2014

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

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## DOI

http://dx.doi.org/10.5014/ajot.2014.010975

# 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.

Classen, S., Monahan, M., Auten, B., & Yarney, A. (2014). Evidence-based review of interventions for medically at-risk older drivers. *American Journal of Occupational Therapy, 68,* e107–e114. http://dx.doi.org/10.5014/ajot.2014.010975

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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 Reviews (CDSR) |
| Simulat* | "Dementia"[MeSH] | Database of Abstracts of Reviews of Effects (DARE) |
| Accident* | "Brain Injuries"[MeSH] | Cochrane Central Register of Controlled Trials (CCRCT) |
| Crash* | "Mild Cognitive Impairment"[MeSH] | |
| "Police Report*" | "Cataract"[MeSH] | |
| Citation* | "Macular Degeneration"[MeSH] | |
| Violation* | "Glaucoma"[MeSH] | |
| Warning* | "Intraocular Lens Implantation"[MeSH] | |
| Senior(s) | "Arthritis"[MeSH] | |
| Parkinson Disease | "Myocardial Infarction"[MeSH] | |
| Dementia | "Chronic Obstructive Pulmonary Disease"[MeSH] | |
| Alzheimer Disease | "Treatment Outcome"[MeSH] | |
| Stroke | | |
| CVA | | |
| "Cerebrovascular Accident*" | | |
| 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 synopsized 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:<br>• The number, size, or quality of individual studies<br>• Inconsistency of findings across individual studies<br>• Limited generalizability of findings to routine primary care practice<br>• Lack of coherence in the chain of evidence.<br>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:<br>• The limited number or size of studies<br>• Important flaws in study design or methods<br>• Inconsistency of findings across individual studies<br>• Gaps in the chain of evidence<br>• Findings not generalizable to routine primary care practice<br>• Lack of information on important health outcomes.<br>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. |

[a]See Sackett, Rosenberg, Muir Gray, Haynes, & Richardson (1996). [b]The 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. [c]Recommendation 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 nondrivers 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, copiloting, 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 intervention 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. ▲

## Acknowledgment

This study was funded by the American Occupational Therapy Association–National Highway Traffic Safety Administration minigrant project (Sherrilene Classen, Principal Investigator).

## References

Akinwuntan, A. E., De Weerdt, W., Feys, H., Pauwels, J., Baten, G., Arno, P., & Kiekens, C. (2005). Effect of simulator training on driving after stroke: A randomized controlled trial. *Neurology, 65,* 843–850. http://dx.doi.org/10.1212/01.wnl.0000171749.71919.fa

Berger, J. T., & Rosner, F. (2000). Ethical challenges posed by dementia and driving. *Journal of Clinical Ethics, 11,* 304–308.

Bowers, A., Peli, E., Elgin, J., McGwin, G., Jr., & Owsley, C. (2005). On-road driving with moderate visual field loss. *Optometry and Vision Science, 82,* 657–667.

Chapman, D. P., Williams, S. M., Strine, T. W., Anda, R. F., & Moore, M. J. (2006). Dementia and its implications for public health. *Preventing Chronic Disease, 3,* A34. Retrieved from http://www.cdc.gov/pcd/issues/2006/apr/05_0167.htm

Classen, S. (2010). From the Desk of the Editor—Special issue on older driver safety and community mobility. *American Journal of Occupational Therapy, 64,* 211–214. http://dx.doi.org/10.5014/ajot.64.2.211

Classen, S., Levy, C., McCarthy, D., Mann, W. C., Lanford, D., & Waid-Ebbs, J. K. (2009). Traumatic brain injury and driving assessment: An evidence-based literature review. *American Journal of Occupational Therapy, 63,* 580–591. http://dx.doi.org/10.5014/ajot.63.5.580

Classen, S., & Monahan, M. (2013). Evidence-based review on interventions and determinants of driving performance in teens with attention deficit hyperactivity disorder or autism spectrum disorder. *Traffic Injury Prevention, 14,* 188–193. http://dx.doi.org/10.1080/15389588.2012.700747

Cooper, H. M., & Hedges, L. V. (1994). *The handbook of research synthesis.* New York: Russell Sage Foundation.

Crotty, M., & George, S. (2009). Retraining visual processing skills to improve driving ability after stroke. *Archives of Physical Medicine and Rehabilitation, 90,* 2096–2102. http://dx.doi.org/10.1016/j.apmr.2009.08.143

Devos, H., Akinwuntan, A. E., Nieuwboer, A., Ringoot, I., Van Berghen, K., Tant, M., . . . De Weerdt, W. (2010). Effect of simulator training on fitness-to-drive after stroke: A 5-year follow-up of a randomized controlled trial. *Neurorehabilitation and Neural Repair, 24,* 843–850. http://dx.doi.org/10.1177/1545968310368687

Devos, H., Akinwuntan, A. E., Nieuwboer, A., Tant, M., Truijen, S., De Wit, L., . . . De Weerdt, W. (2009). Comparison of the effect of two driving retraining programs on on-road performance after stroke. *Neurorehabilitation and Neural Repair, 23,* 699–705. http://dx.doi.org/10.1177/1545968309334208

Duchek, J. M., Carr, D. B., Hunt, L., Roe, C. M., Xiong, C., Shah, K., & Morris, J. C. (2003). Longitudinal driving performance in early-stage dementia of the Alzheimer type. *Journal of the American Geriatrics Society, 51,* 1342–1347. http://dx.doi.org/10.1046/j.1532-5415.2003.51481.x

Elgin, J., Owsley, C., & Classen, S. (2012). Vision and driving. In M. J. McGuire & E. Schold-Davis (Eds.), *Driving and community mobility: Occupational therapy strategies across the lifespan* (pp. 172–220). Bethesda, MD: AOTA Press.

Falck-Ytter, Y., Schünemann, H., & Guyatt, G. (2010). AHRQ Series Commentary 1: Rating the evidence in comparative effectiveness reviews. *Journal of Clinical Epidemiology, 63,* 474–475. http://dx.doi.org/10.1016/j.jclinepi.2010.01.003

Freund, B., & Petrakos, D. (2008). Continued driving and time to transition to nondriver status through error-specific driving restrictions. *Gerontology and Geriatrics Education, 29,* 326–335. http://dx.doi.org/10.1080/02701960802497852

Geldmacher, D. S., & Whitehouse, P. J. (1996). Evaluation of dementia. *New England Journal of Medicine, 335,* 330–336. http://dx.doi.org/10.1056/NEJM199608013350507

Korner-Bitensky, N., Gelinas, I., Man-Son-Hing, M., & Marshall, S. (2005). Recommendations of the Canadian Consensus Conference on driving evaluation in older drivers. In W. Mann (Ed.), *Community mobility: Driving and transportation alternatives for older persons* (pp. 123–144). Binghamton, NY: Haworth Press.

Lamoureux, E. L., Pallant, J. F., Pesudovs, K., Rees, G., Hassell, J. B., & Keeffe, J. E. (2007). The effectiveness of low-vision rehabilitation on participation in daily living and quality of life. *Investigative Ophthalmology and Visual Science, 48,* 1476–1482. http://dx.doi.org/10.1167/iovs.06-0610

Law, M., & Baum, C. (1998). Evidence-based occupational therapy. *Canadian Journal of Occupational Therapy, 65,* 131–135.

Man-Son-Hing, M., Marshall, S. C., Molnar, F. J., & Wilson, K. G. (2007). Systematic review of driving risk and the efficacy of compensatory strategies in persons with dementia. *Journal of the American Geriatrics Society, 55,* 878–884. http://dx.doi.org/10.1111/j.1532-5415.2007.01177.x

Mazer, B. L., Sofer, S., Korner-Bitensky, N., Gelinas, I., Hanley, J., & Wood-Dauphinee, S. (2003). Effectiveness of a visual attention retraining program on the driving performance of clients with stroke. *Archives of Physical Medicine and Rehabilitation, 84,* 541–550. http://dx.doi.org/10.1053/apmr.2003.50085

Ott, B. R., Heindel, W. C., Papandonatos, G. D., Festa, E. K., Davis, J. D., Daiello, L. A., & Morris, J. C. (2008). A longitudinal study of drivers with Alzheimer disease. *Neurology, 70,* 1171–1178. http://dx.doi.org/10.1212/01.wnl.0000294469.27156.30

Owsley, C., McGwin, G., Jr., Phillips, J. M., McNeal, S. F., & Stalvey, B. T. (2004). Impact of an educational program on the safety of high-risk, visually impaired, older drivers. *American Journal of Preventive Medicine, 26,* 222–229. http://dx.doi.org/10.1016/j.amepre.2003.12.005

Owsley, C., Stalvey, B. T., & Phillips, J. M. (2003). The efficacy of an educational intervention in promoting self-regulation among high-risk older drivers. *Accident; Analysis and Prevention, 35,* 393–400. http://dx.doi.org/10.1016/S0001-4575(02)00016-7

Sackett, D. L., Rosenberg, W. M., Muir Gray, J. A., Haynes, R. B., & Richardson, W. S. (1996). Evidence-based medicine: What it is and what it isn't. *BMJ, 312,* 71–72. http://dx.doi.org/10.1136/bmj.312.7023.71

Schold Davis, E., & Dickerson, A. (2012). The Gaps and Pathways Project: Meeting the driving and community mobility needs of OT clients. *OT Practice, 17*(21), 9–13, 19.

Söderström, S. T., Pettersson, R. P., & Leppert, J. (2006). Prediction of driving ability after stroke and the effect of behind-the-wheel training. *Scandinavian Journal of Psychology, 47,* 419–429. http://dx.doi.org/10.1111/j.1467-9450.2006.00550.x

Stalvey, B. T., & Owsley, C. (2003). The development and efficacy of a theory-based educational curriculum to promote self-regulation among high-risk older drivers. *Health Promotion Practice, 4,* 109–119. http://dx.doi.org/10.1177/1524839902250757

Stav, W. B., Arbesman, M., & Lieberman, D. (2008). Background and methodology of the older driver evidence-based systematic literature review. *American Journal of Occupational Therapy, 62,* 130–135. http://dx.doi.org/10.5014/ajot.62.2.130

Strong, J. G., Jutai, J. W., Russell-Minda, E., & Evans, M. (2008). Driving and low vision: An evidence-based review of rehabilitation. *Journal of Visual Impairment and Blindness, 109,* 410–419.

Szlyk, J. P., Seiple, W., Laderman, D. J., Kelsch, R., Ho, K., & McMahon, T. (1998). Use of bioptic amorphic lenses to expand the visual field in patients with peripheral loss. *Optometry and Vision Science, 75,* 518–524. http://dx.doi.org/10.1097/00006324-199807000-00021

Szlyk, J. P., Seiple, W., Laderman, D. J., Kelsch, R., Stelmack, J., & McMahon, T. (2000). Measuring the effectiveness of bioptic telescopes for persons with central vision loss. *Journal of Rehabilitation Research and Development, 37,* 101–108.

Szlyk, J. P., Seiple, W., Stelmack, J., & McMahon, T. (2005). Use of prisms for navigation and driving in hemianopic patients. *Ophthalmic and Physiological Optics, 25,* 128–135. http://dx.doi.org/10.1111/j.1475-1313.2004.00265.x

U.S. Preventive Services Task Force. (1996). *Guide to clinical preventive services: Report of the U.S. Preventive Service Task Force* (2nd ed.). Baltimore: Williams & Wilkins.

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| | | | Stroke | | |
| Akinwuntan et al. (2005) | To determine the immediate and long-term effects of a simulator intervention program on on-road performance and overall driving fitness | I<br><br>RCT<br><br>$N = 83$ subacute stroke patients enrolled (42 intervention, 41 control; 81% men)<br><br>$N = 73$ completed study (intervention group: $n = 37$, mean age = 54, $SD \pm 12$, days since stroke = 53, $SD \pm 6$; control group: $n = 36$, mean age = 54, $SD \pm 11$, days since stroke = 54, $SD \pm 6$)<br><br>$N = 52$ completed on-road test ($n = 26$ intervention, $n = 26$ control) | *Intervention*<br>5-wk, 15-hr program divided into 1-hr sessions 3×/wk of simulator-based intervention on the STISIM Drive® system in a full-size car with adaptive aids as needed. Preintervention assessment scenario varied in traffic, highway, and speed conditions. Practice drives were followed by feedback. Reassessment drive was same length but used a different scenario. Control group completed a standardized program of cognitive tasks using maps, numerical memory interventions, tile patterning, and road and traffic sign recognition.<br><br>*Outcomes*<br>• Acuity and kinetic vision tests<br>• UFOV<br>• Stroke Driver Screening Assessment<br>• On-road tests | Groups did not differ in preintervention on-road assessment. At postintervention, the intervention group showed greater (but not significant) improvement. Drivers improved significantly on simulator tasks postintervention. Improvements in several items during on-road assessment were predicted by improvement in selected items on the simulator. A significant difference was found between groups at 6 mo in passing of on-road assessment. At follow-up, improved driving performance in the simulator (i.e., decreases in total number of crashes, excessive speed, and pedestrians hits) predicted overall road performance. A combination of more education and reduced disability predicted improved on-road performance in the intervention group. | Possible selection bias is indicated by the attrition rate of 28.8% in both groups. No variable appeared to predict dropout, but limited demographics were provided. Intent-to-treat analysis using postintervention scores of dropouts showed significant differences favoring the experimental group. Groups differed significantly in educational levels, but effects of attrition on education were not reported. Long-term follow-up did not include measures of physical or functional recovery. |
| Crotty & George (2009) | To determine the effectiveness of an intervention program using Dynavision in improving driving performance in people with stroke | I<br><br>RCT<br><br>$N = 26$ people ≥1 mo poststroke randomly allocated to intervention ($n = 13$) and control ($n = 13$) groups (92.3% men; mean age 65.6, $SD \pm 13.1$; median days since stroke = 83.5, range = 29–816) | *Intervention*<br>18 sessions on Dynavision Light Training Board 2000, 40-min sessions 3×/wk for 6 wk, graded in complexity depending on skill level. Control participants were assigned to wait list.<br><br>*Outcome*<br>• Standardized on-road driving assessment results | No significant differences were found between groups on the on-road assessment ($p = .223$). | Study group varied in time since stroke (1 mo to >2 yr). No exclusion criteria were used for age or driving frequency. No standardized screening was used for visual neglect, visual attention, or motor severity. Significant differences were found between groups at initial assessment on sections of Visual Scanning Analyzer and Abilities in Response Time Measures. Standardized on-road assessments may have varied in weather, traffic, and risk conditions for each driver. Type 1 errors were possible because of the number of statistical tests performed. |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| Devos et al. (2009) | To determine whether a comprehensive driving intervention program using a simulator had better carryover to driving skills than a cognitive intervention program | I<br><br>Further analysis of data from RCT by Akinwuntan et al. (2005)<br><br>$N = 73$ subacute stroke patients 6–9 wk post first stroke (intervention group: $n = 37$, mean age = 54, $SD \pm 12$, days since stroke = 53, $SD \pm 6$; control group: $n = 36$, mean age = 54, $SD \pm 11$, days since stroke = 54, $SD \pm 6$) | *Intervention*<br>Simulator intervention. Control group received a cognitive intervention.<br><br>*Outcome*<br>• On-road driving performance using TRIP immediately after intervention and 6 mo poststroke | Overall on-road performance improved significantly over time in both groups; patterns of improvement differed. The intervention group showed greater improvement postintervention and at follow-up in overall score and subcomponent scores of anticipation and perception of signs, visual behavior and communication, quality of traffic participation, and left turns. | Simulator intervention gradually increased in complexity, whereas the cognitive games did not. A ceiling effect to TRIP may have missed improvements in approximately 25% of the intervention group postintervention. Dropout rate was high (12% postintervention and 37% at 6-mo follow-up). Intention-to-treat analysis showed dropout rate did not change results obtained. |
| Devos et al. (2010) | (1) To determine the effect of simulator vs. cognitive rehabilitation therapy on fitness to drive (i.e., performance in on-road and off-road tests) at 5 yr poststroke and (2) to investigate differences in clinical characteristics between stroke survivors who resumed and stopped driving | I<br><br>5-yr follow-up of RCT by Akinwuntan et al. (2005)<br><br>$N = 61$ subacute stroke patients (78.7% men; intervention group: $n = 30$, mean age = 58, $SD \pm 12$; control group: $n = 31$, mean age = 59, $SD \pm 12$) | *Intervention*<br>5-wk, 15-hr program divided into 1-hr sessions 3×/wk of simulator-based intervention on the STISIM Drive® system in a full-size car with adaptive aids as needed. Preintervention assessment scenario varied in traffic, highway, and speed conditions. Practice drives were followed by feedback. Reassessment drive was same length but used a different scenario. Control group completed a standardized program of cognitive tasks using maps, numerical memory interventions, tile patterning, and road and traffic sign recognition.<br><br>*Outcomes*<br>• Primary: Fitness to drive 5 yr poststroke<br>• Secondary: Clinical characteristics | At 5 yr poststroke, 34 of 61 (56%) participants were driving; 18 of 30 participants (60%) in the intervention group were considered fit to drive compared with 15 of 31 (48%) in the control group ($p = .36$). Current drivers were younger ($p = .04$), had higher Barthel Index scores ($p = .008$), had less comorbidity ($p = .01$), and were less severely depressed ($p = .02$) compared with those who gave up driving. | 27% ($n = 21$) of stroke patients did not participate, a major limitation, but intent-to-treat analysis showed that dropout occurred completely at random. |
| Mazer et al. (2003) | To compare the effectiveness of a visual attention intervention program using the UFOV with a traditional visuoperception treatment program in promoting the driving performance of clients with stroke | I<br><br>RCT<br><br>$N = 97$ stroke patients (intervention group: $n = 47$, mean age = 65.5, $SD \pm 11.4$, 74.5% male, days poststroke = 91.2, $SD \pm 51.8$; control group: $n = 50$, mean age = 66.5, $SD \pm 8.9$, 70.0% male, days poststroke = 66.7, $SD \pm 28.2$) | *Intervention*<br>Four 1-hr sessions/wk for 5 wk. Intervention group received 20 sessions of UFOV for visual processing speed and divided and selective attention. Control group received 20 sessions of targeted perceptual and cognitive skills intervention using computerized programs—Tetris, Mastermind, Othello, and Jigs@w Puzzle. | At pretest, the groups did not differ on personal characteristics, medical condition, rehabilitation involvement preintervention (other than the time of evaluation poststroke), driving competence and importance, or frequency and reasons they had driven before their stroke. At posttest, no significant differences were found by group in | Rate of noncompliance was 17% in the intervention group and 12% in the control group. More participants withdrew than expected, decreasing to 82% the power of the study to detect a 30-percentage-point difference. The study did not have sufficient power to detect significant differences between the intervention and control groups. |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| | | | *Outcome*<br>• On-road driving evaluation results | proportion of participants who passed and failed the on-road evaluation, $\chi^2 = 0.38$, $p = .536$ (experimental group $n = 41$, control group $n = 43$). Passing the on-road driving evaluation was associated with younger age and with better FIM, UFOV, double cancellation, Charron, and MVPT scores and reaction time. | |
| Söderström, Pettersson, & Leppert (2006) | To determine whether drivers with stroke who failed a driving test could improve their driving ability with an on-road intervention | II<br>2 groups, nonrandomized<br>$N = 54$ stroke patients (intervention group: $n = 34$ with first cerebral insult; time since insult 1.4–14.0 mo, mean age = 54, $SD$ ± 8.8, range = 28–67, 94% men; control group: $n = 20$ matched for age, gender, education, and driving experience) | *Intervention*<br>Participants who failed the on-road evaluation received 2-hr lessons on traffic theory and on-road intervention. Errors made in the on-road test were used to calculate the number of hours of intervention and type of intervention (traffic theory and on-road intervention); participants received either 6 hr or 12 hr of intervention on the basis of their on-road test scores. Control group completed the same assessments but were not offered an intervention if they failed the on-road evaluation.<br>*Outcomes*<br>• Primary: Results of a 1-hr road test on a predetermined route with 5 subvariables graded on a 5-point scale<br>• Secondary: TTKT, neuropsychological test battery | Although not significant, a larger percentage of the control group failed road driving preassessment. Of the intervention group, 44% failed the on-road test and were offered either 6 hr of intervention ($n = 8$) or 12 hr of intervention ($n = 7$). Of those who failed the initial road test, 87% passed the follow-up road test after intervention. Participants who completed the on-road intervention had significant increases in TTKT scores, $t(9) = 3.06$, $p = .016$. | Sample size was small; time since stroke, severity of impairments, and locations and types of stroke were heterogeneous. Number of participants age 65 or older was not stated; oldest participant was 67.<br>On-road assessments and intervention sessions varied in traffic, road, risk, and weather conditions. Dichotomous pass–fail score on on-road test may not have captured change. Intervention was not explained sufficiently. No intervention was provided to control participants who failed; therefore, no comparison was possible between experimental and control groups who failed the on-road test. |
| | | | Vision | | |
| Bowers, Peli, Elgin, McGwin, & Owsley (2005) | To determine, through self-report, the extent to which bioptic telescopes were used by and met the driving needs of people with moderately reduced visual acuity | IV<br>Survey design<br>$N = 58$ low vision users (mean age = 47, $SD$ ± 17, range 17–86; 62% men) | *Intervention*<br>Bioptic telescope when driving. Control group received no intervention.<br>*Outcomes*<br>• Mean bioptic helpfulness score<br>• Percentage of time viewing with bioptic | 62% of participants reported wearing the telescope all the time when driving; 74% rated the bioptic telescope as very helpful, and 90% would continue to use it for driving. 100% of participants used a telescope for reading road signs, whereas fewer than 30% used a telescope for seeing brake and signal lights or judging the distance to the car in | Sample was limited in size, a convenience sample, and not a homogenous group of older drivers. Drivers who did not use or rarely used their bioptic telescopes were probably underrepresented, especially in the group recruited via the advertisement on the Bioptic Drivers website. Study captured |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| | | | • Mean driving difficulty<br>• Miles per wk | front of them. 85% reported no difficulties in using a bioptic telescope when driving. Multiple regression analysis results indicated that mean visual difficulty without the bioptic was the only significant predictor ($R^2 = 0.58$, $p = .001$) of mean bioptic helpfulness score. The presence of central field loss was weakly predictive ($R^2 = 0.22$, $p < .001$) of the estimated percentage of driving time spent viewing with the bioptic. No significant predictors of driving difficulty were found. The only variable predicting weekly mileage was age ($R^2 = 0.12$, $p = .006$). | self-report of driving vs. assessment of actual driving. |
| Owsley, Stalvey, & Phillips (2003) | To evaluate 6-mo outcomes after an educational program to promote safe driving practices among visually impaired older drivers | I<br><br>Experimental design with participants randomly assigned to 2 groups<br><br>$N = 365$ high-risk older drivers legally licensed to drive in AL (mean age = 74, range = 60–91, *SD* ± 6; 23% African American, 77% White; 69% men) with visual acuity of 20/30 to 20/60 and/or visual processing deficits of >40% on UFOV | *Intervention*<br>Usual care plus KEYS individual educational intervention: 2 educational sessions that included a 2-hr visit and a booster session 1 mo later. Control group received usual care (eye care specialist discussed impact of any diagnosed visual impairment on activities of daily living such as driving).<br><br>*Outcomes*<br>• Self-perceptions of vision and driving<br>• Attitudes toward driver safety<br>• Driver behavior: self-regulatory practices, driver dependency | At posttest, compared with the control group, the intervention group reported<br>• more difficulty with visually challenging driving situations, $t(352) = 4.4$, $p < .01$<br>• more frequent performance of self-regulatory practices, $t(350) = 8.24$, $p < .01$<br>• more frequent avoidance of hazardous driving, $t(360) = 6.21$, $p < .01$<br>• similar likelihood of increasing their dependence on others to drive, $t(361) = 1.44$, $p = .14$<br>• fewer places traveled to, $t(361) = 2.01$, $p < .05$; fewer trips per wk, $t(361) = 2.26$, $p < .02$; and fewer days driven per week, $t(361) = 2.01$, $p < .05$ | Generalizability of findings to drivers beyond AL is limited. No blinding was used, outcomes were self-reported, and no valid driving outcomes were assessed. |
| Owsley et al. (2004) | To determine whether an individualized educational program promoting strategies to enhance driver safety reduced the crash rate of high-risk older drivers | I<br><br>Randomized, controlled, single-masked intervention evaluation at an ophthalmology clinic | *Intervention*<br>Usual care plus KEYS individual educational intervention promoting safe driving strategies. Control group | The intervention group did not differ significantly from the usual care–only group in crash rate per 100 person-years of driving, relative risk (RR) = 1.08, 95% CI | Generalizability of findings to drivers beyond AL is limited. No blinding was used. |

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**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| | | *N* = 403 older drivers (average age = 73, more likely to be men, to be White, and to have at least a high school education) with a visual acuity deficit (20/30 to 20/60) or slowed visual processing speed (reduction of >40% on UFOV) or both who were involved in a crash in the previous year and drove at least 5 days or 100 miles per wk | received usual care (comprehensive eye exam).<br>*Outcomes*<br>• Police-reported vehicle collision rates measured as person-years of follow-up<br>• Person-miles of travel over 2 yr postintervention | [0.71–1.64], and per 1 million person-miles of travel, RR = 1.40, 95% CI [0.92–2.12]. The intervention group reported more avoidance of challenging driving maneuvers and self-regulatory behaviors during follow-up than the usual care–only group ($p$ = .0001). | |
| Stalvey & Owsley (2003) | To determine the efficacy of an educational intervention for visually impaired older drivers in improving self-awareness and self-regulation of driving | I<br>Experimental design with participants randomly assigned to 2 groups<br>*N* = 365 high-risk older drivers with visual acuity of 20/30 to 20/60 and/or visual processing deficits of >40% on UFOV and legally licensed to drive in AL (mean age = 74, range = 60–91, *SD* ± 6; 23% African American, 77% White; 69% men) | *Intervention*<br>Usual care plus KEYS individual educational intervention: 2 educational sessions that included a 2-hr visit and a booster session 1 mo later. Control group received usual care (eye care specialist discussed impact of any diagnosed visual impairment on activities of daily living such as driving).<br>*Outcomes*<br>• Self-perception of vision<br>• Perceived threat<br>• Perceived barriers<br>• Perceived benefits<br>• Regulatory self-efficacy | The intervention group improved self-perceptions of vision impairment and understanding of its impact on driving compared with the control group, $t(362) = 4.42$, $p <$ .01, and perceived a greater number of benefits in the performance of self-regulatory behaviors, $t(352) = 3.53$, $p < .01$. | Generalizability of findings to drivers beyond AL is limited. No blinding was used, outcomes were self-reported, and no valid driving outcomes were assessed. |
| Szlyk et al. (1998) | To test the effectiveness of an amorphic bioptic lens in patients with retinitis pigmentosa (RP), choroideremia, and Usher's syndrome type 2 | II<br>Crossover study design<br>*N* = 15 adult and older adult drivers with peripheral field and visual acuity impairment (mean age = 44.2, *SD* ± 13.4, range = 27–67; 7 women, 8 men) and RP ($n$ = 13), choroideremia ($n$ = 1), or Usher's syndrome type 2 ($n$ = 1) | *Intervention*<br>Training in functional use of amorphic lenses over 3 mo. Control group had wait period of 3 mo and then received the intervention.<br>*Outcomes*<br>• Mobility outcomes, measured as walking-related activities<br>• Driving measures on the simulator: Accidents, braking response time, speed, deceleration ratio<br>• Road test: Pulling out into traffic, negotiating traffic<br>• Global driving score | Overall, test scores improved; improvement ranged from 46.4% in the mobility category to 27.0% in the scanning category, with an overall improvement of 37.3%. | Sample size was small, age groups were heterogeneous, no blinding was used, no detailed results of simulator or on-road components were provided, and generalizability of findings is limited. |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| Szlyk et al. (2000) | (1) To evaluate a bioptic telescope training intervention aimed at people with central vision loss to improve life skills, including driving, and (2) to compare the outcomes of people given bioptic telescopes and a training intervention with those of people prescribed telescopic lenses without a training intervention | II<br><br>2-group crossover experimental design with a third, control group not crossing over<br><br>$N = 25$ adolescent, adult, and older drivers with central vision loss (age range 16–78; 13 men, 12 women) | *Intervention*<br>Group 1 received bioptic telescopes and orientation and mobility intervention for 5 wk followed by a driving intervention in a simulator and on the road for 8 wk during the first 3-mo period of the 6-mo study. Group 2 received lenses and training during the second 3-mo period of the study. The driving intervention consisted of reading dashboard displays, maintaining proper vehicle position, engaging in gap acceptance, locating traffic control signs, improving visual memory skills, using mirrors, and navigating complex traffic situations as a passenger. Control group received the lenses for approximately 3 mo without any training.<br><br>*Outcomes*<br>• Recognition<br>• Mobility<br>• Peripheral identification<br>• Scanning<br>• Tracking<br>• Visual memory | Participants showed significant improvement in all task categories with use of the telescopes. The intervention groups improved; the trained and untrained groups differed significantly only in the recognition, peripheral identification, and scanning categories but not in mobility, tracking, or visual memory. When the tasks involving driving-related skills were analyzed separately, training also resulted in a significant difference between the intervention groups and the control group, $t(20) = 2.45$, $p = .02$. | Sample size was small, age groups were heterogeneous, no blinding was used, no detailed results of simulator or on-road components were provided, and generalizability of findings is limited. |
| Szlyk, Seiple, Stelmack, & McMahon (2005) | (1) To compare the outcomes of orientation and mobility (O&M) and driver training interventions with Fresnel prisms and the Gottlieb Visual Field Awareness System for patients with homonymous hemianopsia and (2) to determine whether participants continued to use the prisms at 2-yr follow-up | II<br><br>Experimental design with random assignment<br><br>$N = 10$ adolescent, adult, and older drivers (mean age $= 52.3$, range $=$ 16–74; all male) with left or right hemianopsia because of cerebral vascular accidents ($n = 8$), brain tumor ($n = 1$), or arteriovenous malformation ($n = 1$). Participants were screened to include only occipital lobe strokes; 7 had left hemifield loss and 3 had right hemifield loss. | *Intervention*<br>Gottlieb prisms and intervention the first 3 mo of the study, then Fresnel prisms and intervention in last 3 mo of the study. The O&M intervention consisted of four 2- to 3-hr sessions in the lab conducted by a low vision specialist. The driving skill intervention consisted of eight 2-hr sessions conducted by a kinesiotherapist and included spotting critical roadway information, using the prisms to read vehicle instrumentation, and executing maneuvers. Control group received the same interventions in reverse order. | Patients with hemianopsia showed improvements in all of the visual skills categories, ranging from 26% of tasks improved in the mobility category to 13% in the recognition category. The majority of patients with hemianopsia ($n = 7$) reported using the prisms at the 2-yr follow-up interview, but only 3 of them continued to drive and only 2 of the 3 continued to use their lenses for driving. | Participants were of heterogeneous age, older drivers were underrepresented, findings are not generalizable, no blinding was used, and no data on the long-term safety of device use while driving were provided for any of these participants. Attrition after 2 yr was high ($n = 8$). |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
| --- | --- | --- | --- | --- | --- |
| | | | *Outcomes*<br>• Recognition<br>• Mobility<br>• Peripheral identification<br>• Scanning<br>• Tracking<br>• Visual memory | | |
| | | | Dementia | | |
| Freund & Petrakos (2008) | (1) To determine how long error-specific driving restrictions might prolong driving time and (2) to determine whether restricted drivers had driving safety profiles similar to those of unrestricted drivers | II<br>Prospective nonrandomized 3-group study<br>$N = 47$ cognitively impaired older drivers who were currently driving or had driven within 3 mo before enrollment and held a valid driver's license (mean age = 77.4, $SD$ ± 7.3, range 61–91; 57% men; safe group $n = 17$, safe with restrictions group $n = 13$, unsafe to drive group $n = 16$), with 1 participant not completing the driving simulation test at baseline | *Intervention*<br>Error-specific driving restrictions. Control groups were the safe with restrictions group and the unsafe to drive group.<br>*Outcomes*<br>• Time to an unsafe rating<br>• Time to an accident<br>• Time to a traffic violation | *Time to an unsafe rating:* Of the safe group, 4 became unsafe (3 after 360 days, 1 after 540 days). Of the restricted group, 4 became unsafe (1 after 180 days, 2 after 360 days, 1 after 540 days). Of the unsafe group, 10 remained unsafe.<br>*Time to an accident:* No accidents were reported.<br>*Time to a traffic violation:* One person in the safe driver category had a traffic violation after the 18-mo follow-up visit. | Generalizability of findings is limited. Selection bias is possible because of simulation technology (e.g., included only older adults who accepted new technologies, excluded participants who wanted to avoid on-road testing). Dropouts after Visit 1 included 3 (12.5%) safe drivers, 5 (42.9%) restricted drivers, and 6 (46.7%) unsafe drivers. Sample size was small. |
| Man-Son-Hing, Marshall, Molnar, & Wilson (2007) | To determine whether efficacious methods exist to reduce driving risk in people with dementia | I<br>Systematic review of the literature<br>$N = 2$ studies, 1 with a cross-sectional design and 1 with a longitudinal prospective design | *Intervention*<br>Intervention and education programs on use of a copilot, use of on-board navigation and crash warning systems, use of restricted licensing, use of self- and family-imposed driving restrictions, and use of cognitive enhancers. Control group received no intervention.<br>*Outcome*<br>• Driving risk | *Education programs:* No intervention studies were found. Underlying memory and cognitive deficits, insight and judgment impairment, and progression of dementia make refresher courses not a reasonable option.<br>*Use of a copilot:* No intervention studies were found, and conflicting opinions exist among experts on the use of copilots.<br>*Use of on-board navigation and crash warning systems:* No intervention studies were found, but because of poor information processing, use of these technologies is unlikely to compensate for driving deficits. | No intervention studies were found, and recommendations were based on a cross-sectional study and a longitudinal prospective study. |

(*Continued*)

**Supplemental Table 1. Evidence for the Effect of Rehabilitation Interventions on the Driving Performance of Medically At-Risk Older Drivers (*cont.*)**

| Author/Year | Study Objectives | Level/Design/Participants | Intervention and Outcome Measures | Results | Study Limitations |
|---|---|---|---|---|---|
| | | | | *Use of restricted licensing or self- and family-imposed driving restriction:* These measures are not recommended because drivers with dementia do not perform well in less predictable situations and may not have sufficient insight to understand the rationale for driving restrictions.<br><br>*Use of cognitive enhancers:* No intervention studies were found. If clients demonstrate improvements in cognitive or functional status with use of cognitive enhancers, they must undergo a comprehensive on-road driving evaluation for decisions on driving. | |

*Notes*. AL = Alabama; Charron = Minnesota Clerical Test; CI = confidence interval; FIM = Functional Independence Measure; KEYS = Knowledge Enhances Your Safety; MVPT = Motor-Free Visual Perceptual Test; RCT = randomized controlled trial; *SD* = standard deviation; TRIP = Test Ride for Investigating Practical fitness to drive; TTKT = Traffic Theory Knowledge Test; UFOV = Useful Field of View.