Driving After Brain Injury

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Presenter Disclosure Information

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Driving After Stroke

FINANCIAL DISCLOSURE:
No relevant financial relationship exists
Learning Objectives

- Participants will learn which deficits could impair driving after a brain injury
- Participants will learn what adaptive equipment is available to facilitate driving after brain injury
- Participants will learn what a Driver Rehabilitation Specialist is and how they can assist clients who have had a brain injury
- Participants will know how to locate a Driver Rehabilitation Specialist
Why is driving important?

- Fundamental link to community integration
- Essential to access basic needs
  - Health Care
  - Shopping
  - Recreation
  - Social Support
  - Employment
- Transportation Method of Choice
  - Even with readily available alternate transport, quality of life declines (Legh-Smith et al, Liddle et al)
Why is driving important?

- Autonomy
- Identity
- Decreased out-of-home activity directly linked to physical and psychological morbidity (Glass et al, Legh-Smith et al, Marittoli et al)
Autonomy vs. Public Safety

- Independence vs. danger to self and public
  - Timing is everything
  - Some drivers will surprise you
  - HIPPA laws allow reporting in cases where public safety is at risk
  - Licenses can be temporarily suspended and then reinstated if a patient’s skills improve
Driving—the ultimate IADL

Requires:
- Physical Skills
- Visual Skills
- Cognitive Skills
- Emotional/Behavioral Appropriateness
- (Everything you’ve got!)

Environment:
- Constantly changing
- Requires quick interaction and good timing
- Visual information 360 degrees around you
- Unpredictable - other drivers’ errors
A Theoretical Framework for Driving
Michon Hierarchy of Driving

- **Level 1 - Strategic**
  - **Pre-driving activities**
    - **Choice of route**
      - Avoid left-hand turns
      - Choose route with less traffic at time of day
      - Using traffic reports effectively
      - Stops for rest, food
    - **Choice of time to drive**
      - Bad weather, rush hour, darkness
      - Physical state - fatigue, emotional upset, etc.
    - **Choice to take public transportation if necessary**
  - **No time constraint**
  - **Affects all other driving-related behaviors**
  - **Often masked by structure of the driving assessment**
Level 2 - Tactical
- Decisions made while driving the vehicle
- Processing information about other road users - drivers, pedestrians, bicyclists
  - Anticipatory awareness of hazards
  - Risk avoidance
    - Adjusting Speed
    - Wipers/Headlights
    - Evasive Steering
- Planning, flexibility, adaptation (speed, lane changes, passing, etc.)
- Requires focused attention, judgment, inhibition of distracters, self-awareness
- Speed of information processing crucial
Michon Hierarchy (cont.)

- Level 3 - Operational
  - Basic Vehicle Control - Physical
    - Steering
    - Braking
    - Acceleration
  - Visual scanning, motor control, strength, coordination, reaction time
  - Requires high speed information processing—must react instantaneously
  - Overlaps with tactical
The Research
Statistics

- Roughly 80% of TBI survivors and 30% of stroke survivors return to driving
  - Many return AMA
- More than 60% of those who returned drive every day and > 50 miles/week
- Nearly 66% had not been professionally evaluated
  - Most common source of advise = family member
Random Facts

- Increased crash risk following TBI
  - Risk is 2.3 times higher than general pop.
    - Executive function deficits
    - Premorbid “accident-type behavior”
    - Young age at time of TBI (lack of experience)
    - Medication
  - FIM - not predictive, but high FIM = greater chance of driving AMA
- TBI survivors had significantly more accidents than stroke survivors
Mild vs. Mod/Severe TBI

Mild TBI (and perhaps TIA)
- May appear relatively intact BUT...
  - Headache, dizziness, poor balance, forgetfulness, slowed thinking, impaired concentration, decreased executive function, fatigue, irritability, visual impairment, sensitivity to light/noise
- Any of these could affect driving safety
- Most studies have not addressed mTBI

Useful Field of View Results

- Worse scores after TBI - particularly subtests of divided & selective attention
- Significant correlation between these subtests and result of BTW
- Correlation not confirmed with mTBI
  - Confirmed for moderate to severe

Classen et al
Affect of Anasognosia

- Insight & self-criticism more important than level of cognitive deficit
  - Subjects with good awareness of problems more likely to return to driving
  - Subjects with good neuropsych test performance but poor awareness more at risk of accidents/offenses
- Perception of danger significantly reduced for 24 hours following mild TBI

Predictive Factors

- Time between trauma and evaluation
  - Only variable consistent thru the research
  - Longer time = better result

- If return to driving not possible within 2 years following non-severe TBI it is unlikely to change

- In severe TBI chance of returning increases each year and is greater at 5 years than 2 years post

- Other factors yielded only weak evidence

*Ortoleva et al (2012); Lew et al (2009)*
Gold standard - behind the wheel driving evaluation with a specialist

- Difficult to assess in research studies
  - Routes not standard - different geographic areas
  - Traffic fluctuates - challenges different each time
  - BUT driving envir. can not be adequately simulated

Simulators may be helpful in ADDITION

- Research does not justify use for final decisions
- Useful to treat cognitive deficits
Simulator Research Results

- Results do not correlate highly with BTW
- Great for research
  - TBI subjects spend more time looking at close environment, don’t use rear-view mirror
    - Lack of anticipatory control
  - TBI subjects who score poorly for attention and exec. fx have poor visual exploration
  - Dual task performance was significantly correlated with rate of accident

Milleville-Pennel et al (2010)
Physical Deficits in Brain Injury

- Hemiplegia
- Spasticity
- Weakness/Fatigue
- Coordination Deficits
- Motor Planning Delays
- Possible pre-existing orthopedic conditions (rotator cuff tears, joint replacements, arthritis, etc.)
Vision Deficits in Brain Injury

- Acuity deficits - may be temporary
- Ocular-motor deficits (pursuits, saccades)
  - Decreased ability to scan for hazards
  - Nerve palsy - decreased eye range of motion
  - Nystagmus—abnormal oscillations of eye(s)
- Fusion deficits
  - Not using both eyes together as a team
  - Loss of depth perception
- Eye alignment deficits (diplopia, “shadows”)
  - Active double vision—should not drive!
  - Phoria vs. strabismus
Strabismus

- Normal
- Hypotropia (eye turns down)
- Hypertropia (eye turns up)
- Exotropia (eye turns out)
- Esotropia (eye turns in)

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Vision Deficits (cont.)

- **Peripheral Field Deficits**
  - **Visual Field Cuts** – more common in CVA
    - One eye only
    - Homonymous – both eyes affected; most states won’t allow driving (NJ & NY do, PA requires 140 deg)
    - Normal binocular field=180 deg. side to side
  - **Effect of vehicle speed on Visual Field**
    - 200 deg field at 20 mph=104 degrees
    - 200 deg field at 40 mph=70 degrees
    - Normal VF at 60 mph=40 degrees
    - Field deficit will worsen as speed increases (Pierce)
  - **Peripheral vision is not clear**—alerts to motion
Field Cut
Vision Deficits (cont.)

- Visual Midline Shift Syndrome
  - Sees floor as tilted
  - Illusions of movement in environment leads to dizziness or nausea
  - Walk to one side of hall - leaning forward, backward or to one side
  - Spatial disorientation - bumping into objects
Useful field of view

- Visual area over which information can be extracted at a brief glance without eye or head movements.

- Correlated to crash risk in older drivers (Owsley)

- UFOV decreases with age
  - decreases in visual processing speed
  - reduced attentional resources
  - less ability to ignore distracting information.

- 40% of 90 year olds have a UFOV of less than 20 degrees (tunnel vision)
Visual Attention Deficits in BI

- **Inattention/Neglect (more in CVA)**
  - Field is either normal or decreased
  - Unfit for driving
  - Very little ability to compensate

- **Decreased divided visual attention**
  - Field can be either normal or decreased
  - Common in neurological dx, but also prevalent in the well elderly
Visual Processing

- **Simple**
  - recognizing objects, colors, shapes
  - making gross discrimination of size, position & direction

- **Complex**
  - accurately perceiving detailed visual scenes
  - Making subtle discriminations
  - Grasping inter-relationships among simultaneously presented visual stimuli
  - Requires concentration, effort, analysis
Impaired Processing

- Combines visual and cognitive systems
- Slow Processing common in:
  - Neurological dx - CVA, PD, MS, TBI
  - General aging population
- Compounded by:
  - Low illumination
  - Stress
  - Illness
  - Fatigue
  - Sensory overload
Spatial Skills Deficits

- Figure Ground
  - Differentiating foreground from background

- Form Constancy
  - Perceiving the whole object when you only see a piece of it

- Position in Space
  - Up/down, front/behind, left/right
Spatial Skills Deficits (cont.)

- **Topographical Disorientation**
  - Relationships of places to one another
  - Finding your way in space

- **Spatial Relations**
  - Position of objects in relation to each other
  - Interpreting speeds of movement
Spatial Skills Deficits (cont.)

**Implications for Driving**
- Time and space management (stopping too late or too soon at intersections)
- Parking difficulties (esp. backing)
- Not seeing signs, confusing arrows
- Interpretation of the unexpected (construction, car breakdowns)
- Lane integrity—position on road
- Getting lost in familiar surroundings
- Lane selection
Cognitive Deficits in BI

- Attention/Concentration
  - Sustained, divided, shifting
- Initiation
- Planning/organizing
- Mental flexibility/abstract thinking
- Self-monitoring/self-correction
- Problem-solving
- Judgment
- Anticipatory thinking
Cognitive Deficits (cont.)

Memory

- Semantic - store and recall information
  - Resistant to decay

- Procedural - learning rule-based or automatic behavioral sequences
  - Subcortical
  - Resistant to decay

- Prospective - future intentions
  - Difficulty in unfamiliar situations
Medication Effects

- Polypharmacy
  - Check for drug interactions:
- Impact of drugs on driving capacity
  - Anxiolytic
  - Neuroleptic
  - Narcotic
  - Hypnotic
- Medication may be sedating or cause dizziness/lightheadedness
- May forget to take crucial medication
Other Considerations

- Seizures - all states have laws prohibiting driving for a certain length of time (6 mo. in NJ)
- Impulsivity
- Emotional Lability
  - Depression common
- Behavioral Abnormalities/Impulse control
  - Appropriate gestures; asking for directions
Other Considerations (cont.)

- Sleep Apnea or poor sleep quality
  - Disorientation, confusion, confrontation
  - Communication
  - Anasognosia - not aware of deficits
The Challenge

“Driving safely is much more than just mechanically operating a vehicle, and can never be reduced to automatic behaviors. Driving requires planning, concentration, inhibition of distracters, foresight, anticipation, problem-solving capacities, the ability to interpret rapidly complex arrays of multimodal stimuli, and prompt, effective and calm reactions” (Tamietto et al)
Decisions...

- Those clearly unable often do not need intervention
  - DON’T ASSUME!
  - Consider reporting for license suspension

- Mild strokes (TIA’s) or concussions may not need intervention
  - Be very sure--easy to miss visual or cognitive deficits
  - MD clearance in the medical chart may be enough

- Grey areas – send to specialist
  - Physical skills, vision, processing speed, executive functioning and self awareness need to be evaluated with an on-road assessment. (Dickerson)
CDRS Driving Evaluations
Pre-Driving Evaluation

- Medical and Driving History
- Physical Skills
  - Strength, coordination, reaction time, need for adaptive equipment
- Visual Skills
  - Ocular-motor, depth, fields, etc.
- Cognitive/Perceptual Skills
  - Visual scan speed, divided attention, etc.
Off-road testing

Research consistently suggests off-road tests are not adequate for neuro patients

- “...there are currently no standard neuropsychological tests that validly predict the ability to drive in stroke patients” (Soderstrom et al)

- Impairment varies depending on lesion area, severity, age, co-morbidities

- Consistent inconsistency of results
  - Easy to miss something in the clinic
  - Easy to find deficits that are not affecting driving fitness
Behind the Wheel Evaluation

- Preparation to Drive
- Starting/Initial Movement
- Turning/Tracking
- Speed Control/Space Management
- Road Law/Right of Way
- Lane Use/Passing Skills
- Maneuvering
- S.I.P.D.E. Factors (Search, Identify, Predict, Decide, Execute)
Recommendations

- **Pass**
  - No safety concerns

- **Fail**
  - Safety lapses that don’t look “fixable”
  - May recommend return in 6 mo./1 year
  - May report for license suspension

- **Training Required**
  - Always required with adaptive equipment
    - DMV road test also required with a.e. in most states
  - Compensatory strategies
  - Defensive Driving Techniques
Driving with vision deficits

- **Neglect/Inattention**
  - Personal, peripersonal, extra-personal
  - Not easy to assess in a clinical eval
  - No reliable compensation
  - May resolve enough to allow driving

- **Small field loss**
  - Should be evaluated to determine ability to compensate
  - May benefit from extra mirrors
Driving with vision deficits (cont.)

- **Homonymous hemianopias (HH)**
  - Approx. 40% of post-chiasmal lesions
  - 22 states and many countries do not allow driving (2009)
    - Disqualified by arc of vision requirement
    - Some allow after special evaluation

- **Monocular Sector Prisms**
  - Can increase arc of vision enough to qualify
  - No research yet to determine if they increase safety (Elgin)
  - Recommend training prior to evaluation on-road
Driving with vision deficits (cont.)

HH Research

- No study has looked at actual crash rates
- Prognosis may be better with macular sparing
- Lower accuracy in seeing pedestrians in simulator and traffic/pedestrians in on-road study (Bowers I)
- Widely differing abilities to compensate (miss rates from 0-100%)
- Greater incidence of positioning errors (over lane line Bowers II)
- Age is the best predictor of blind-side miss rates
Driving with vision deficits (cont.)

- HH research (cont.)
  - Most detection errors occurred at intersections (Bowers pilot)
  - Scan magnitude was not large enough (especially to right side Bowers IV)
    - No peripheral vision cue how far to scan
    - Missing pedestrians, etc. on sidewalk
  - Judgment on fitness to drive cannot be based solely on visual field size (Gera)
  - Longer time not driving adversely affects outcome (Gera)
  - Better prognosis with good contrast sensitivity and faster processing speed (Elgin)
  - Research shows that many people with HH are driving AMA
Driving with adaptive equipment

- State legal requirements vary
  - i.e. NJ will not allow one handed steering, prosthetic or brace on pedal, two footed driving, left foot crossing over

- Increased comfort = increased safety

- Wheelchair considerations
Primary Control Adaptations

- Left Foot Accelerator
- Hand Controls - push/pull, push/right angle, push/twist, push rock
- Pedal Extensions
- Reduced effort pedals
- Scott Van
- Electronic Gas/Brake Controls
- Foot steering
Steering Adaptations

- Spinner knob
- Quad spinner/V-Grip
- Tri-Post or Quad Tri-Pin
- Palm Grip Spinner
- Low effort steering
- Electronic steering interface
- Horizontal wheel
- Reduced diameter wheel
Secondary Control Adaptations

- **Directional**
  - Crossover
  - Electronic Wireless Directional
  - Spot switches
  - Voice Activated controls

- **Remote**
  - Wipers
  - Headlights/High Beams
  - Horn
Supplemental Mirrors

- Expanded rearview mirrors
- Spot Mirrors
- Interior mirrors
- Bus/Trailer mirrors
Wheelchair/Scooter Concerns

- Ramp or lift for entry
- Raised roof for entry
- Power seat base/swivel seat
- Dropped floor
- Safe wheelchair tie-down
- Adapted seatbelts—in addition to w/c seatbelts
- Wheelchair loading devises
Other Adaptations

- Adapted gear shift
- Adapted keys for door/ignition
- Chest straps
- Adapted seat belt clasps
- Pedal blocks
- Special splinting for positioning
Vehicle Technology

- GPS
- Integrated Blue Tooth
- “Smart” cruise control
- Blind spot awareness monitors
- Back-up cameras
- Lane correction systems
- Automatic braking
- Self-driving vehicles
Other Considerations
Patient Liability

- After neurological event or significant injury:
  - Should have medical clearance before returning to driving
    - MD note in Medical Chart
    - Driving Program evaluation
  - NJ wants MD’s to report CVA’s to state licensing agency (MVC)
  - Patients required to self-report on renewal form
Funding for Driving Rehab

- Clients who may return to work
  - State Division of Vocational Rehabilitation
- Brain Injury Fund
- Workman’s Compensation
- No-fault Insurance
- Medicare/caid will not pay expenses related to driving
  - Most private insurances follow Medicare rules - no CPT code
Finding a CDRS

- ADED - National Association of Driver Rehabilitation Specialists
  - **Locator feature to find a CDRS in your area
  - [http://www.aded.net/](http://www.aded.net/)
Resources

- NMEDA - national organization of equipment dealers and vehicle modifiers
  - www.nmeda.com/

- NHTSA (Nat’l Hwy Traffic Safety Admin)
  - Driver Fitness Medical Guidelines
    - www.nhtsa.gov/DOT/NHTSA/.../Articles/.../811210.pdf
  - Video Toolkit
    - http://www.nhtsa.gov/Driving+Safety/ Older+Drivers/ Video+Toolkit+On+Medical+Conditions on Medical Conditions

- Fact Sheets for medical professionals
Fitness to Drive Screening Measure

- For those currently driving
- Administered by friend/family member who has driven with them
- Identifies red flags; estimates risk
- Great for older drivers

http://fitnesstodrive.phhp.ufl.edu/
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Questions