stav et al., 2008), we assigned the level and strength of the evidence and provided recommendations for the intervention studies. The parameters for rating an article by Level (I–V, with Level I being the highest level of evidence); for determining the strength of the evidence (high, moderate, low); and for making recommendations at Categories A, B, C, D, and I are described in Table 1.

The review was conducted based on the team's prior experience (Classen et al., 2009; Classen & Monahan, 2013), consultation with AOTA experts on systematic and evidence-based reviews (D. Lieberman & M. Arbesman, personal communication, March 6, 2013), joint decisions from the primary research team on classifying the studies, and agreement through consensus for making recommendations.

Results

Three medically at-risk groups—patients with conditions related to stroke, vision, and cognition—emerged from the 15 intervention studies. Sample sizes across the 15 studies varied from 2 (Man-Son-Hing, Marshall, Molnar, & Wilson, 2007) to 403 (Owsley, McGwin, Phillips, McNeal,

Key Words	MeSH Headings	Databases
Automobile	"Automobile Driving"[MeSH]	PubMed
Driving	"Accidents, Traffic"[MeSH]	CINAHL
"Automobile Driving"	"Frail Elderly"[MeSH]	Web of Science
Driver(s)	"Aged"[MeSH]	AgeLine
Car(s)	"Parkinson's Disease"[MeSH]	Sociological Collection
Vehicle*	"Stroke"[MeSH]	Cochrane Database of Systematic
Simulat*	"Dementia"[MeSH]	Reviews (CDSR)
Accident*	"Brain Injuries"[MeSH]	Database of Abstracts of Reviews
Crash*	"Mild Cognitive	of Effects (DARE)
"Police Report*"	Impairment"[MeSH]	Cochrane Central Register of
Citation*	"Cataract"[MeSH]	Controlled Trials (CCRCT)
Violation*	"Macular Degeneration"[MeSH]	
Warning*	"Glaucoma"[MeSH]	
Senior(s)	"Intraocular Lens	
Parkinson Disease	Implantation"[MeSH]	
Dementia	"Arthritis"[MeSH]	
Alzheimer Disease	"Myocardial Infarction"[MeSH]	
Stroke	"Chronic Obstructive Pulmonary	
CVA	Disease"[MeSH]	
"Cerebrovascular Accident*"	"Treatment Outcome"[MeSH]	
TBI		
"Traumatic Brain Injury*"		
"Mild Cognitive Impairment"		
Cataract		
"Macular Degeneration"		
Glaucoma		
"Lens Implant*"		
Arthritis		
"Myocardial Infarction"		
"Chronic Obstructive Pulmonary		
Disease"		
COPD		
Effectiveness		
Efficacy		

Figure 1. Search strategy for the evidence-based review on rehabilitation interventions for medically at-risk older drivers by key words, MeSH headings, and databases.

& Stalvey, 2004), and studies represented five countries (i.e., Australia, Belgium, Canada, Sweden, United States). The data from these studies are synopsisized in Supplemental Table 1 (available online at <http://otjournal.net>; navigate to this article, and click on "supplemental materials").

Stroke Studies

Results. The review rendered a total of 6 studies: 5 Level I randomized controlled trials (RCTs), 3 from the same group of researchers (Akinwuntan et al., 2005; Devos et al., 2010, 2009) and 2 from independent researchers (Crotty & George, 2009; Mazer et al., 2003); and 1 Level II nonrandomized two-group study (Söderström, Pettersson, & Leppert, 2006).

Conclusion. Given the longitudinal nature of three stroke studies (Akinwuntan et al., 2005; Devos et al., 2009, 2010), Level I evidence, with a high level of certainty, exists to support the effectiveness of task-specific training in a driving simulator versus cognitive training to improve on-road driving skills in clients with mild stroke. The remaining Level I RCTs displayed a lack of carryover effects by training driving skills through a cognitive (Mazer et al., 2003) or a visual attention (Crotty & George, 2009) component. However, a Level II study (Söderström et al.,

2006), with moderate level of certainty, indicates that drivers with stroke who failed a driving test improved their driving ability with interventions consisting of traffic theory knowledge tests (TTKTs) and on-road training interventions.

Recommendations. We suggest three sets of recommendations. First, we strongly recommend (Category A) that trained occupational therapy practitioners provide the graded simulator intervention as validated on the STISIM Drive Simulator (Systems Technology, Inc., Hawthorne, CA) to eligible stroke clients. Second, we recommend (Category B) that practitioners routinely provide TTKTs and on-road training interventions to clients with stroke. Third, insufficient (Category I) evidence exists to recommend for or against routinely providing Dynavision (visual attention), Useful Field of View (visual attention), and general visual-perceptual training interventions for effective on-road outcomes in patients with stroke.

Vision Studies

Results. The review rendered 7 studies: 3 Level I RCTs (Owsley et al., 2004; Owsley, Stalvey, & Phillips, 2003; Stalvey & Owsley, 2003), 3 Level II experimental studies (2 with crossover designs and 1 with random assignment;

Table 1. Guidelines for Assigning the Level and Strength of Evidence and for Making Recommendations

Guideline	Definition
Levels of evidence ^a	
Level I	Systematic reviews, meta-analyses, randomized controlled trials
Level II	Two groups, nonrandomized studies (e.g., cohort, case control)
Level III	One group, nonrandomized (e.g., before and after, pretest and posttest)
Level IV	Descriptive studies that include analysis of outcomes (e.g., single-subject design, case series)
Level V	Case reports and expert opinion that include narrative literature reviews and consensus statements
Strength of the evidence: Level of certainty ^b	
High	The available evidence usually includes consistent results from well-designed, well-conducted studies in representative primary care populations. These studies assess the effects of the preventive service on health outcomes. This conclusion is therefore unlikely to be strongly affected by the results of future studies.
Moderate	The available evidence is sufficient to determine the effects of the preventive service on health outcomes, but confidence in the estimate is constrained by such factors as the following: <ul style="list-style-type: none"> • The number, size, or quality of individual studies • Inconsistency of findings across individual studies • Limited generalizability of findings to routine primary care practice • Lack of coherence in the chain of evidence. As more information becomes available, the magnitude or direction of the observed effect could change, and this change may be large enough to alter the conclusion.
Low	The available evidence is insufficient to assess effects on health outcomes. Evidence is insufficient because of the following: <ul style="list-style-type: none"> • The limited number or size of studies • Important flaws in study design or methods • Inconsistency of findings across individual studies • Gaps in the chain of evidence • Findings not generalizable to routine primary care practice • Lack of information on important health outcomes. More information may allow estimation of effects on health outcomes.
Recommendation ^c	
A	Strongly recommend that occupational therapy practitioners routinely provide the intervention to eligible clients. Good evidence was found that the intervention improves important outcomes and that benefits substantially outweigh harm.
B	Recommend that occupational therapy practitioners routinely provide the intervention to eligible clients. At least fair evidence was found that the intervention improves important outcomes and that benefits outweigh harm.
C	There is weak evidence that the intervention can improve outcomes, and the balance of the benefits and harms may result either in a recommendation that occupational therapy practitioners routinely provide the intervention to eligible clients or in no recommendation because the balance of the benefits and harm is too close to justify a general recommendation.
D	Recommend that occupational therapy practitioners do not provide the intervention to eligible clients. At least fair evidence was found that the intervention is ineffective or that harm outweighs benefits.
I	Insufficient evidence to recommend for or against routinely providing the intervention. Evidence that the intervention is effective is lacking, of poor quality, or conflicting, and the balance of benefits and harm cannot be determined.

^aSee Sackett, Rosenberg, Muir Gray, Haynes, & Richardson (1996). ^bThe U.S. Preventive Services Task Force (USPSTF; 1996) defines *certainty* as “likelihood that the USPSTF assessment of the net benefit of a preventive service is correct.” The *net benefit* is defined as benefit minus harm of the preventive service as implemented in a general, primary care population. The USPSTF assigns a certainty level based on the nature of the overall evidence available to assess the net benefit of a preventive service. ^cRecommendation criteria are based on the standard language of the Agency for Healthcare Research and Quality Series Commentary (Falck-Ytter, Schünemann, & Guyatt, 2010). Suggested recommendations are based on the available evidence and content experts’ opinions.

Szlyk et al., 1998, 2000; Szlyk, Seiple, Stelmack, & McMahon, 2005), and 1 Level IV survey design (Bowers, Peli, Elgin, McGwin, & Owsley, 2005).

Conclusion. The 3 vision studies using an individual educational intervention (Owsley et al., 2003, 2004; Stalvey & Owsley, 2003) yielded consistent results from the RCT. We have concluded that visually impaired older drivers at higher risk for crash involvement may benefit from educational interventions by increasing their knowledge about vision and driving and increasing their self-perceptions of self-regulatory behaviors. We have also concluded that they are reducing their driving exposure and increasing their avoidance of visually challenging driving situations. Additionally, we have concluded that the educational intervention

did not yield any differences in police-reported crashes after 1 yr.

The 3 studies using the bioptic telescope system (BTS) intervention (Bowers et al., 2005; Szlyk et al., 1998, 2000) indicated that the intervention met the self-reported driving needs of the majority of visually impaired drivers as an aid for tasks requiring resolution of detail. They also indicated that drivers with low vision may benefit from a rehabilitation program that combines low vision training with BTS. The study on prism lenses (Szlyk et al., 2005) indicated that training in their use improves the visual skills necessary to drive. The study, however, included only one older adult (age >65 yr), and he did not drive. Thus, we cannot conclude that this

study is helpful to understand the effect of prism lenses on the driving performance of older drivers with homonymous hemianopia.

Recommendations. From the educational intervention findings (Owsley et al., 2003, 2004; Stalvey & Owsley, 2003), we recommend with high certainty (1) that occupational therapy practitioners cannot expect to see a difference in crash rates on the basis of an educational intervention in drivers with low vision (Category D) and (2) that practitioners may routinely provide the educational intervention to drivers with low vision because it improves self-reported regulatory behaviors and minimizes exposure to challenging situations (Category A). From the findings of 3 BTS studies (Bowers et al., 2005; Szlyk et al., 1998, 2000), we recommend with moderate certainty (Category B) that practitioners with adequate training in BTS routinely provide the bioptic training for clients to improve their visual skills and simulated and on-road driving skills, but with caution because the findings of the studies were not all specific to visually impaired at-risk older drivers. As for prism lenses (Szlyk et al., 2005), we have insufficient evidence (Category I) to recommend for or against routinely providing the intervention.

Cognitive Studies

Results. The review rendered 1 Level II nonrandomized three-group study (Freund & Petrakos, 2008) and 1 Level I systematic literature review (Man-Son-Hing et al., 2007).

Conclusion. From the Level II study (Freund & Petrakos, 2008), we conclude with low certainty that restricted drivers had safety profiles similar to safe drivers and gained additional driving time to transition to non-drivers following driving restrictions. From the Level I systematic literature review, we conclude, with high certainty, that with regard to possible compensatory strategies for enhancing the driving capabilities of persons with dementia (i.e., retraining and education programs, co-piloting, on-board navigation and crash warning systems, restricted licensing such as limiting where and when a person can drive, self- and family-imposed driving restriction, cognitive enhancers), none seem to be reasonable evidence-based options.

Recommendations. We have weak evidence (Category C) that the driving restriction intervention improves driving outcomes. If practitioners use driving restrictions, caution needs to be applied and consideration must be given to the multiple factors that may affect fitness to drive, such as client insight, external support, and unanticipated events in the driving environment. We have

insufficient (Category I) evidence, that is, no intervention studies, to support that compensatory strategies (as mentioned earlier) enhance driving capabilities in people with dementia.

Discussion

We classified and synthesized the results of 15 primary studies to determine the effectiveness of rehabilitation interventions for medically at-risk older drivers with stroke, vision impairment, or dementia. Although the on-road test conducted by a CDRS is the current industry-accepted gold standard (Korner-Bitensky, Gelinas, Man-Son-Hing, & Marshall, 2005), our review included various driving outcomes, that is, on-road studies, driving simulation, crash reports, or self-report. Researchers from five countries published on rehabilitation interventions and driving, underscoring the global importance of this field of study.

Implications From the Stroke Studies for Occupational Therapy Practice, Research, and Policy

From the 5 Level I studies on stroke and driving and for clinical practice, we discerned that multimodal interventions (i.e., graded simulator intervention, TTKT, on-road training) are effective, with moderate to high certainty, to improve on-road driving outcomes. We have insufficient evidence, however, to suggest that interventions directed at client factors (i.e., visual attention, speed of processing, and visual-perceptual training) result in effective on-road outcomes. Taken together, this evidence suggests that occupational therapy practitioners should focus on remediating driving-related tasks such as behind-the-wheel training rather than on the underlying client factors. That said, using an evidence-based approach includes three components (i.e., the client perspective, the client's context, and the best evidence; Law & Baum, 1998). By contemplating this three-pronged evidence-based approach, the practitioner must discern, in light of the existing evidence, mindful of the client's context, and in a client-centered way, what the main priorities and intervention options are for improved driving outcomes.

From a research perspective, scholars are advised to establish quantifiers for dose-response interventions as well as for the duration and specific type of interventions. Thus, researchers must clearly distinguish the maximum gains, appropriate dose (frequency and intensity of intervention), and duration to optimize client gains in driving fitness. Focusing on simulators as one example of an intervention strategy, we caution that not all simulators are created equal, and validation studies across simulators are

needed to establish which type of simulator (e.g., fixed base vs. motion base, full car cab vs. cockpit type, 180-degree field of view vs. 135- or 65-degree field of view) may best be used for the intervention. From a policy perspective, such research (dose–response, duration, type) will reveal critical information on the most cost-effective interventions, which may affect reimbursement procedures and facilitate policy changes.

Implications From the Vision Studies for Occupational Therapy Practice, Research, and Policy

Vision is essential for driving. When vision is impaired because of uncorrected or undetected age-related or medical conditions, drivers are a risk to themselves, their passengers, pedestrians, and other road users. With the burgeoning baby boomer population, it is imperative to understand the effectiveness of vision-related interventions in improving the driving performance of older adults.

For occupational therapy practice and research, we have discerned that an educational intervention may be used to improve self-knowledge on driving and low vision and improve self-perceptions on driving exposures. The effects do not carry over to crash reduction, but considering that crashes are rare events, the effects may not be observable through this outcome. We are not certain, however, whether the intervention improves fitness-to-drive skills because no simulator or on-road intervention studies emerged in our review. Training in the use of BTS holds potential as an effective strategy, but studies must be replicated in older drivers (>65 yr) to ascertain improvements in this group's driving fitness.

Our findings hold interesting implications for policy. As of August 2009, 39 states allow persons with low vision to drive with BTS (Elgin, Owsley, & Classen, 2012). Each state has different rules for driving with BTS, and wide variations exist in vision requirement policies throughout the United States. As such, occupational therapy practitioners working in the area of driving need to understand the laws and policies in the jurisdictions where they practice and where their clients live and drive. Moreover, practitioners can also, through documentation and record keeping, affect policy, especially if their documentation shows a benefit for older drivers using BTS.

Implications From the Cognitive Studies for Occupational Therapy Practice, Research, and Policy

Two studies examined the efficacy of driving restrictions in terms of driving outcomes. Although Freund and Petrakos (2008) found that driving restrictions prolonged driving time and time to unsafe driving in those with cognitive impairment, Man-Son-Hing et al. (2007) found no in-

tervention studies to support compensatory strategies to enhance driving capabilities in persons with dementia. For occupational therapy practice and research, clinicians must consider that drivers with dementia do not perform well in less predictable situations, such as what may be occurring before or during a crash. Moreover, knowing that they may not have the insight to understand the rationale for driving restrictions or follow through with compensatory strategies, we suggest that there is insufficient evidence to support the use of driving restrictions or compensatory strategies to enhance their driving capabilities (Berger & Rosner, 2000). Because approximately 6%–10% of the population over age 65 have dementia (Chapman, Williams, Strine, Anda, & Moore, 2006), well-designed RCTs are critically important to study the effectiveness of such interventions in improving the driving fitness of older drivers with cognitive impairment.

Regarding policy, some people in the early stages of mild dementia are able to continue to drive with the recommendation to be reevaluated by an OT–CDRS as their condition deteriorates (Geldmacher & Whitehouse, 1996). Longitudinal studies indicate that 88% of drivers with very mild dementia and 69% of drivers with mild dementia were still able to pass a formal on-road assessment. In fact, the median time to cessation of driving in very mild dementia was 2 yr and 1 yr for mild dementia (Duchek et al., 2003; Ott et al., 2008). As such, and because an increase in the number of drivers with dementia is expected over the next few decades, policies will have to balance the needs of drivers who have varying types, durations, and levels of dementia severity with the safety of the public.

Limitations and Strengths

Limitations of this review include heterogeneity among the primary studies, such as variability in age of study participants (Bowers et al., 2005; Szlyk et al., 2000), population size (Crotty & George, 2009; Szlyk et al., 2005), and gender composition, because some studies included only men (Crotty & George, 2009; Söderström et al., 2006). We reviewed only studies published in the English literature and within a specific time frame. Although we did footnote-chase reference lists from the included studies, we did not search for government publications (gray literature) or unpublished manuscripts (Cooper & Hedges, 1994). Methodological rigor may be affected by including studies using different simulators and simulator scenarios or different driving outcomes, bias from greater representation of men, and not controlling for prior rehabilitation or clinical interventions.

Strengths of this study are that it is the first evidence-based review to determine the level and strength of evidence for rehabilitation interventions in medically at-risk groups, and it provides recommendations to occupational therapy practitioners, researchers, and policymakers. We also used a team process with consensus for study classification, had expertise in evidence-based reviews (Classen & Monahan, 2013), used the AOTA classification system, and had expertise in older driver research (Classen, 2010).

Conclusion

This is the first evidence-based review to provide recommendations to occupational therapy practitioners on the effectiveness of driving interventions for medically at-risk older drivers. Although we provide recommendations to practitioners, we further assert the need for continued RCTs, Level I studies, and A-level recommendations. Because much of the evidence derived from other fields and disciplines (physical therapy, ophthalmology, public health), we strongly encourage occupational therapy researchers to examine interventions used in everyday occupational therapy practice. Driving is a key function for continued independence, autonomy, and quality of life, and well-designed Level I intervention studies will make clear the effectiveness of interventions, further provide recommendations for clinical decision making, and afford opportunities to occupational therapy practitioners to influence policy as a result. ▲

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