Dementia and Driving: Current Evidence and Clinical Relevance

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Peggy P. Barco

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  - TIRF
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Objectives

1. To develop an understanding of the types of dementia and the unique impacts on driving performance.

2. To develop a broader perspective and knowledge base related to cognition and driving.

3. To gain a better understanding of evidence-based assessment approaches in driving rehabilitation.

4. To understand the various considerations, evidence, and discussions regarding restricted driving recommendations for individuals with dementia.
Objective

1. To develop an understanding of the types of dementia and the unique impacts on driving performance

Epidemiology

5 Million AD Cases Today—
Over 14 Million Projected Within a Generation

Affects > 5 million people in the U.S. (20 million worldwide)
Results in > 100,000 deaths per year/Costs > $100 billion annually
Forecast of Prevalence in U.S.

2000 2030 2050
4.5 Million (est) 7.7 Million (est) 13.2 Million (est)

☐ 65-74 Years ☐ 75-84 Years ☐ 85+ Years


The Changing Definitions of Cognitive Impairment and Dementia

Normal Cognition

Prodromal Dementia

Mild Cognitive Impairment

Stable or Reversible Impairment

Brain Aging

Dementia

Other dementias

Mixed

Alzheimer's disease

Mixed

Vascular Dementia

From Golomb, Kluger, Ferris NeuroScience News, 2000
In vivo Amyloid Imaging
Pittsburgh Compound B (PIB)
(Klunk et al, Ann Neurol 2004)

Histology - Thioflavin T

PET Imaging - \(^{11}C\)6-OH-BTA-1 (PIB)

Courtesy of William Jagust
Department of Neurology
Knight ADRC

Hypothetical model of dynamic biomarkers
Of AD with emphasis on the preclinical period

Abnormal
- Amyloid abnormal on (CSF/PET)
- Synaptic dysfunction (FDG PET/MRI)
- Taurine (neuronal injury (CSF))
- Brain structure (volumetric MRI)
- Cognition
- Clinical Function

Clinical Disease Stage
Sperling et al., 2011, Alzheimers Dement 7:280-92
(Modified from Juck et al., 2009, Brain 132:1355-65)

Department of Neurology
Knight ADRC
2004 MCI Classification Process
Experience revealed that multiple cognitive domains frequently were impaired in MCI (Grundman M et al. Arch Neurol 2004;61:59-66)
MCI criteria thus were broadened in 2004 to include multiple domain MCI, leaving only “essentially normal functional activities” to distinguish from dementia

Slide Courtesy of Dr. John Morris

Department of Neurology
Knight ADRC

Recommendations from the NIA-Alz Assn Workgroups on Diagnostic Guidelines AD
Criteria for Dementia is dx when cognitive and/or behavioral sx;
1. Interfere with the ability to function at work or at usual activities; and
2. Represent a decline from previous levels of functioning and performing; and
3. Are not explained by delirium or major psychiatric disorder;
4. Cognitive impairment is detected and diagnosed through a combination of;
a) history-taking from the patient and a knowledgeable informant and
b) an objective cognitive assessment, either a “bedside” mental status examination or neuropsychological testing.
5) Cognitive or behavioral impairment involves two or more domains;
memory, reasoning or judgment, visuospatial abilities, language, personality
NOTE: MCI rests on the determination of whether or not there is significant impairment in the ability to perform work or usual daily activities

(Mckhann G et al, Alzheimer’s & Dementia 2011; 7: 263-269,
updated from Mckhann G et al, Neurology 1984; 34: 939-944)

Department: Division
Health Professionals/Organizations

- Primary Care Physician/NP's
- Neurologist
- Geriatrician
- Psychiatrist
- Pharmacist
- Neuropsychologist
- Alzheimer's Association
- Case managers/social workers

The Clinical Dementia Rating

<table>
<thead>
<tr>
<th>CLINICAL DEMENTIA RATING (CDR)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory Impairment</td>
<td>No memory loss or difficulty remembering recent events.</td>
<td>Mild memory loss, difficulty remembering recent events, but not interfering with daily activities.</td>
<td>Moderate memory loss, difficulty remembering recent events, interfering with daily activities.</td>
<td>Severe memory loss, difficulty remembering recent events, unable to function independently.</td>
<td>Severe memory loss, severely impaired function, unable to function independently.</td>
</tr>
<tr>
<td>Orientation</td>
<td>No problems</td>
<td>Mild problems</td>
<td>Severe problems</td>
<td>Extremely severe problems</td>
<td>Extremely severe problems</td>
</tr>
<tr>
<td>Cognition</td>
<td>No problems</td>
<td>Mild problems</td>
<td>Moderate problems</td>
<td>Severe problems</td>
<td>Severe problems</td>
</tr>
<tr>
<td>Judgement</td>
<td>No problems</td>
<td>Mild problems</td>
<td>Moderate problems</td>
<td>Severe problems</td>
<td>Severe problems</td>
</tr>
<tr>
<td>Functioning</td>
<td>Independent</td>
<td>Mildly impaired</td>
<td>Moderately impaired</td>
<td>Severely impaired</td>
<td>Severely impaired</td>
</tr>
</tbody>
</table>

Department Division
### Rating Dementia Severity by Tests

<table>
<thead>
<tr>
<th>Clinical Measure of Dementia Severity</th>
<th>No Dementia (ACDR 0)</th>
<th>Questionable or Very Mild Dementia (ACDR = 0.5)</th>
<th>Mild Dementia (ACDR = 1.0)</th>
<th>Moderate to Severe Dementia (ACDR &gt; 2.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the Dementia Specialist: Clincial Dementia Rating</td>
<td>No memory loss, no recent memory loss, Full social contacts, Full occupational activity, Function intact</td>
<td>Last year slight difficulty with memory, Difficulty with recent memory, Slight slowness in daily activities</td>
<td>Moderate to severe memory loss, Significant difficulty with daily activities, Impairment in non-memory areas, Impaired in community activities</td>
<td>Severe memory loss, Significant difficulty with daily activities, Impaired in activities of daily living, Impaired in work, home, or community activities, Impaired in personal care, Needs supervision or help in personal care</td>
</tr>
<tr>
<td>For the Clinician: Short Blessed Test (SBT)</td>
<td>24-26 (3.3)</td>
<td>20-22 (5.3)</td>
<td>15-19 (8.3)</td>
<td>15-19 (8.3)</td>
</tr>
<tr>
<td></td>
<td>In 11-17</td>
<td>In 11-17</td>
<td>In 11-17</td>
<td>In 11-17</td>
</tr>
</tbody>
</table>

### Reversible Causes of Cognitive Decline

- **D**: Drugs
- **E**: Emotional disorders
- **M**: Metabolic disorders
- **E**: Eye/ear impairment
- **N**: Nutritional deficiencies
- **T**: Tumor, trauma
- **I**: Infection
- **A**: Atherosclerotic complications
Additional Causes of Dementia

- Etiologic category
  - Endocrine/metabolic*
  - Autoimmune/inflammatory
  - Infectious
  - Neoplastic**
  - Toxic*
  - Sleep disorder**
  - Vascular
  - Traumatic
  - Depression

- Examples
  - TSH/B12/renal/liver*
  - Vasculitis/SLE/sarcoid/HIV
  - Syphilis/lyme/encephalitis
  - Paraneoplastic
  - Hashimoto's Encephalitis
  - Menigoma/tumors
  - Drugs/heavy metals
  - OSA/CSA/PLMD
  - Hypertensive encephalopathy
  - Mild traumatic brain injury
  - Subdural/NPH

Review of Brain Functions
CLUES TO SPECIFIC NEURODEGENERATIVE DISEASES

Alzheimer's Disease

- Temporal media + laboratory results
- Single focal signs
- Behavior
- Language
- EPS: Visual Hallucinations
- Frontotemporal dementias

Rapidly evolving dementias

Vascular dementia

Lewy body dementia

Dementia Lewy Body: Consensus Criteria

- Progressive cognitive decline of sufficient magnitude to interfere with normal social or occupational function

- Core features (2→probable DLB; 1→possible DLB)
  - Fluctuating cognition
  - Recurrent visual hallucinations
  - Parkinsonism

- Supportive features
  - Repeated falls
  - Syncope and transient loss of consciousness
  - Neuroleptic sensitivity
  - Systematized delusions
  - Hallucinations in other modalities
  - REM sleep disorder

DLB = dementia with Lewy bodies; REM = rapid eye movement.
Frontotemporal Dementia: Clinical Diagnostic Criteria

- Core features
  - Insidious onset and gradual progression
  - Early decline in social interpersonal skills or language skills
  - Early emotional blunting or early loss of insight

- Supportive features
  - Behavioral disorders
  - Speech/language disorders: aspontaneity, pressure speech, stereotypical speech, echolalia, perseveration, and mutism
  - Physical signs: primitive reflexes, incontinence, parkinsonism, and low/labile blood pressure
  - Neuropsychology testing: significant frontal lobe impairment
  - Neuroimaging: frontal and/or anterior temporal lobe abnormalities


Posterior Cortical Dysfunction

- Core Features
  - Insidious onset and gradual progression
  - Prominent visuoperceptual and visuospatial impairments but no significant impairment in vision itself
  - Relative preservation of memory and insight
  - Evidence of complex visual disorders (e.g. elements of Balint's syndrome/Gerstmann's syndrome, visual field defects, visual agnosia, environmental disorientation
  - Absence of stroke or tumor

- Core Features
  - Presenile onset
  - Alexia
  - Ideomotor or dressing apraxia
  - Prosopagnosia
  - Prolonged color after-images

Crutch et al Alzheimer's Dementia 2013
Rapidly Progressive Dementia: Clinical Criteria

- Core features
  - Evolves hyperacutely (over days or weeks)
  - Evolves subacutely (months to 1-2 years)
  - More rapidly than expected

- Myriad of Causes
  - Neurodegenerative: Prion disease (CJD)
  - Antibody mediated brain diseases
  - Sarcoid
  - MS
  - Lupus
  - Vasculitis
  - Other

Behavioral and Psychological Symptoms of Dementia (BPSD)

- Common: >90% of patients have at least 1 symptom
- Occur early in the disease—present in MCI
- Multiple simultaneous symptoms
- Symptoms emerge as disease progresses
- Once present, highly recurrent
- Decrease patient and caregiver quality of life
- Precipitate institutionalization

Differential Presentation of BSPD

- Alzheimer's disease:
  - Irritability
  - Self-centeredness
  - Delusions
  - Hallucinations
  - Apathy
  - Depression
  - Insomnia
  - Agitation and aggression

- Frontotemporal dementia:
  - Decline in interpersonal skills
  - Apathy
  - Decline in personal hygiene
  - Mental rigidity/inflexibility
  - Distractibility
  - Hyperorality
  - Stereotyped behavior

- Vascular dementia:
  - Emotional liability
  - Severe depression
  - Apathy
  - Disinhibition

- Dementia with Lewy bodies:
  - Psychosis
  - Anxiety and/or depression
  - Apathy/amotivational states
  - Aggressivity/violent behavior
  - Nocturnal confusion/insomnia
  - REM behavior disorder


Mechanism of Impaired Driving based on Dementia Subtypes

- AD
  - Amnestic, executive function: way finding, multitasking

- FTD
  - Language and behavior: road rage, reading signs

- DLB
  - Visuospatial: lane changing, gap acceptance

- PCA
  - Cortical blindness: disorientation, lane maintenance
The Long QT Syndrome

- Disorder of myocardial repolarization
- Increased risk of life-threatening arrhythmia: torsade de pointes (TdP)
- Symptoms: palpitations, syncope, seizures, and sudden cardiac death
- Causes: Metabolic (low states), CNS, CTD, Cardiac, HIV, Meds
- Meds
  - Antiarrhythmics: (Amiodarone, disopyramide, procainamide, sotalol)
  - Antidepressants: (TCA's, SSRI's)
  - Antibiotics: (Quinolones, Macrolides)
  - Antipsychotics: (Haloperidol, risperidone, clozapine, thioridazine, ziprasidone)
  - Others: (Cisapride, ondansetron, sumatriptan, zolmitriptan, HIV drugs)

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Sedation and Anticholinergic Side Effects

<table>
<thead>
<tr>
<th>Condition</th>
<th>Signs</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amnesia</td>
<td>• Memory loss</td>
<td>• Confusion</td>
</tr>
<tr>
<td>Anticholinergic</td>
<td>Stiffness</td>
<td>Dry mouth</td>
</tr>
<tr>
<td>Autonomic</td>
<td>Tachycardia</td>
<td>• Dry skin</td>
</tr>
<tr>
<td>Biventricular</td>
<td>Palpitations</td>
<td>• Photophobia</td>
</tr>
<tr>
<td>Cardiac</td>
<td></td>
<td>• Blurred vision</td>
</tr>
<tr>
<td>Conduction</td>
<td></td>
<td>• Difficulty in speaking</td>
</tr>
<tr>
<td>Delay</td>
<td></td>
<td>• Difficulty in swallowing</td>
</tr>
<tr>
<td>Hypoglycemia</td>
<td></td>
<td>• Difficulty in voiding</td>
</tr>
<tr>
<td>Hypotension</td>
<td></td>
<td>• Difficulty in breathing</td>
</tr>
<tr>
<td>Intestinal</td>
<td></td>
<td>• Difficulty in order</td>
</tr>
<tr>
<td>Irritation</td>
<td></td>
<td>• Difficulty in speaking</td>
</tr>
<tr>
<td>Myocardial</td>
<td></td>
<td>• Difficulty in swallowing</td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td>• Difficulty in voiding</td>
</tr>
<tr>
<td>Noncardiac</td>
<td></td>
<td>• Difficulty in breathing</td>
</tr>
<tr>
<td>Orthostatic</td>
<td></td>
<td>• Difficulty in order</td>
</tr>
<tr>
<td>Photophobia</td>
<td></td>
<td>• Difficulty in speaking</td>
</tr>
<tr>
<td>Prominent</td>
<td></td>
<td>• Difficulty in swallowing</td>
</tr>
<tr>
<td>Rotational</td>
<td></td>
<td>• Difficulty in voiding</td>
</tr>
<tr>
<td>Sinusoidal</td>
<td></td>
<td>• Difficulty in breathing</td>
</tr>
</tbody>
</table>

*This table is adapted from Rudolph, J. L. et al. Arch Intern Med 2008;168:508-513.*
The Serotonin Syndrome

- Definition: potentially life-threatening adverse drug reaction that results from therapeutic drug use, intentional self-poisoning, or inadvertent drug interactions
- Classic triad: mental status-changes, autonomic hyperactivity, and neuromuscular abnormalities

![Image of the serotonin syndrome spectrum]


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Most prevalent* PDI medications by original (literature informed) drug class list

<table>
<thead>
<tr>
<th>Response</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No / does not take PDI medications routinely</td>
<td>70 (31.1)</td>
</tr>
<tr>
<td>Yes / does take PDI medications routinely</td>
<td>155 (68.9)</td>
</tr>
<tr>
<td>Selective serotonin reuptake inhibitors</td>
<td>69 (30.7)</td>
</tr>
<tr>
<td>Proton pump inhibitors</td>
<td>40 (17.8)</td>
</tr>
<tr>
<td>Hypoglycemic agents</td>
<td>38 (16.9)</td>
</tr>
<tr>
<td>Antiepileptic agents</td>
<td>26 (11.5)</td>
</tr>
<tr>
<td>Antiparkinsonian agents</td>
<td>22 (9.8)</td>
</tr>
<tr>
<td>Second generation / related antidepressants</td>
<td>18 (8.0)</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>15 (6.6)</td>
</tr>
<tr>
<td>Opioid analgesics</td>
<td>10 (4.5)</td>
</tr>
<tr>
<td>Non-benzodiazepine hypnotics</td>
<td>9 (4.0)</td>
</tr>
<tr>
<td>Tricyclic antidepressants</td>
<td>9 (4.0)</td>
</tr>
</tbody>
</table>

Association with PDI meds/sleepiness

PDI medication use: Epworth Sleepiness Scale

<table>
<thead>
<tr>
<th></th>
<th>Sample mean (N = 218)</th>
<th>'Yes' on PDI mean (N = 152)</th>
<th>'No' on PDI mean (N = 66)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.25</td>
<td>7.80</td>
<td>5.98</td>
<td>0.007</td>
</tr>
</tbody>
</table>


Medications/Driving

- Narcotics
- Barbituates
- Benzo's
- Antihistamines
- Antidepressants
- Antipsychotics
- Hypnotics
- Alcohol
- Muscle Relaxants
- Antiemetics
- Antiepileptic
Pharmacist/Client Resources

Driving When You are Taking Medications

Department of Medicine and Neurology
Division of Geriatrics and Nutritional Science/Knight ADRC

Pharmacist/Client Resources

No Medication Interactions Detected

Roadwise Rx did not find any interactions between your medications. Please consult with your doctor before altering any medications or changing your driving habits.

Roadwise Rx did not find any interactions between your medications. However, your medication may still have side effects that could affect your driving. Click on the Driver Warnings tab to find out more.

Please consult with your doctor before altering any medications or changing your driving habits.
How to detect and manage drug side effects for non-clinicians...

- Be aware of reports from patient or family that note associations with drugs

- Sedation, confusion, slowed response time, impaired attention, dizziness could be due to medications

- Drinking alcohol with any psychotropic medication may cause problems

- If you suspect side effects from medications, recommend your client discuss their drugs with their PCP/Pharmacists/RoadWiseRX

Objective

2. To develop a broader perspective and knowledge base related to cognition and driving

DISCUSSION OBJECTIVES

- Know website resources available to you that might inform your decision making
- Understand the neurology Approach to evaluating driving risk
- Know the different fitness to drive approaches used by clinicians when assessing older adults with dementia
  - Driving Questionnaires/Caregiver Assessments
  - Single Test Approaches
  - Combination of Tests
  - Multi-Domain Models
- Know basic statistics on determining FTD and how they may guide you
- Know the concept of the probability calculator and how it might impact your decision-making
Clinician Medical Guidelines
Updated, Evidenced-Based
Also Refer to Your Own State Guidelines

http://www.cma.ca/driversguide

http://geriatricscareonline.org


Signs of Unsafe Driving? Alz Association

• Hitting curbs
• Using poor lane control
• Failing to observe traffic signs
• Making slow or poor decisions in traffic
• Driving at an inappropriate speed
• Becoming angry or confused while driving
• Making errors at intersections
• Confusing the brake and gas pedals
• Returning from a routine drive later than usual
• Forgetting the destination during the trip

Dementia and Driving Resource Center Alz Association
Signs of Unsafe Driving: At the Crossroad Hartford

http://www.thehartford.com/advance50/publications-on

Dementia and Driving Toolkit


When it is time to hang up the keys: the driving and dementia toolkit — for persons with dementia (PWD) and caregivers — a practical resource [letter].

BMC Geriatrics

http://www.rgpeo.com/media/30695/dementia%20toolkit.pdf
What Should Be in an Evidenced-Based Driving History?

- Driving Behaviors
- Informant Rating
- Exposure
- Personality
- Violations
- Crashes
- Cognitive Impairment
- Functional Impairment
- Others?

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Neurology Approach to Evaluate Driving Risk in Dementia

Robust Steps in Determining FTD

- **STEP 1**: Adopt a Framework or Model

- **STEP 2**: Decide on an Outcome

- **STEP 3**: Take a Driving History and/or Perform a PE

- **STEP 4**: Make Test Characteristics Your Friend

- **STEP 5**: Clinical Judgment
Driving Screens Assessment Batteries

- Driving Questionnaires
- Single Test Approaches
- Combinations of Psychometric Tests
- Multi-Domain Models

Dickerson et al, 2014, 2013 Driving Tools Used by DRS

Driving Questionnaires-Part I

- Driving Cognitions Questionnaire (Ehlers et al, 2007)
  Evaluates Anxiety
- Adelaide Driving Self-Efficacy Scale (George et al, 2006)
  Evaluates Confidence
- Impulsiveness, Venturesome, Empathy Test (Owsley et al, 2003)
  Evaluates Personality Traits
- Driving Cognitions Questionnaire (Ehlers et al, 2007)
  Evaluates Fear While Driving
- The Driving Habits Questionnaire (Owsley et al, 1999)
  General Questions Regarding Behaviors
- Fitness to Drive Screening Measure (Classen et al, 2015)
  Predicts road test performance
- Assessment Readiness Mobility Transition (Meuser et al, 2011)
  Evaluates readiness for driving cessation
Driving Questionnaires-Part II

- Driving Confidence Rating Scale (Baldock et al, 2006) 
  Evaluates Confidence
- The Driving Confidence Rating Scale (Marottoli et al, 1998) 
  Evaluates Confidence
- Driving Comfort Scales (Myers et al, 2008) 
  Evaluates Confidence
- DriveSafe and DriveAware (Hines, et al, 2014) 
  Evaluates Driver Awareness
- Driving Anxiety Scale (Parker et al, 2001) 
  Evaluates Anxiety
- Self-rated Driving Abilities (Paradis et al, 2006) 
  Evaluates Insight
- The Driving Behavior Questionnaires (Reason et al, 1990) 
  Evaluates risk for crashes

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Slide courtesy of Dr. Sherrilene Clasey
Division
Single Test Approach

- Trailmaking (Molnar, et al 2013)
- UFOV (Ball, et al 1991)
- SIMARD (Dobbs, et al 2011)
- ANT (Weaver, et al 2009)
- Dynavision (Klavora et al, 1998)
- Other

Do Single Test FTD Approaches Work?

Does a Single FTD Test Make Sense?

Figure 1. Two major visual processing pathways of the brain.

Reprinted with permission from 31

Ott BR and Daniello LA. Aging Health 2010; 6: 77-85

SYSTEMIC REVIEWS/META-ANALYSIS

Systematic review of the evidence for Trails B cut-off scores in assessing fitness-to-drive

Monmohan Roy PhD FRCP 1,2 Frank Michael M poured MD FRCP 1,2

Review of 47 Driving Studies Using Trailmaking B
- "Verified" use of 3 minutes or 3 errors rule
- Recommendations
  1. Determine sample size needed to prevent Type II/Beta Error
  2. Determine clinically useful cut-offs using AUC/ROC
  3. Consider multiple cut-offs or dichotomization
  4. Explore different scoring methods of Trailmaking B

- Trails B-A or Trails B/A
  - Trails B-A has been described as reflecting "the attention and set switching components of the Trails Tests"
  - Color Trails may overcome literacy barriers
  - Consider adding errors

CANADIAN GERIATRICS JOURNAL, VOLUME 16, ISSUE 3, SEPTEMBER 2013

Combination of Psychometric Tests

- DHI (Staplin, 2013)
- DriveAble (Dobbs, et al, 2013)
- Rockwood (McKenna et al, 2007)
- ADReS (Ott et al, 2013)
- NorSDSA (Nouri et al, 1993)
- Other

Predictive Values of Neuropsychological Tests and Test Batteries for Road Test Performance

<table>
<thead>
<tr>
<th>Test(s)</th>
<th>Sample</th>
<th>Outcome Measure</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy (% Correctly Classified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computerized mazes</td>
<td>Normal + AD (CDR .5-1)</td>
<td>Road test</td>
<td>NA</td>
<td>NA</td>
<td>68.6</td>
</tr>
<tr>
<td>Computerize mazes + Hopkins Verbal Learning + Age</td>
<td>Normal + AD (CDR .5-1)</td>
<td>Road test</td>
<td>NA</td>
<td>NA</td>
<td>81.0</td>
</tr>
<tr>
<td>Maze Navigation</td>
<td>Normal + AD (CDR .5)</td>
<td>Road test</td>
<td>NA</td>
<td>NA</td>
<td>80.0</td>
</tr>
<tr>
<td>Maze Task</td>
<td>MCI + mild AD</td>
<td>Road test</td>
<td>77.8</td>
<td>82.4</td>
<td>77.4</td>
</tr>
<tr>
<td>Driving Scenes of NAB</td>
<td>Normal + AD (CDR .5)</td>
<td>Road test</td>
<td>NA</td>
<td>NA</td>
<td>68.0</td>
</tr>
<tr>
<td>Eight test battery</td>
<td>Mixed dementia</td>
<td>Road test</td>
<td>80.0</td>
<td>61.5</td>
<td>76.2</td>
</tr>
</tbody>
</table>

Carr D and Ott B. JAMA 2010; 303(16):1632-164
**Odds Ratios of Predicting Fail in Dementia Sample**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDTF (0-7)</td>
<td>6.6</td>
<td>(1.8, 10.6)</td>
</tr>
<tr>
<td>SBT (0-28)</td>
<td>2.3</td>
<td>(.99, 6.2)</td>
</tr>
<tr>
<td>AD-8 (2-8)</td>
<td>4.0</td>
<td>(2.3, 14.3)</td>
</tr>
<tr>
<td>Trails B (secs)</td>
<td>154</td>
<td>(.86, 4.7)</td>
</tr>
<tr>
<td>Trails A (secs)</td>
<td>.42</td>
<td>(1.1, 6.4)</td>
</tr>
</tbody>
</table>

*All P values <0.05
**Cut Point was calculated where the variable predicted .5 probability of failure

**Likelihood Ratios**

- LR+ is simply the % of “sick” people with a given test divided by the % of “well” people with same result
  - Ex: LR+ = Sens/(1-Spec): LR+ 2-.5 small, 5-10 moderate, >10 large ↑
  - Ex LR- =(1-Sens)/Spec: LR-.2-.5 small, .1-.2 moderate, < .1 large ↓
- LR’s are useful across a wide range of frequencies
  - Predictive values of tests are driven by the prevalence of dx
  - Uses all four cells of the 2x2 table
  - Can apply to a specific patient
  - LR’s are ratios of probabilities
  - 95% confidence intervals can calculate the precision of the estimate.

Likelihood Ratios

- Be wary of ordering tests when pretest probability is high or low-30-70%
- LR+ >10 means a positive test is good at ruling in the diagnosis
- LR<.1 means a test is good at ruling out a diagnosis
- Extreme test values may yield imprecise LR’s
  - Few patients having values high or low does not give good precision
- LR’s closer to 1 are not very useful


Dementia Model 1: HIGH Probability of Failure >80%
Based on Trails A, CDT-F, and AD-8 scores
"You can’t drive, no road test needed"

<table>
<thead>
<tr>
<th></th>
<th>Unfit to Drive (Fails Road Test)</th>
<th>Fit to Drive (Passes Road Test)</th>
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<tr>
<td><strong>Test Combo &gt; .80</strong></td>
<td><img src="image" alt="Table" /></td>
<td><img src="image" alt="Table" /></td>
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<tr>
<td><strong>Test Combo &lt; .80</strong></td>
<td><img src="image" alt="Table" /></td>
<td><img src="image" alt="Table" /></td>
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<tr>
<td><strong>a + c (63)</strong></td>
<td><img src="image" alt="Table" /></td>
<td><img src="image" alt="Table" /></td>
</tr>
<tr>
<td><strong>b + d (34)</strong></td>
<td><img src="image" alt="Table" /></td>
<td><img src="image" alt="Table" /></td>
</tr>
</tbody>
</table>

\[
a = \text{true+},\ b = \text{false+},\ c = \text{false-},\ d = \text{true-}
\]

\[
\text{Sensitivity (TPF)} = \frac{a}{a+c} = 59\%
\]
\[
\text{Specificity} = \frac{d}{b+d} = 97\%
\]
\[
\text{LR +} = 19.7
\]
Dementia Model: LOW Probability of Failure <30%
Based on Trails A, CDT-F, and AD-8 scores
"You can drive: No road test needed"

<table>
<thead>
<tr>
<th>Test Combo &gt; .3</th>
<th>Unfit to Drive (Fails Road Test)</th>
<th>Fit to Drive (Passes Road Test)</th>
<th>a + b (85)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a (52)</td>
<td>b (23)</td>
<td></td>
</tr>
<tr>
<td>Test Combo &lt; .3</td>
<td>c (1)</td>
<td>d (11)</td>
<td>c + d (12)</td>
</tr>
<tr>
<td></td>
<td>a + c (63)</td>
<td>b + d (34)</td>
<td>977T</td>
</tr>
</tbody>
</table>

a = true+, b = false+, c = false-, d = true-

Sensitivity (TPF) = a/(a+c) = 98%
Specificity = d/(b+d) = 32%
LR+ = .06

---

Cut-offs

Computerized Tests of Driving Performance
The DrivingHealth Inventory with UFOV

Peak valid at-fault OR

Visualization of missing information (MFVPT; Visual Closure) 4.96
Directed visual search (Trail-Making B) 3.50
Working memory (Delayed Recall) 2.92
Information processing speed (Useful Field of View, subtest 2) 2.48
Lower limb strength (Rapid Pace Walk) 2.64
Head/neck flexibility (Recognizing Clock Time) 2.56

Ball et al. J. ATOs 2005
Dobbs AR. Accuracy of DriveABLE.

Canadian Family Practice 2013: 59: e158-161.

Multi-Domain Tests

- 4 C’s (O’Connor et al, 2013)
- PC (Barco, Carr et al, 2011, 2014)
- CanDrive (Marshall et al, 2013)
- OT-DORA (Unsworth et al, 2011)
- AMP (Dickerson, 2011)
- Other
The 4 C's:

N=161, hospital based driving evaluation program, outcome marginal and fail on road test

O'Connor MG, et al. JAGS 2010; 58: 1104-8

Results
Scores of 9 or greater on the 4Cs identified 84% of participants who were at risk for poor performance. AUC=0.81 for pass vs. marginal and fail, 0.70 comparing pass and marginal to fail
Recent Studies in the Literature

- Papandonatos, GD, et al. JAGS 2015
  - Trailmaking A and B tests compared across sites
  - Test A scores greater 48 secs indicate risk
  - Prediction modest and need to validate own sites
- Bennett JM, et al. JAGS 2016
  - MMSE should not be used for FTD
  - Single tests not reliable
  - Composite computerized battery recommended
- Piersma, D PLOS one 2016
  - Neuropsychological testing was best FTD predictor in AD participants
  - Combining clinical interviews, driving simulation and psychometric testing resulted in accuracy of 93%
Objective

3. To gain a better understanding of evidence-based assessment approaches in driving rehabilitation

The Design

<table>
<thead>
<tr>
<th>Recruitment</th>
<th>Assessment</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruit and telephone screen Dementia sample n=99</td>
<td>Mail out Questionnaires</td>
<td>Perform clinical vision, motor, and cognitive testing</td>
</tr>
</tbody>
</table>
Testing Protocol

Clinical Testing for Driving

Vision Assessment
- Visual Acuity
- Visual Fields
- Humphreys FDT
- Pell Robson
- Contrast Sensitivity

Motor Assessment
- Neck ROM
- UE/LE ROM
- UE/LE Strength
- Rapid Pace Walk
- LE Sensation
- 9 Hole Peg
- Brake Test

Cognitive Assessment
- Clock Drawing Test
- Masulam Test
- Trails A and B
- Snellgrove Maze Test
- DHI/MVPT
- DHI/ UFOV
- Road Sign Recognition
- Rules of the Road

Outcome Measure Road Evaluation
1 hour

Road Evaluation

Testing Protocol

Clinical Testing for Driving
2 hours

Vision Assessment

Motor Assessment

Cognitive Assessment

BREAK

Outcome Measure Road Evaluation
1 hour

Road Evaluation

Recommendation Meeting

Pass/Fail Status
Note: Marginals were collapsed into pass category for statistical analysis
Driving Behaviors in the “Fail” Category

- The evaluator needs to take the wheel or utilize the dual brake to avoid a collision
- The surrounding traffic has to urgently adjust or maneuver to avoid a collision
- The driver fails to stop at a stop sign or traffic light
- The driver requires multiple verbal directions and cueing to maintain safety
- The driver consistently drifts into another lane, drivers off the road, or drives in wrong lane
- The driver fails to yield to a pedestrian or vehicle requiring verbal or manual intervention

Demographics of Dementia Sample Based on Road Test Outcome

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Sample (N=99)</th>
<th>Pass Road Test (N=34) (35%)</th>
<th>Fail Road Test (N=65) (65%)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>74.2±9.0 (52-89)</td>
<td>73.4±9.3 (52-84)</td>
<td>74.7±8.9 (52-90)</td>
<td>0.49</td>
</tr>
<tr>
<td>Gender (% M)</td>
<td>63%</td>
<td>68%</td>
<td>61%</td>
<td>0.56</td>
</tr>
<tr>
<td>Education (years)</td>
<td>14.8±3.3 (8-20)</td>
<td>15.1±2.8 (8-20)</td>
<td>14.6±3.5 (8-20)</td>
<td>0.50</td>
</tr>
<tr>
<td>Race (% AA)</td>
<td>12%</td>
<td>10%</td>
<td>13%</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Carr DB, et al. Predicting Road Test Performance in Drivers with Dementia. 2011 JAGS;59:1152-17
### Psychometric Measures of Dementia Sample Based on Road Test Outcome

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total Sample (N=99) Avg+SD/Range</th>
<th>Pass Road Test (N=35) (35%)</th>
<th>Fail Road Test (N=65) (65%)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Short Blessed Test (SBT)</strong>&lt;sup&gt;*&lt;/sup&gt; (N=99)</td>
<td>8.9±6.9 (0-28)</td>
<td>5.8±5.3 (0-24)</td>
<td>10.5±7.2 (0-28)</td>
<td>0.003*</td>
</tr>
<tr>
<td><strong>Maze Test (secs)</strong>&lt;sup&gt;*&lt;/sup&gt; (N=96)</td>
<td>49.5±35.1</td>
<td>35.2±12.3</td>
<td>62.5±43.9</td>
<td>0.001*</td>
</tr>
<tr>
<td><strong>CDT-Freund (0-7)</strong>&lt;sup&gt;*&lt;/sup&gt; (N=98)</td>
<td>4.9±2.3 (0-7)</td>
<td>6.2±1.2 (2-7)</td>
<td>4.2±2.5 (0-7)</td>
<td>0.0004*</td>
</tr>
<tr>
<td><strong>Trails A</strong>&lt;sup&gt;*&lt;/sup&gt; (secs) (N=98)</td>
<td>68.1±39.5 (20-88.5)</td>
<td>45.8±17.2 (19.5-89.0)</td>
<td>79.9±42.8 (19.6-151)</td>
<td>0.0007*</td>
</tr>
</tbody>
</table>

<sup>*</sup>p<0.05

---

### Psychometric Measures of Dementia Sample Based on Road Test Outcome

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total Sample (N=99) Avg+SD/Range</th>
<th>Pass Road Test (N=35) (35%)</th>
<th>Fail Road Test (N=65) (65%)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trails B</strong>&lt;sup&gt;*&lt;/sup&gt; (secs) (N=99)</td>
<td>196.9±86.0 (42-301)</td>
<td>151.8±75.7 (42-301)</td>
<td>226.9±79.6 (61-301)</td>
<td>0.0002*</td>
</tr>
<tr>
<td><strong>AD-8 Total</strong>&lt;sup&gt;*&lt;/sup&gt; (N=99)</td>
<td>5.3±1.7 (2-8)</td>
<td>4.3±1.5 (2-7)</td>
<td>5.8±1.6 (3-8)</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td><strong>MFVPT (# incorrect)</strong> (N=74)</td>
<td>3.9±2.8</td>
<td>3.1±2.7</td>
<td>4.5±2.8</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>UFOV (msec)</strong>&lt;sup&gt;*&lt;/sup&gt; (N=56)</td>
<td>276.4±148.1</td>
<td>216.8±129.0</td>
<td>342.9±136.5</td>
<td>0.012*</td>
</tr>
</tbody>
</table>

<sup>*</sup>p<0.05
Dementia Sample
ROC CURVE for Trails A, AD-8, CDT
(AUC=.91 non-blinded N=56, AUC=.84 blinded N=43)

Probability of Failing Road Test Calculator

Probability of Failing Driver Test

\[
\text{Score} = \frac{e^{-1.7594 + 0.0283 \times \text{trIA} + 0.5516 \times \text{AD8TOT} - 0.3643 \times \text{CDTf}}}
\]

<table>
<thead>
<tr>
<th>Intercept</th>
<th>trIA</th>
<th>AD8TOT</th>
<th>CDTf</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.7594</td>
<td>0.0283</td>
<td>0.5516</td>
<td>-0.3643</td>
</tr>
</tbody>
</table>

Observed Value

Score: 2.251
exp(score): 9.497228318
Probability: 0.904736758

How much uncertainty are you willing to accept?
How good do our tests need to be?

\[
P_{\text{fail}} = \frac{1}{1+e^{-1.7594 + 0.0283 \times \text{trIA} + 0.5516 \times \text{AD8TOT} - 0.3643 \times \text{CDTf}}}
\]

and \( e = 2.718281 \).
CASE STUDIES
TO BE PRESENTED

Acknowledgements

• Our Participants and informants
• Our Referral Sources
• Memory and Diagnostic Center
• Steve Ice, Independent Drivers LLC
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  Caleb Krenk
  Jacob Rosen

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  • Leanna Depue
  • Jackie Rogers
  • Bill Whitfield

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Mike Wallendorf, PhD, Statistician
Katie Rutkoski, OTR/L
Kathy Dolan, OT/L
Lily Hu, Data Base Manager

• Jefferson Barracks VA
  Pat Niewoehner, OTR/L
• Department of Psychology, UMSL
  Dr. Thomas Meuser
• SLU
  Dr. Maria Berg-Weger
Driving Restrictions for Persons with Dementia

Disclaimer

Carol Wheatley does not receive funding from any organization or group.
Restricted Driver Licensing for Medical Impairments: Does it work?

• N: 703,758 drivers
  – 23,185 drivers (3.3%) had a restricted licence

• Types of Restrictions:
  – daylight only
  – limited geographical range

• Outcome:
  – At-fault crash rates decreased by 12.8%
  – Traffic violation rates decreased by 10.0%

Possible MVA Restrictions for Persons with Cognitive Impairment - Maryland

• No freeway
• No night time driving
• Geographical restriction – 5, 10 or 15 mile radius

MAB Restrictions serve to alert Law Enforcement of a possible medical condition
Possible Physician Restrictions for Persons with Cognitive Impairment

- Accompanied by family member
- Specific routes between destinations

Co-Piloting vs. Co-Navigation

- Co-Navigation – assistance provided by passenger for route, upcoming turns
  - Acceptable

- Co-Piloting – assistance provided by passenger for vehicle control, traffic interaction, following rules of the road
  - Unacceptable
Driver Rehabilitation Assessment — Possible recommendations

- Continue to drive without restrictions, re-evaluation in * months
  - Provide pt/family with list of 'red flags'
    - Hartford Guide
- Continue to drive with restrictions, re-evaluation in * months
  - Provide pt/family with 'red flags' list
- Driving cessation, recommendations for alternative transportation, i.e., transport by family/friends

Driver Rehabilitation Assessment — indications for Geographical Restriction

- Clinical Assessment – mixed/borderline results
- Patient’s driving needs limited to local community
- Patient has lived in local community prior to onset of memory impairment
- No reported history of becoming lost in familiar areas
Driver Rehabilitation Assessment for Geographical Restriction

- On-Road Assessment – performed in patient’s local community
- Consideration of GPS tracking – ‘Find Friends’
- MVA Driving Skills Test – also performed in patient’s local community
- Driver Rehabilitation re-assessment in * months

Presenters

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David B. Carr, MD
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Carol Wheatley, MS, OTR/L, CDRS
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Dementia and Driving: Current Evidence and Clinical Relevance

Peggy P. Barco, OTD, OTR/L, SCDCM, CDRS
David B. Carr, MD
Carol Wheatley, MS, OTR/L, CDRS

Objectives

1. To gain knowledge related to evidence based assessment approaches when assessing driving skills in individuals with dementia.
2. To demonstrate an understanding of the types of dementia and the unique considerations of the various dementias subtypes that may have unique impacts on driving performance.
3. To apply the use of evidence assessments and know the strengths and limitations of these tests in case study scenarios when making driving recommendations.
4. To gain understanding of the role of the caregiver’s input via questionnaires to the importance of the driving recommendations.
5. To understand the various considerations, evidence, and discussions regarding restricted driving recommendations for individuals with dementia.

Topics/References/Links

<table>
<thead>
<tr>
<th>Topics/Brief Outline</th>
<th>References</th>
<th>Links to explore</th>
</tr>
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<tbody>
<tr>
<td>DEMENTIA and MEDICATIONS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Attention and Driving</td>
<td></td>
<td></td>
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<tr>
<td>2. Memory and Driving</td>
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<td>3. Executive Function and Driving</td>
<td></td>
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</tr>
<tr>
<td>4. Visual spatial/visual processing and driving</td>
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</tbody>
</table>

<p>| THE EVIDENCE BEHIND COMMON COGNITIVE ASSESSMENTS UTILIZED IN COMPREHENSIVE DRIVING ASSESSMENTS |                                                                                                                                  |
|                                                                                      | <a href="http://www.strokengine.ca/family/tmt_family/">http://www.strokengine.ca/family/tmt_family/</a>                                                                                                                                             |
| Snellgrove Maze Test                                                                  | Snellgrove C. Cognitive screening for the safe driving competence of older people with mild cognitive impairment or early dementia, Australia Transport Safety Bureau: 2010.                                                                                       |
|----------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------|</p>
<table>
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<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Classen, S.; Wang, Y.; Winter, S.M; Velozo, C. A.; Langford, D.N.; Bedard, M.;</strong></td>
<td><strong><a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/</a></strong></td>
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<tr>
<td><strong>Concurrent Criterion Validity of the Safe Driving Behavior Measure: A Predictor of On-Road Driving Outcomes. AJOT, 2013; 67 (1).</strong></td>
<td><strong><a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/</a></strong></td>
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<tr>
<td><strong>CONSIDERATIONS OF LEVEL OF COGNITIVE FUNCTION WHEN MAKING DRIVING RECOMMENDATIONS</strong></td>
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<td><strong>Driver License Restrictions</strong></td>
<td><strong><a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3722666/</a></strong></td>
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**AAA Foundation for Traffic Safety: Driver License Policies and Practices**

- **http://lpp.seniordrivers.org/lpp/index.cfm?selection=restrictedlicensetypes1**
- **www.nhtsa.gov/people/injury/olddrive/modeledriver/vol3scr.pdf**