Rapid Fire: Vision and Driving: From Research to Evidence-Based Clinical Practice

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Unauthorized recording of this session is prohibited.
Disclosure Statement:
Nothing to disclose
I. Established research on vision and driving performance and safety

- There are many challenges in providing clinical care for patients with vision loss who want to drive. While research on the effects of vision loss on driving should play a role in informing the clinical care of these patients, incorporating this research can also be challenging.

- Our goal is to briefly review driving research techniques and some major studies, present two challenging cases in which research may provide some insight, and then discuss some vision and driving research highlights from the past 1-2 years.
• There are a number of important aspects of the research methodology to consider while reading driving research:
  – Driving Safety vs. Driving Performance
  – Simulated visual impairment vs. Actual visual impairment
  – Open road studies vs. Closed road studies
Methods for Driving Research

- Retrospective review of state crash data
- Driving simulators
- Road courses
- Naturalistic driving observation
The Role of Visual Acuity

Safety

- Decades of work on the role of visual acuity have generally concluded that there is probably only a weak correlation (if any) with crashes assessed retrospectively.
  - See the work of Albert Burg in California beginning in the 1960s and many studies in the following decades

Performance

- Poor VA has an effect on some driving tasks, like sign recognition or hazard perception, but probably not some others
  - (see, for instance, Higgins and Wood OVS 2005)
Visual Field

• Significant binocular visual field loss has been associated with an increased crash risk.
  – See Johnson and Keltner 1983, Rubin et al. 2007, and others
• The variety of ways in which visual field loss presents and can be defined presents challenges for interpretation of results
• On-road studies of hemianopia and quadrantanopia have shown that some of these drivers are rated as safe, and that safety may be related to compensatory head movements. (See Wood et al., IOVS 2011)
Contrast Sensitivity

- Some studies have found increased crash risk associated with impaired contrast sensitivity (see Hennessy and Janke CA DMV report, 2005).
- Studies of the effects of cataract and cataract surgery on driving safety are also consistent with the hypothesis that CS is important for driving (see Owsley et al. JAMA 2002).
- There are a number of driving performance studies in which contrast sensitivity impairments predict poor performance on a range of driving tasks.
Other Characteristics

• Useful Field of View test (Ball, Roenker, Bruni 1990):
  – A number of studies have shown that decreased performance on this test is associated with increased crash risk.

• Color Vision / Stereoacuity:
  – Most studies have concluded that impairments in these are not highly correlated with crash risk.
Other Characteristics

• Glare Sensitivity:
  – Most studies have failed to find an association between sensitivity to glare and collisions.
  – However, there is evidence that aspects of driving performance are affected by glare sensitivity (see Gray 2007 or Kimlin, Black, and Wood 2017)

• Cognitive Function:
  – It is certainly important to consider the possibility of cognitive impairment when evaluating vision for driving
Bioptic Telescopic Spectacles

• Bioptic telescopic spectacles are an option for people with impaired central vision to obtain or maintain driving privileges.

• Studies have generally found at least a slight increased crash risk in bioptic drivers, though there is considerable variability.
  – How vision and crash risk in bioptic drivers is related remains to be determined.

• Bioptic telescopes have been shown to improve sign recognition distances in a driving simulator, but their usefulness for other driving tasks is still unclear.
Where to Look for More Research

• There are excellent reviews of the relationships among visual factors and driving performance and safety available, including:
  – Owsley and McGwin, Vision Research 2010

• Also see 2016 Special Issue of Clinical and Experimental Optometry on Vision and Road Safety.
VISION CHANGES PRE- AND POST-CRASH FOR BIOPTIC DRIVER WITH ALBINISM

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OSU College of Optometry
Background

- Age 20: 1st visit to OSU Low Vision Service
- Age 32: Starts/ Stops Bioptic Driving Program
- Age 44: Completes Bioptic Driving Program

- Stable vision findings:
  - BCVAs: OD 20/190  OS 20/120  Bailey Lovie
  - Glare VA: OS 20/190  Bailey Lovie
  - Contrast sensitivity: log CS 1.65  Pelli Robson chart
  - Visual fields: full peripherally
Routine Visit: License Renewal

- Age 52: reports stable vision; seeks license renewal; confident in driving; ocular comfort complaints

- BCVAs: OD 20/190 OS 20/120 Bailey Lovie
- Contrast sensitivity: log CS 1.36 Mars chart
- Visual fields: full peripherally

Management:
- Signed for renewal of day bioptic privileges.
- Scheduled eye health visit, but patient “no showed.”
Interval Visit: New Issues

- **Age 54:**
  - Vision hx: hazy vision x 5 months; wonders if caused by scratched lenses, Rx changes, or eye changes; glasses only help at near
  - Health hx: “borderline diabetic,” steroids for asthma, trauma
  - Driving hx: 10 yrs of driving; crashed 5 months ago; d/ced re. vision and no car

- **BCVAs:** OD 20/200 OS 20/160 ETDRS (1 line reduced)
- **Contrast sensitivity:** log CS 0.84 Mars chart (3-6x worse)
- **Visual fields:** full peripherally
More about the crash:

- “It was March, there was no snow on the ground, and I was driving on very curvy, hilly roads near my home. It was earlier than I usually drive, but the sun was up.”

- “I was headed eastbound, and when I crested the hill, there was a snow plow truck with no lights on in the middle of the road. My car was totaled, but the airbag didn’t go off.”

- “I was only a little sore and didn’t want to go to the hospital...but, since then, my vision has been worse.”
Interval Visit: New Issues

- **Refraction:**
  - Habitual: OD +7.00 -3.50 x 013  OS +6.25 -2.25 x 165
  - Best: OD +0.50 -3.50 x 010  OS plano -1.75 x 165

- **Ocular examination:**
  - OD G 3+ NS  OS G 2+ NS

- **Blood sugar:** 150 mg/dl

- **Management post-crash and post-vision decline:**
  - Do not resume driving.
  - Consult cataract surgeon.
  - Regulate blood sugar.
  - Defer updating of Rxs.
  - Review driving potential post-op.
3 months later (now 8 months post-crash)
Vision hx: even worse vision
Pt concern: should I get phacoemulsification + artificial iris implant?

BCVAs: OD 20/320 OS 20/250 ETDRS (2-6 lines reduced)
Contrast sensitivity: log CS 0.28 Mars chart (3-23x worse)

Artificial iris contact lens trial: Alden Optic HP49 black, 3 mm pupil
  Subjective and objective evidence of improved light tolerance
  BAT: unable to read any letters on chart
  Hx of unable to insert and remove artificial iris CLs

Management:
  Advised of reasonable likelihood of benefit from artificial iris implant.
  Offered referral for further surgical opinion. (Pt declines.)
Pre-surgical Images
Post-surgical Images

CustomFlex (silicone) Artificial Iris Prosthesis (HumanOptics).
Performed under compassionate use exemptions from the FDA.
A U.S. multicenter FDA IDE trial of the device was launched in August 2013.
Post-op Visit: 1 mon (OD); 3 mon (OS)

- Vision hx: much improved, less light sensitive
- Driving hx: now confident she can return to driving
- Mental health: happy about vision/appearance, but struggling with depression, worsened by being stuck at home without driving x 17 mon; no remorse despite high cost

- BCVAs: OD 20/200 OS 20/120 ETDRS (back to baseline)
- Contrast sensitivity: log CS 1.56 Mars chart (back to baseline)

- Management:
  - Update all refractive corrections.
  - Pursue mental health care.
  - Strive for glycemic control.
  - Plan for cautious return to day bioptic driving.
Evidence Base
for Prosthetic Irides in Albinism

- Limited


Using the Evidence Base in Managing Patients with Albinism and Cataract

- Acuities
- Refractive blur
- Contrast sensitivity
- Glare sensitivity testing
- Crash risk of new drivers
- Meaning of driving
The Road to Retirement from Driving
Many Americans take an interest in driving from an early age

One’s ability to drive has deeply-rooted social implications

Patients with early vision loss are often concerned about their licensure status
FIRST EXAM: OSU LOW VISION
80 year old Male presents on 7/10/2014 with his wife to renew his daytime-only (with correction) commercial driver’s license (Class B Single > 26,000/Tow <10,001) with motorcycle endorsement.

However, patient states he hasn't driven since May 2014 (daytime-only) at the urging of his daughter -- wife handles most of the driving at this point.

Last Low Vision Exam was 8/12/2013 The Columbus VA

Apparent Cause of Vision Loss
OD:  BCVA 20/400 due to CRAO
OS:  BCVA 20/40   due to Mild AMD/Mild cataracts

Driving history reveals: Patient was in two fender bender accidents last year by the same intersection by Route 13. Patient says “he’s comfortable with driving and, other than the two accidents, he has no issues.”

**However, while asking questions about driving, patient frequently looked to wife for answers.**
Visual Acuities:

OD: 20/400  Feinbloom with Rx eccentric viewing 3 o’cl patient’s view
OS: 20/50   ETDRS with Rx
OU: 20/40-2 ETDRS with Rx [Still monocular status, stable/improved]

Contrast Sensitivity:

OU: 1.40 on a MARS chart (2.5x reduced from normal)

Arc Perimetry:

OD: 0º nasally, 70º temporally (difficult to assess)
OS: at least 45º nasally, 70º temporally; generally full VF

**Patient would qualify for Daytime-only if only considering vision testing!**
Our patient’s history of meds used for dementia (Donepezil) prompted the use of perceptual testing today through the clock drawing test.
Clock Drawing Test

Trail Making Test
Perceptual Testing: Clock Drawing

Score: 5. Severe level of disorganization.

-Score greater than 3 denotes cognitive defect.

Plan: Due to results, told patient and wife that patient is not fit to be driving.
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<td>Discouraged</td>
<td>Intimidated</td>
<td>Guilty</td>
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Patient was seen at OSU Low Vision Rehabilitation for an out-of-pocket driving examination on 07/10/14 with Dr. Hopkins and a 4th year optometry intern. Vision testing revealed adequate central and peripheral vision for daytime-only driving, however clock drawing test demonstrated a severe level of perceptual disorganization.

Patient had a history of d/c'ing commercial driving as well as relying more on the wife to drive exclusively since 05/2014. [Research has shown that self-restriction from driving is a significant cause for concern when considering renewal of licensure privileges]. Additionally, he had multiple accidents at the same complex intersection near his home. Both these items were red-flags during our discussion.

We have advised the patient to retire from driving. He appeared to listen carefully and the family (his wife) was relieved to hear it. After this discussion, however, the patient asked if cataract surgery would be beneficial (and if it would help him drive again). I explained that he is still borderline for cataract surgery, and even if he did it, it would not improve his ability to drive safely going forwards.
SECOND EXAM: OSU LOW VISION
Accompanied By: Wife

Complaint

80 year old male complains of here to try again for driver's license

- **feels vision/cognition has improved** in both eyes for since last month
he has reduced his medications.

Says he has been driving and it has been going well.

**Only drives around his local neighborhood** and feels comfortable in that familiar environment.
All vision testing remains stable, so we repeat cognitive testing.

Score: 3 Time of testing: 1:03
"Inaccurate representation of 10 after 11 - and/or-minor visuospatial deviations"
Time of testing > 3 minutes is problematic

Patient took about 6 minutes to complete test.
Plan: Educated patient that we are not comfortable claiming he is a safe driver at this time, but, given his improvement on clock drawing today, we do believe he could benefit from Driving Evaluation and Training from the OSU Outpatient Rehabilitation Center.

Gave patient/wife information sheet and contact information for OSU Outpatient Rehabilitation Centers and encouraged him to call and schedule an appointment. Pt said he would call today and showed motivation.

Pt also expressed understanding that we could not comfortably allow licensure to drive at this time.

Faxed a referral letter over to Meredith Sweeney, OTR/L and will wait for a report back from her as to whether or not patient would be safe to drive.

We can then schedule another brief office visit for completion of a BMV 6317 if necessary.
Thanks!
IV. Update on emerging research and future challenges
Evidence-based review on driving and dementia (Allan et al.)

- Factors influencing driving fitness:
  - Poor short term memory
  - Disorientation
  - Reduced attention
  - Lack of insight

- Clinicians are generally unable to accurately or reliably predict driving ability.
- Clinical assessment alone should not be used as a basis for determining fitness to drive.
- On-road driving tests are better at estimating driving proficiency.
- Combining clinical assessment, on-road tests, and neuropsychological tests (trail making, visual construction, maze tasks) increases predictive accuracy.
Evidence-based review on driving and dementia

• Cognitive screening tests such as the Mini-Mental State Examination (MMSE) and Montreal Cognitive Examination (MoCA) poorly coordinate with driving ability.

• Cognitive changes that impair driving:
  – Reduced concentration
  – Slow reaction time
  – Problems finding directions

• Non-cognitive changes
  – Visual impairment
  – Frailty
  – Daytime sleepiness
  – Mobility
  – Head-turning ability
Evidence-based review on driving and dementia

• Cognitive, physical, and emotional factors must be weighed against the benefits of driving with regards to independence, self esteem, and convenience.

• Impact of loss of driving privileges:
  – Decreased quality of life
  – Increased depressive symptoms
  – Reduced access to health care services
  – Decline in general physical health
  – Increased risk of entry into long-term care facilities and 3-year mortality rate

• Driving risks and fitness to drive should be assessed annually
Higher-order visual processing skills and driving cessation (Huisingh et al.)

- Risk factors for driving cessation:
  - Older age
  - Female
  - Unmarried
  - Medical comorbidities
  - Decreased contrast sensitivity
  - Visual field impairment
  - Slower cognitive processing speed

- Non-risk factors driving cessation:
  - Race, education
  - Hearing impairment
  - Visual acuity
  - MMSE impairment status
Higher-order visual processing skills and driving cessation

• Useful Field of View (UFOV) tests visual attention
  – Subtest 1: Processing Speed
  – Subtest 2: Divided Attention
  – Subtest 3: Selective Attention

• Trails B tests processing speed
  – Divided attention
  – Problem solving
  – Executive function
  – Working memory
Rapid deceleration events and declining contrast vision (Chevalier et al.)

- Rate of rapid deceleration events (RDE) was used as a surrogate safety measure.
- Declining contrast sensitivity and lower driving confidence increased risk of RDEs per distance (km) driven.
- Older drivers (>75yrs) involved in at least one RDE over the course of one year, drive greater distances than those not involved in RDEs.
- Drivers with lower visual and cognitive function and reduced confidence drive shorter distances.
- Conclude that there is an association between decreased contrast sensitivity and increased crash risk in older drivers.

Visual Field Loss and Driving Performance (Bhorade et al.)

• Twenty-one patients with bilateral moderate or advanced glaucoma (and 38 controls) completed clinical and on-road assessments.

• Clinical assessments that were significantly worse in glaucoma vs control:
  – Contrast sensitivity
  – Trail Making Tests A
  – UFOV

• Marginal/fail score on the on-road driving assessment:
  – Glaucoma (52%)
  – Controls (21%)

• Those with slower performance on psychometric and mobility testing were at greatest risk for unsafe driving.

• The only significant predictor for unsafe driving was performance on Trail Making Test A, not a diagnosis of glaucoma.

Prevalence of Visual Field Loss and Driving (Muir et al.)

• Of the random sample of 10,000 Australian drivers, 1.9% had an identified visual field loss.

• Factors associated with license testing outcomes:
  – Visual field condition
  – Age
  – Crash involvement
  – Referral to medical advisors

• Drivers with VF impairment have an increased rate of at-fault MVCs.

• Other factors that impact safe driving performance:
  – Severity of impairment
  – Response to treatment
  – Capacity to adapt to impairment
  – Co-morbidity
  – Compensatory head or eye movements, increased visual scanning

Driving with Homonymous Visual Field Loss (Bowers)

• Are people with homonymous hemianopia safe to drive?
• Difficulties:
  – Lane positioning
  – Unstable steering
  – Inadequate scanning

• Factors not predictive for blind-side detection:
  – Duration of the field loss
  – Side of the VF defect
  – Size of remaining field (only weakly predictive)
  – Age was the only consistent predictor for blind-side detection

• Factors not predictive for on-road driving performance:
  – Age
  – Neuroimaging
  – Driving status was predictive of road test performance
Interventions for Homonymous Field Defect Drivers

• Lane position and steering stability
• Visual scanning training
• Visual restorative function training
• Prism glasses
• Driving simulator studies (allow compensatory scanning) vs conventional VF measurements (eye movements not permitted).
• Individualized assessments and on-road tests are considered the gold standard for determining practical fitness to drive.
Driving with Central Visual Field Loss (Bronstad et al)

• Subjects with central field loss had higher steering wheel reversal rates compared to controls.
• Suggests that drivers with central VF loss compensate by allocating extra steering effort to maintain their lane position.
• This potentially reduces attentional resources for other driving tasks.

Self-reported Driving Ability: Situational Avoidance (Davis et al)

- Purposeful avoidance of driving situations perceived as challenging or potentially hazardous.
- Situational Avoidance Questionnaire
  - Confidence
  - Difficulty
  - Avoidance
- Increased avoidance was associated with:
  - Older age
  - Female gender
  - Reduced driving space and frequency
  - A change in driving in the past 5 years
  - Poorer indices of health (self-rated mood, vision, cognitive function)

Accid Anal Prev. 2016 Feb; 87: 68-77
Measurement of Driving Ability in Glaucoma (Khadka et al.)

- Glaucoma module of Eye-tem Bank Project: 342 questions.
- Activity limitation subset: 88 questions.
- Driving specific subset: 13 questions.
- The 13 item driving subset formed a stand alone unidimensional scale with excellent precision (PSI=2.94).
- The driving subscale demonstrated good targeting to the visual ability of the study population and showed statistically significant, moderate correlations with VA and VF.
- Enable earlier detection of driving-related issues in people with glaucoma.
- Item banking as a stand alone measurement of driving ability in glaucoma.

Optom Vis Sci. 2016 Dec; 93(12): 1485-1494
Assessment of Night Driving Difficulties (Kimlin et al.)

- Vision and night driving questionnaire (VND-Q)
  - Nine items
  - Quantification of visual difficulties that older drivers report with night driving.
- Validated instrument for detecting difficulties that older drivers (including those hesitant to report difficulties) experience in low-light conditions.

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