



Dementia and Driving: Do We Know When to Say When?

David B. Carr, M.D

Professor of Medicine and Neurology

Washington University at St. Louis

Medical Director, The Rehabilitation Institute of St. Louis



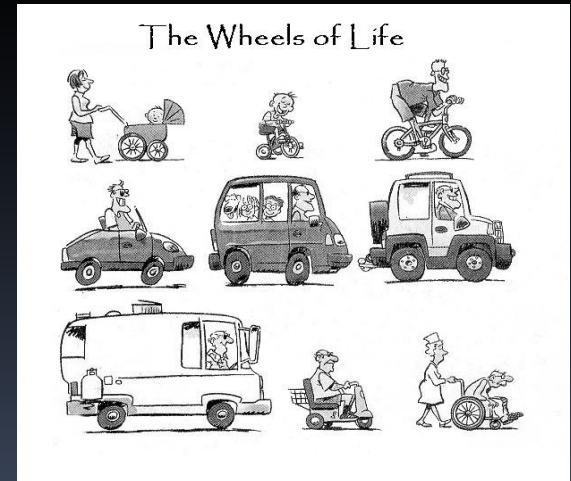
DISCLOSURES (2012-Present)

- Funding Support (last two years)
 - National Institute on Aging (NIA)
 - Missouri Department of Transportation
- Consulting Relationships
 - American Medical Association (AMA)
 - ADEPT
 - TIRF
 - Medscape
- Speakers Bureau
 - St. Louis Alzheimer's Association
- Medical Director
 - Parc Provence
 - The Rehabilitation Institute of St. Louis
- Drug Industry Sponsored Trials
 - Janssen/Pfizer
- Investment/Stock/Equity
 - None



PRESENTATION OBJECTIVES

Review the safety and crash statistics around older drivers and drivers with dementia



Review current approaches and tools that are available to assist decisions in drivers with dementia

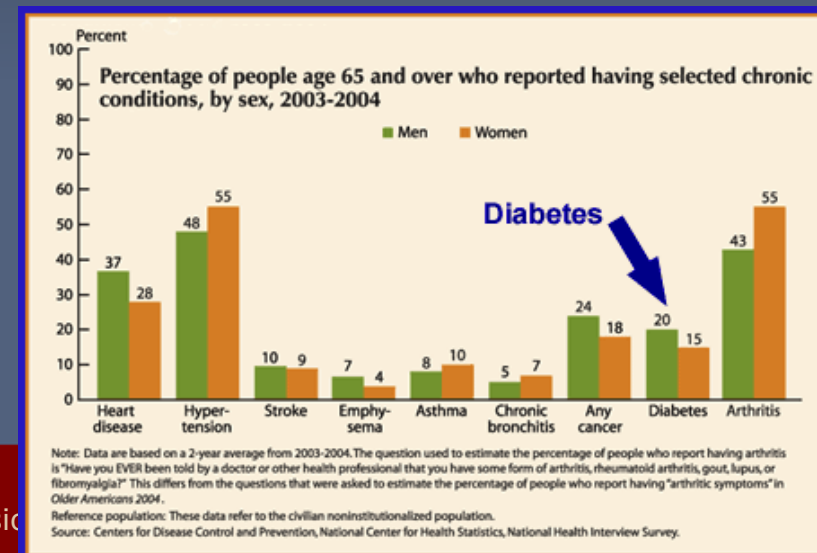
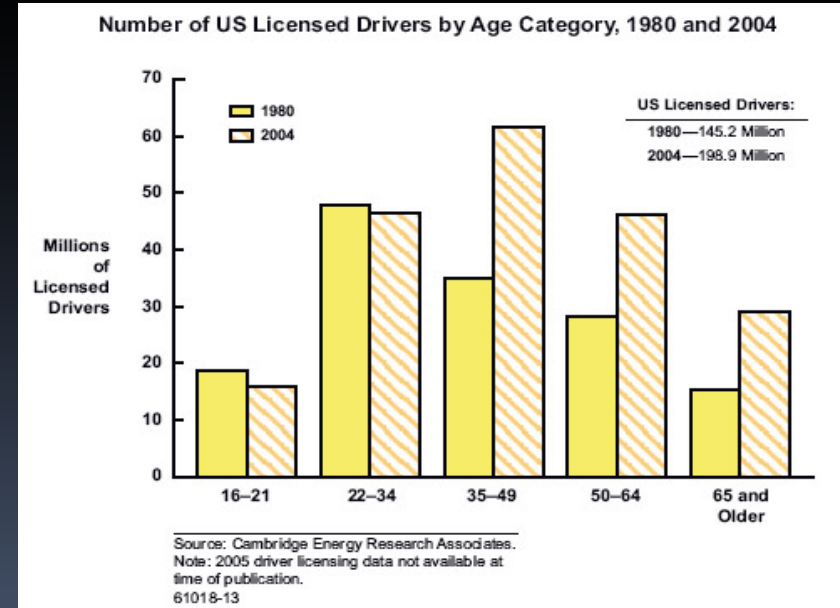
Review current research efforts in the field and areas of future collaboration

STATISTICS ON OLDER DRIVERS

- **Aging Demographics**
 - 2007
 - 36 Million Older Adults
 - 28 Million Licensed Drivers
 - 2050
 - 86 Million Older Adults
 - 66 Million Licensed Drivers

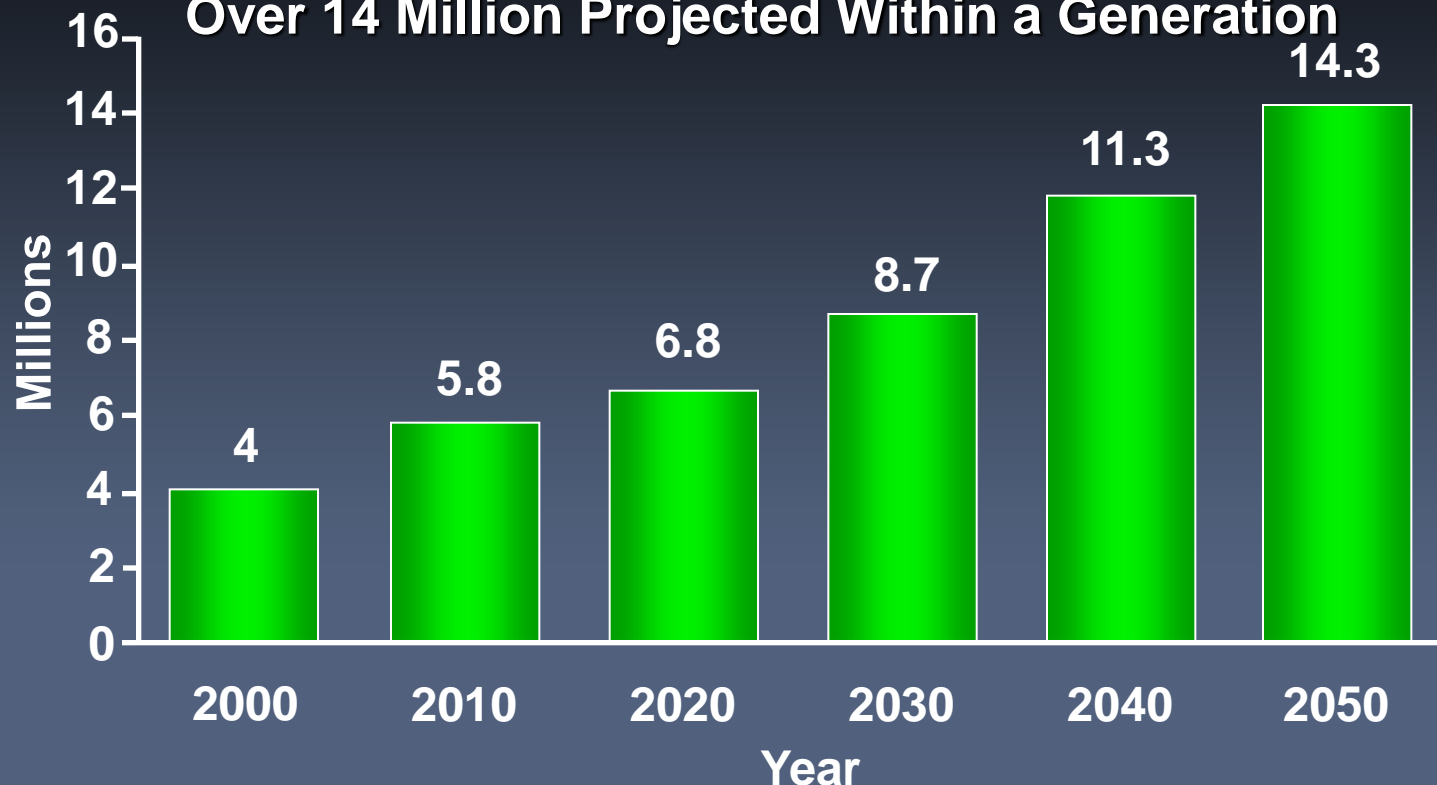
- **Chronic Disease**

- General Population
 - 25 million people or about 1/10 citizens
 - 1.7 million die each year
- Older adults
 - 50% affected over age 65
 - 37% report disease is severe
 - 16% require assistance



Epidemiology

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

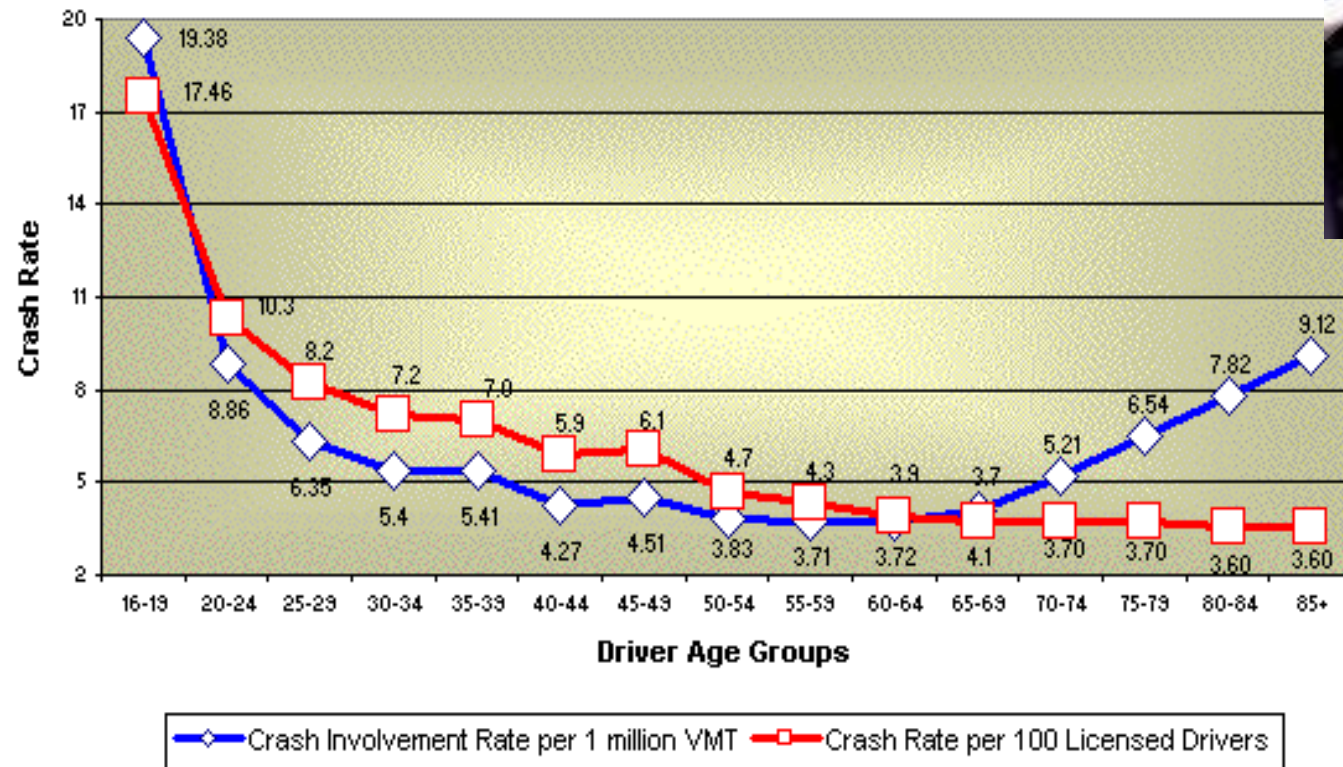


Affects > 5 million people in the U.S. (20 million world-wide)

Results in > 100,000 deaths per year/Costs > \$100 billion annually

MOTOR VEHICLE CRASH RISK BY AGE

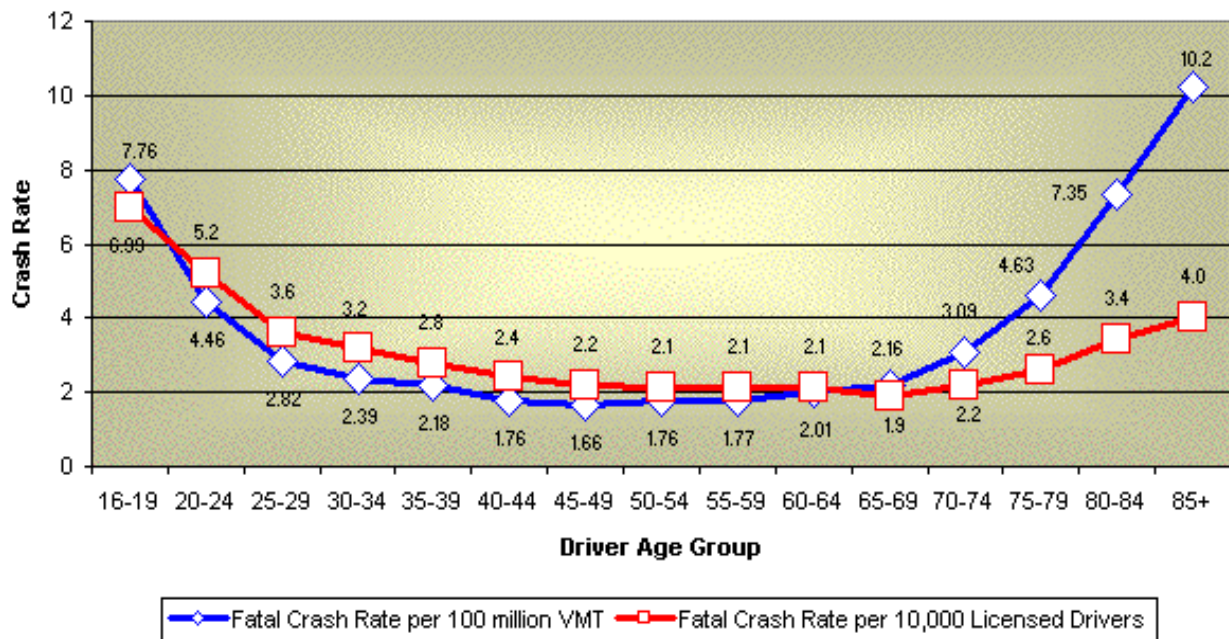
Figure 3: Accident Involvement Rate Age Group Comparison by Licensed Drivers and Vehicle Miles Traveled



http://search.cga.state.ct.us/dtSearch_lpa.html

MOTOR VEHICLE CRASH VULNERABILITY BY AGE

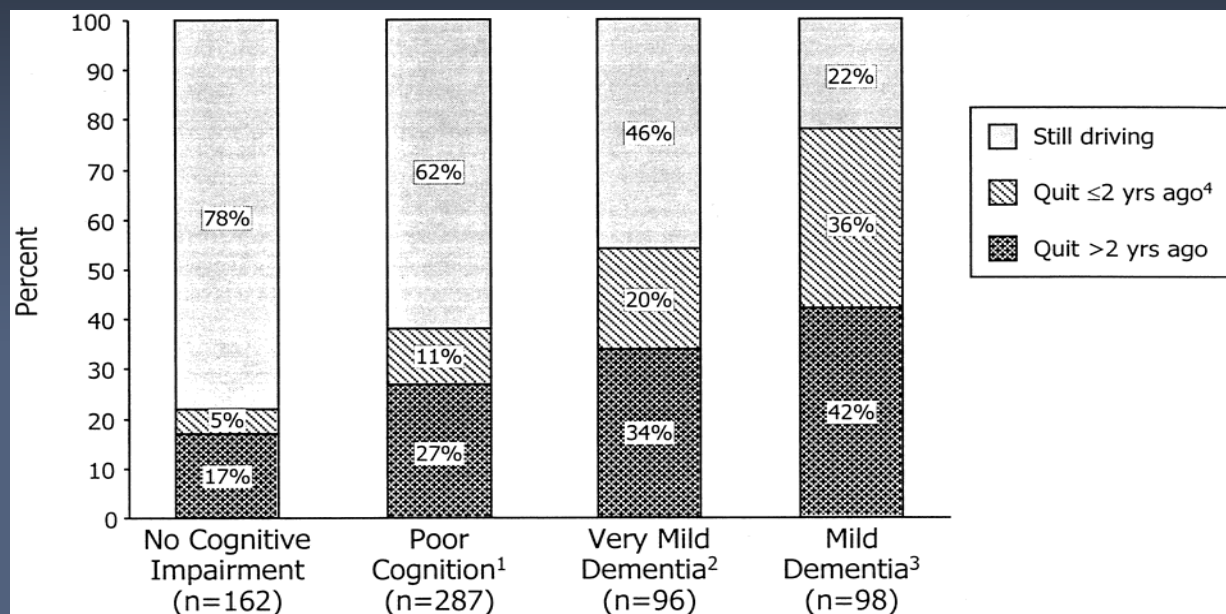
Figure 4: Fatal Accident Rate Age Group Comparison by Licensed Drivers and Vehicle Miles Traveled



http://search.cga.state.ct.us/dtSearch_lpa.html

DEMENTIA AND DRIVING CESSATION

- **DESIGN:** Retrospective cohort data from a community-based study of incident **dementia**. The Honolulu Heart Program and the Honolulu-Asia Aging Study.
- **PARTICIPANTS:** A total of 643 men who were evaluated for the incidence of Alzheimer's disease or other **dementia** between the fourth and the fifth examination of the Honolulu Heart Program.
- **CONCLUSIONS:** **Dementia** is a major cause of **driving** cessation.

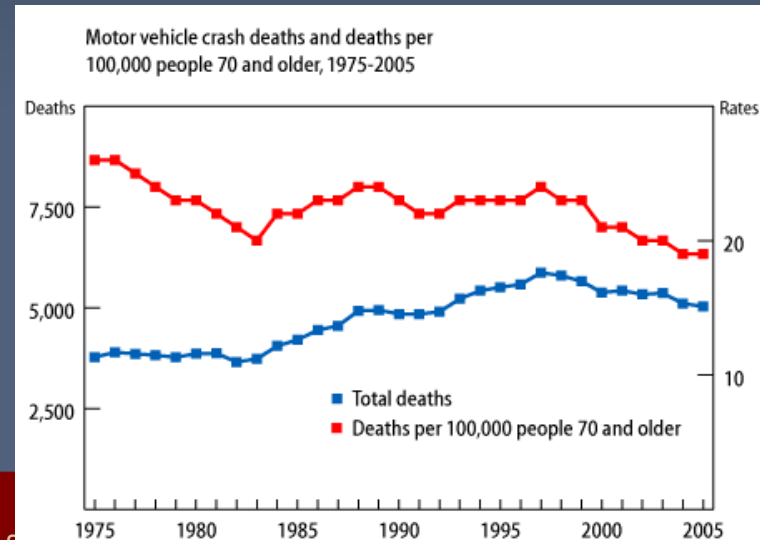


Foley DJ, et al. JAGS. 48(8):928-30, 2000.

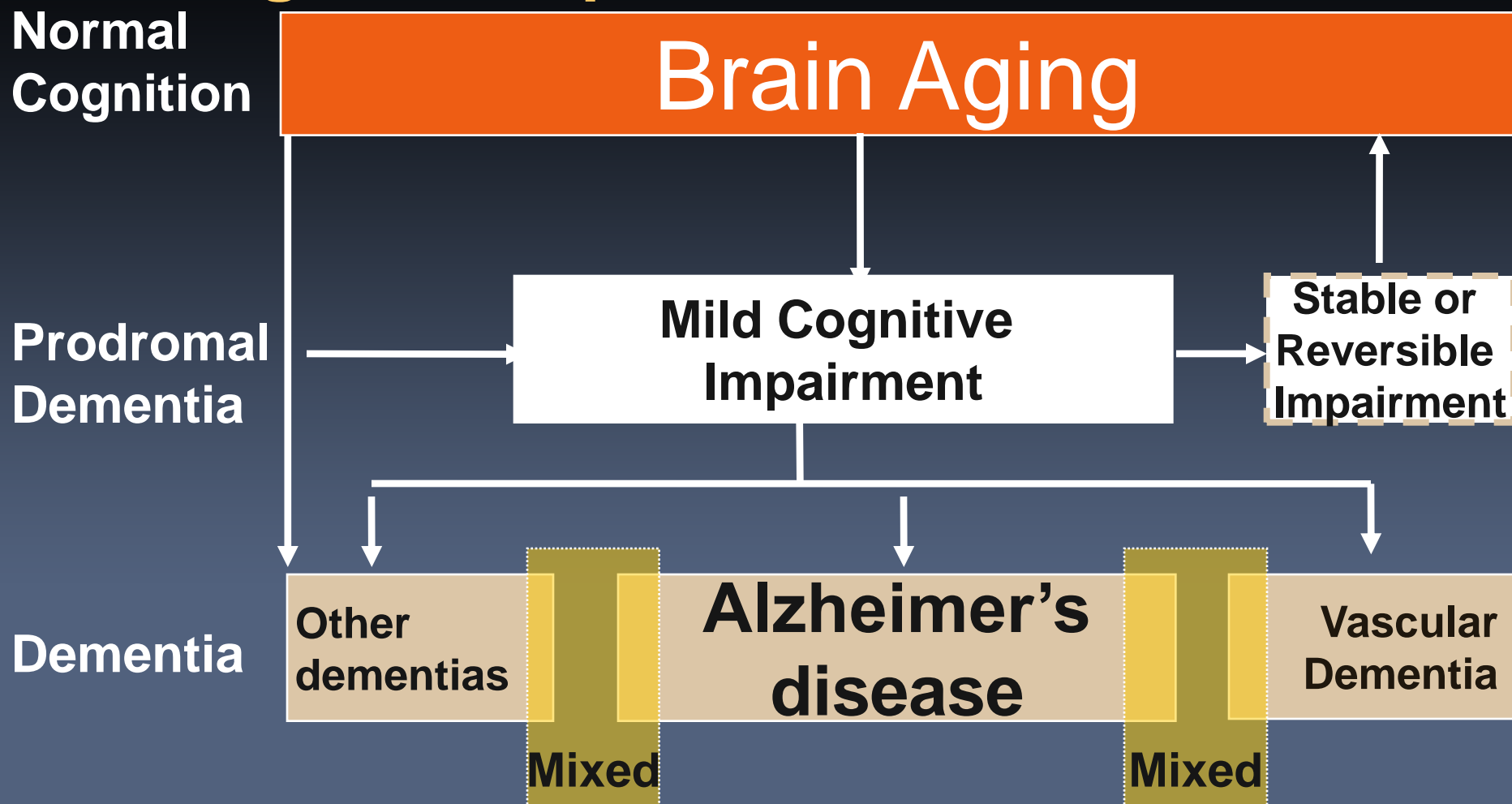
SUMMARY OF DRIVING STATISTICS in DEMENTIA and OLDER ADULTS

- Increasing Numbers of Older Drivers and Drivers with CVA/AD
- Increasing Prevalence of Chronic Disease and Older Drivers
- More Potential Drivers with Multiple Medical Diseases/Meds
- Increased Morbidity and Mortality Rates in MVC's
- Increasing Exposure or Miles per Year for Aging Cohort
- The Most Vulnerable are Likely Low Mileage Drivers
- Low Mileage Drivers include those with physical/cognitive frailty
- Many older adults retire from driving
- Growing transportation burden for families, caregivers, and society to provide trips

list.nsc.org/defensivedriving/images/uploads/811161.pdf



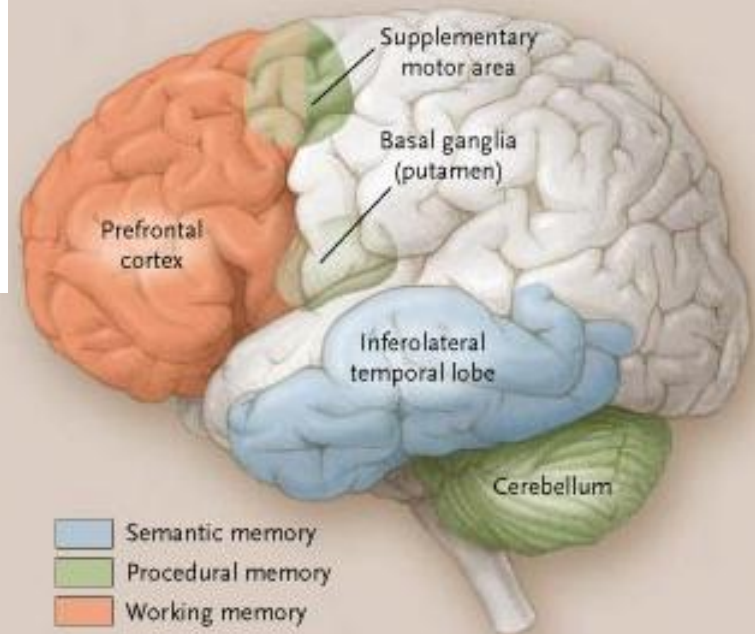
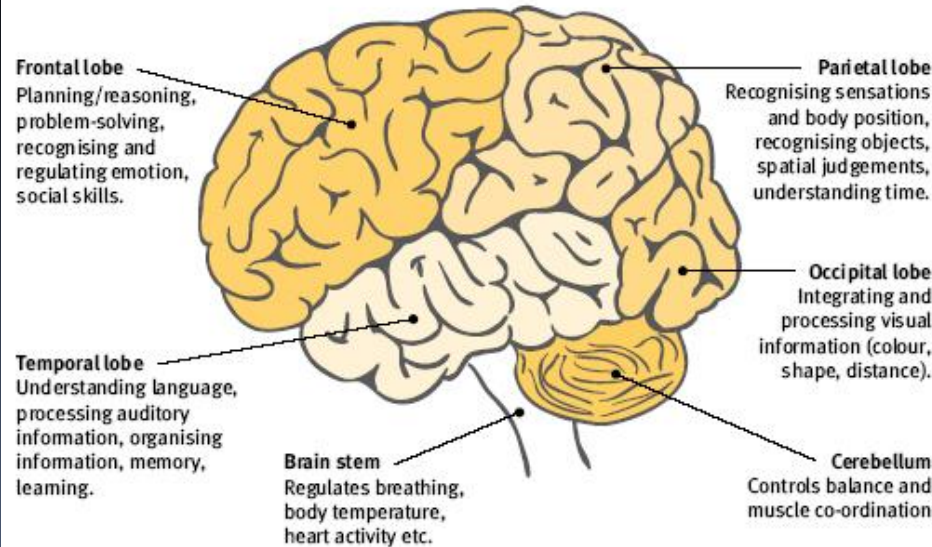
The Changing Definitions of Cognitive Impairment and Dementia



From Golomb, Kluger, Ferris NeuroScience News, 2000

ANATOMY OF CRITICAL COGNITIVE DOMAINS

Areas of the brain (side view)



Budson AE, Price BH. Memory Dysfunction. NEJM 2005; 352: 692-9

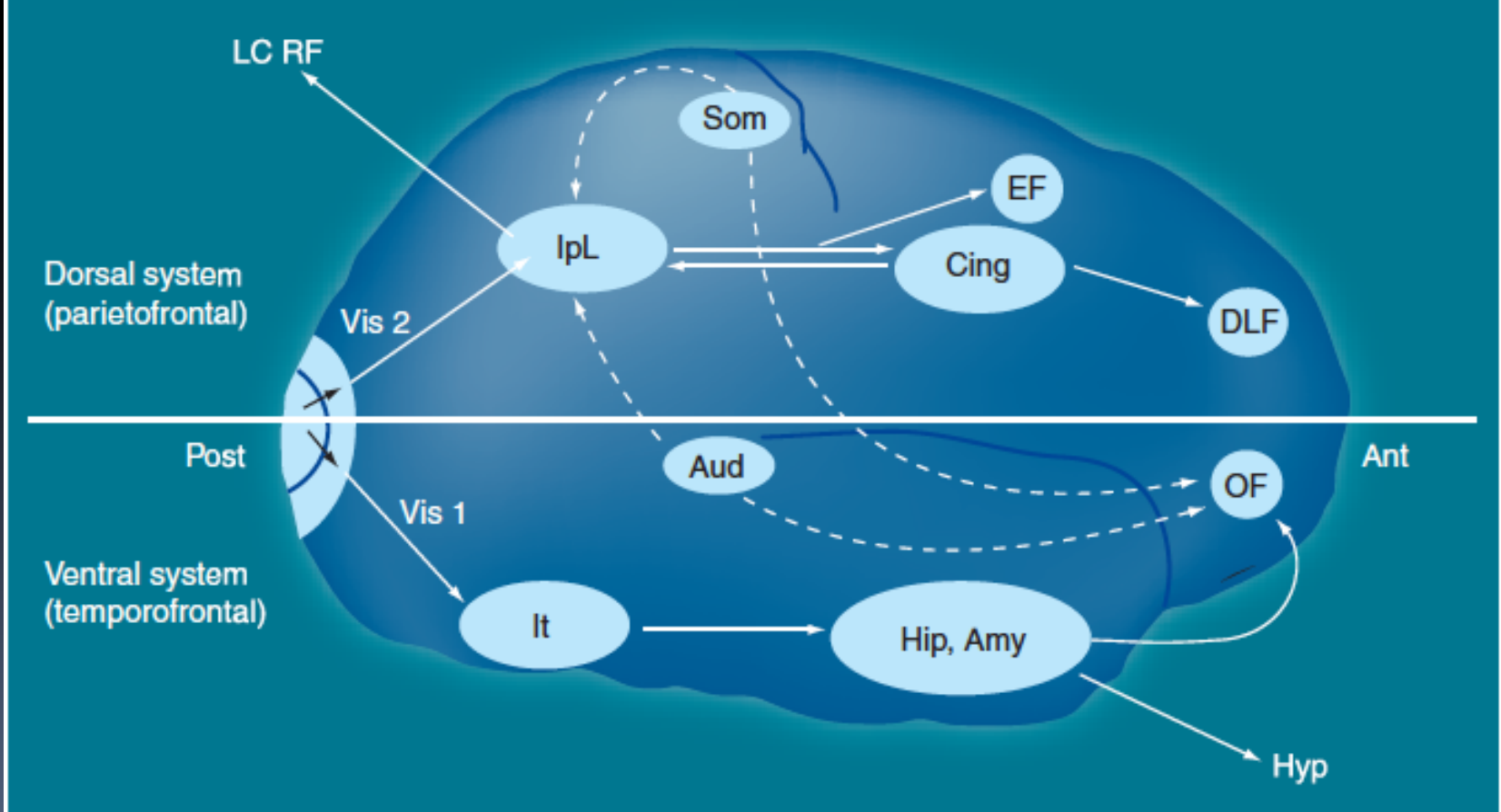


Figure 1. Two major visual processing pathways of the brain.

Amy: Amygdala; Ant: Anterior; Aud: Auditory pathway; Cing: Cingulate gyrus; DLF: Dorsolateral frontal cortex; EF: Frontal eye fields; Hip: Hippocampus; Hyp: Hypothalamus; IpL: Inferior parietal lobule; It: Inferotemporal visual cortex; LC: Locus ceruleus; OF: Orbital frontal cortex; Post: Posterior; RF: Reticular formation; Som: Somasthetic pathway; Vis 1: Ventral visual pathway; Vis 2: Dorsal visual pathway. Reprinted with permission from [14].

Ott B and Daiello L. How does dementia affect driving in demented patients? *Aging Health* 2010; 6: 77-85

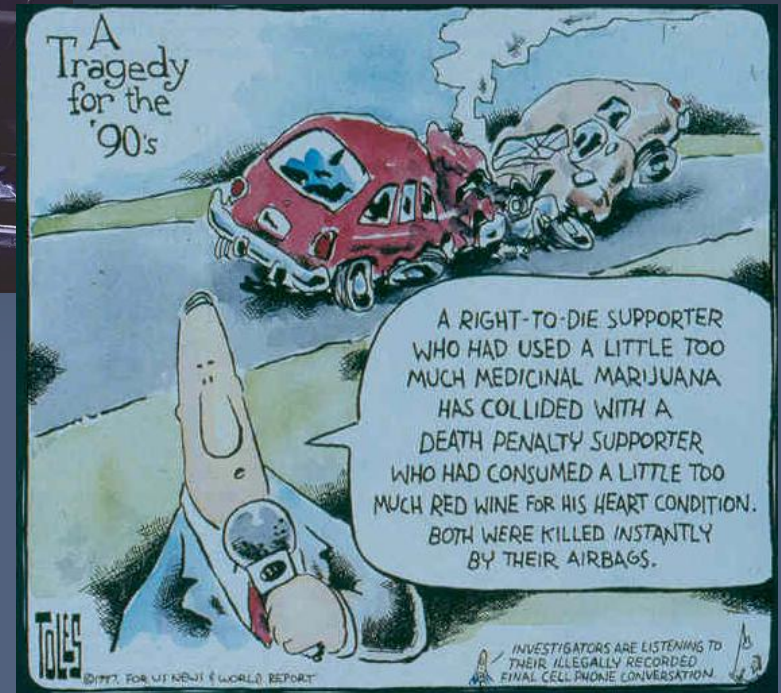
FITNES-TO-DRIVE STAKEHOLDERS

- Patient
- Family and Friends
- Health Professionals
- Organizations
- Patrol Officers
- State DMV
- Insurance
- Community
- Federal/NHTSA



Driving Outcomes

- Cessation/Retirement
- Crashes
- Road Tests
- Simulators
- Others



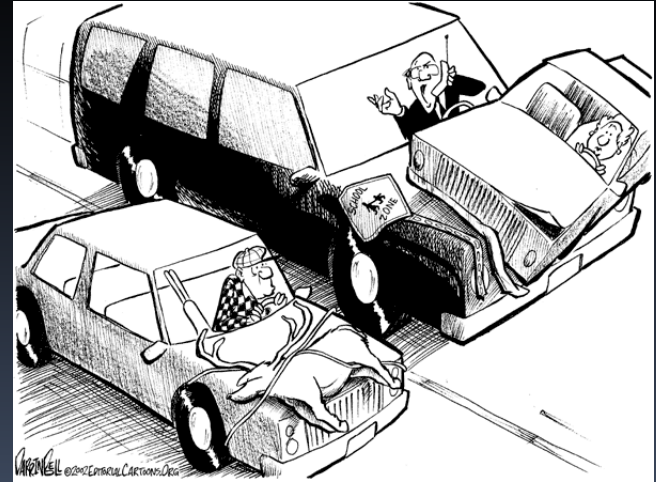
Fitness to Drive Steps

- Step 1:
Driving History and Med Reviews
- Step 2:
Examine Co-Morbidities
- Step 3:
Physical Examination/Psychometric Tests
- Step 4:
Rate Disease Severity/Functional impairment
- Step 5:
Referral, Rehab, and/or Retirement



Step 1: Driving History/Med Review

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



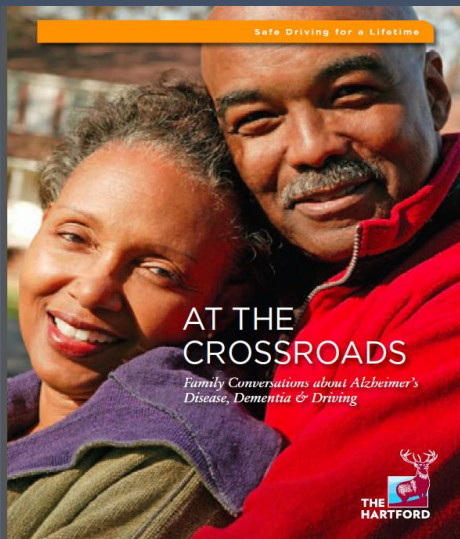
Signs of Unsafe Driving: Alz Association



- 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

<http://www.alz.org/care/alzheimers-dementia-and-driving.asp>

Signs of Unsafe Driving: At the Crossroads (*stop driving immediately)



Driving Behavior Warning Signs - When Noticed, How Often	
1. Decrease in confidence while driving	16. Uses a "copilot"
2. Difficulty turning to see when backing up	17. Bad judgment on making left hand turns
3. Riding the brake	18. Near misses
4. Easily distracted while driving	19. Delayed response to unexpected situations
5. Other drivers often honk horns	20. Moving into wrong lane
6. Incorrect signaling	21. Difficulty maintaining lane position
7. Difficulty parking within a defined space	22. Confusion at exits
8. Hitting curbs	23. Ticketed moving violations or warnings
9. Scrapes or dents on the car, mailbox or garage	24. Getting lost in familiar places
10. Increased agitation or irritation when driving	25. Car accident
11. Failure to notice important activity on the side of the road	26. Failure to stop at stop sign or red light
12. Failure to notice traffic signs	27. Confusing the gas and brake pedals*
13. Trouble navigating turns	28. Stopping in traffic for no apparent reason*
14. Driving at inappropriate speeds	29. Other signs:
15. Not anticipating potential dangerous situations	

<http://www.thehartford.com/advance50/publications-on-aging>

Driving Safety Errors in Dementia

Source: Dawson JD, et al. Predictors of driving safety in early AD. *Neurology* 2009; 72: 521-27.

Table 2 Driver safety errors in Alzheimer disease (AD) and normal control groups

Safety errors	AD (n = 40)	Controls (n = 115)	p Values for difference	
			Crude	Age- and gender-adjusted
Starting and pulling away from curve	1.08 (0.97)	1.09 (0.81)	0.7097	0.4392
Traffic signals	2.35 (1.56)	2.18 (1.56)	0.5101	0.4739
Stop signs	3.80 (1.98)	3.61 (1.89)	0.7610	0.6587
Other signs	0 (0)	0 (0)	—	—
Turns	6.50 (3.09)	5.44 (2.79)	0.0838	0.1412
Lane observance	17.03 (11.00)	10.84 (7.77)	0.0003	0.0039
Lane change	5.75 (2.86)	5.00 (2.75)	0.1253	0.9386
Overtaking	0.10 (0.38)	0.15 (0.46)	0.5075	0.5539
Control of speed	4.03 (2.71)	3.56 (2.79)	0.2634	0.7504
Backing up	0 (0)	0 (0)	—	—
Parallel parking	0.38 (0.49)	0.37 (0.52)	0.8172	0.7172
Head-in parking	0 (0)	0 (0)	—	—
Curves	0.00 (0.00)	0.01 (0.09)	0.5653	0.7983
Railroad crossing	0.03 (0.16)	0.19 (0.58)	0.1115	0.0533
Miscellaneous	0.98 (1.03)	0.73 (1.05)	0.0859	0.4132
Total safety errors	42.00 (12.84)	33.18 (12.22)	<0.0001	0.0148
Total more serious errors	4.35 (2.97)	1.90 (1.59)	<0.0001	<0.0001
Total less serious errors	37.65 (11.66)	31.26 (11.49)	0.0009	0.0516

Groups were compared using Wilcoxon rank sum for crude p values and multiple linear regression for adjusted p values.

Driving Behaviors in Dementia

Table 2

The number of participants (*N*), mean score, confidence interval (\pm), and probability level of the Wilcoxon Signed Rank Sum test (*p*-value).

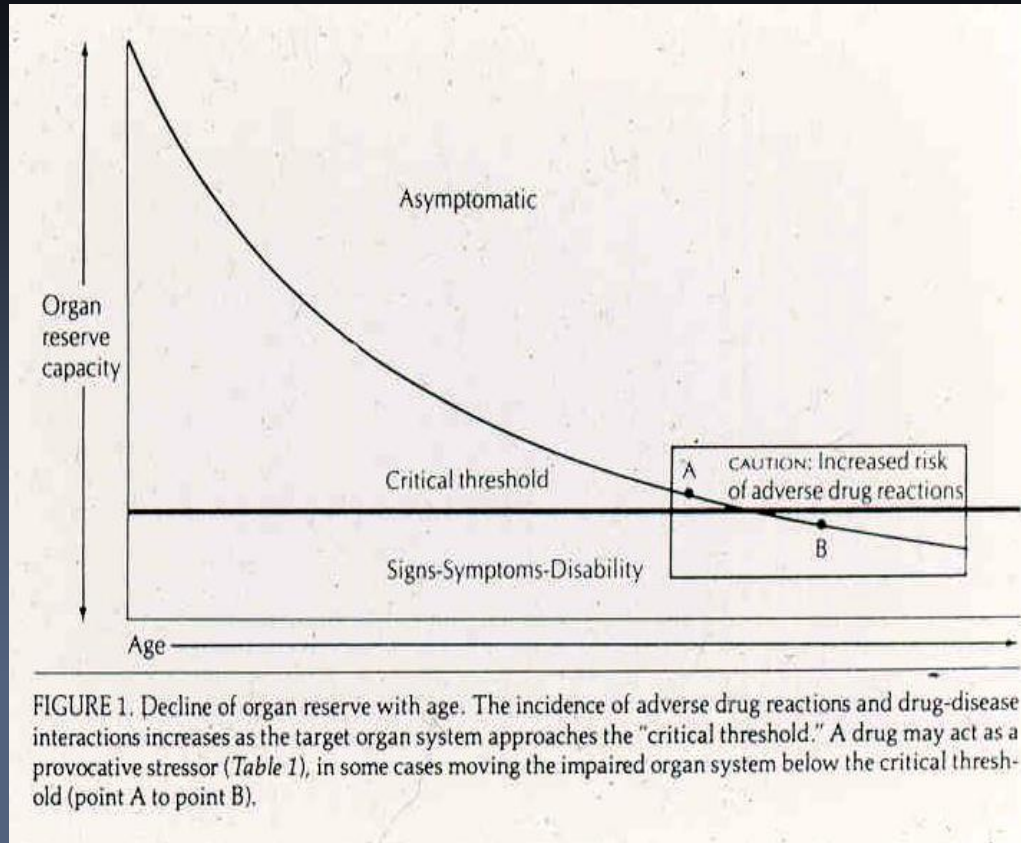
Metric	Early stage dementia Mean (<i>N</i> = 17)	Comparison Mean (<i>N</i> = 26; * <i>N</i> = 17)	<i>p</i> -Value
Trips per day	3.7 \pm 1.0	4.3 \pm 0.7	0.08
Miles per day	14.9 \pm 5.2	35.7 \pm 6.1	<0.01
Number of unique destinations per week	6.1 \pm 1.8	12.8 \pm 2.2	<0.01
Freeway miles (%)	15.0 \pm 9.2	32.9 \pm 6.8	<0.01
Miles driven within 5 miles of home (%)	70.2 \pm 10.4	43.0 \pm 6.5	<0.01
Miles driven within 10 miles of home (%)	84.2 \pm 9.5	60.3 \pm 8.3	<0.01
Miles driven during daylight hours (%)	93.2 \pm 5.1	86.2 \pm 6.1	<0.05
Miles driven during rush hour (%)	15.2 \pm 4.6	16.6 \pm 4.7	0.30
Miles driven alone (%)	53.3 \pm 17.1	Unavailable	N/A
Miles driven with a navigation device (%)	0.0 \pm 0.0	Unavailable	N/A
Number of wayfinding trips of interest	1.9 \pm 1.2	2.4 \pm 0.9 [*]	0.16
Wayfinding trips of interest (%)	2.1 \pm 1.6	2.8 \pm 1.5 [*]	0.13
Number of likely lost trips	0.4 \pm 0.4	0.0 \pm 0.0 [*]	<0.01
Miles belted (%)	88.3 \pm 11.6	98.8 \pm 2.3	<0.01
Miles driven with short headway (%)	2.9 \pm 1.6	6.1 \pm 3.4	<0.05
Miles driven 10 mph or more slower than surrounding traffic (%)	3.9 \pm 1.2	1.8 \pm 0.5	<0.01
Inappropriate midblock stops (%)	0.0 \pm 0.0	0.1 \pm 0.0	0.51
Running stop signs (%)	0.0 \pm 0.0	0.0 \pm 0.0	N/A
Turn signal use for turns (%)	77.2 \pm 10.4	79.4 \pm 8.0	0.26
Left turns causing traffic conflicts (%)	0.0 \pm 0.0	0.0 \pm 0.0	N/A
Red-light running (%)	0.4 \pm 0.0	Unavailable	N/A
Number of gear error events per week	0.0 \pm 0.0	0.0 \pm 0.0	0.28
Number of pedal error events	0.0 \pm 0.0	Unavailable	N/A

Bolded *p*-values are significant at the .05 probability level.

* Indicate where the sample size was on 17 participants (rather than 26) for the comparison group.

Eby D, et al. Driving behaviors in early dementia: A study using in-vehicle technology. *AAP*. 2012; 49: 330-7

MEDICATIONS



- Narcotics
- Barbituates
- Benzo's
- Antihistamines
- Antidepressants
- Antipsychotics
- Hypnotics
- Alcohol
- Muscle Relaxants
- Antiemetics
- Antiepileptic

Hetland A, Carr DB. *Annals of Pharmacology* (in press)

STEP 2: ADDRESS CO-MORBIDITIES



PHYSICIAN'S GUIDE TO

Assessing and Counseling Older Drivers

2nd edition

Table of Contents

Preface	IX
Chapter 1	1
Safety and the Older Driver With Functional or Medical Impairments: An Overview	
Chapter 2	11
Is the Patient at Increased Risk for Unsafe Driving? Red Flags for Further Assessment	
Chapter 3	19
Assessing Functional Ability	
Chapter 4	33
Physician Interventions	
Chapter 5	41
The Driver Rehabilitation Specialist	
Chapter 6	49
Counseling the Patient Who is no Longer Safe to Drive	
Chapter 7	59
Ethical and Legal Responsibilities of the Physician	
Chapter 8	69
State Licensing and Reporting Laws	
Chapter 9	145
Medical Conditions and Medications That May Affect Driving	
Chapter 10	187
Moving Beyond This Guide: Future Plans to Meet the Transportation Needs of Older Adults	
Appendix A	197
CPT® Codes	



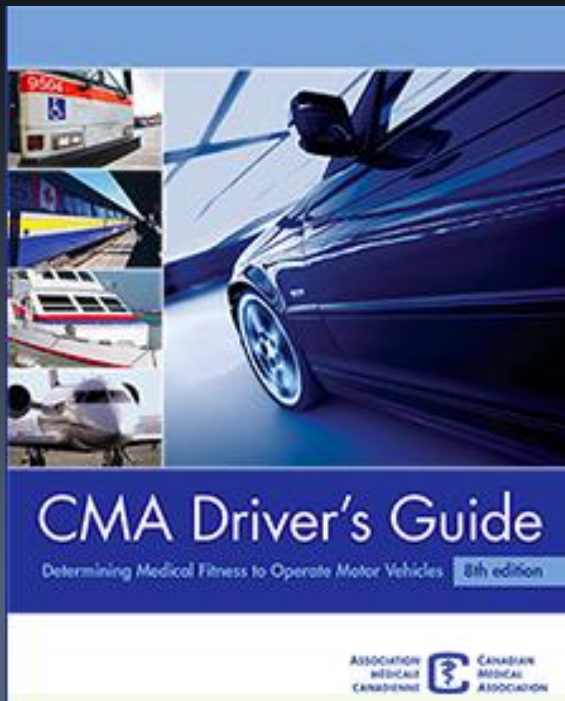
Meuser TM, *et al.* The Instructional Impact of the AMA's Older Drivers Project On-Line Curriculum. *Gerontology & Geriatrics Education* (In press)

Meuser TM, *et al.* The American Medical Association Older Driver Curriculum for Health Professionals: Changes in Trainee Confidence, Attitudes & Practice Behavior. *Gerontol Geriatr Edu* 2010 Oct;31(4):290-309.

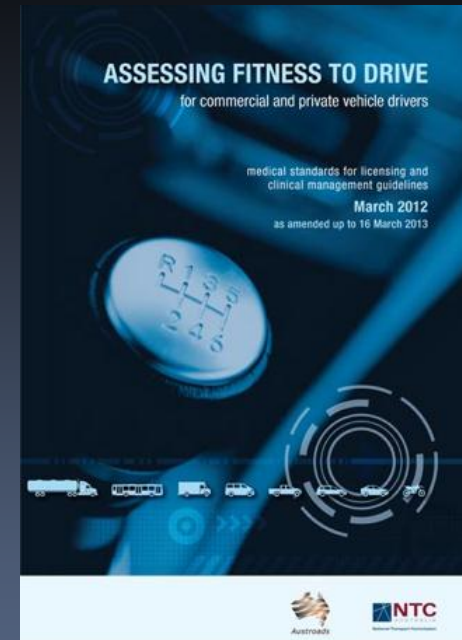
Meuser TM, *et al.* Driving and Dementia in Older Adults: Implementation and Evaluation of a Continuing Education Project. *The Gerontologist* 2006; 46:680-687.

Clinician Medical Guidelines

Mechanism to Update, Evidenced-Based, **Refer to Your Own State Guidelines



<http://www.cma.ca/driversguide>

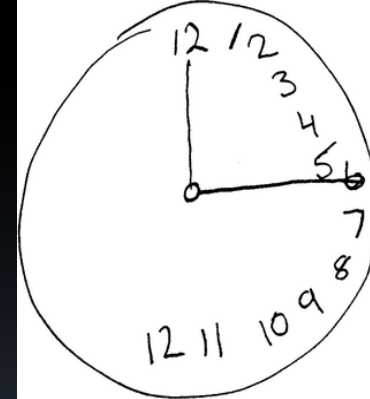


<http://www.austroads.com.au/assessing-fitness-to-drive/>

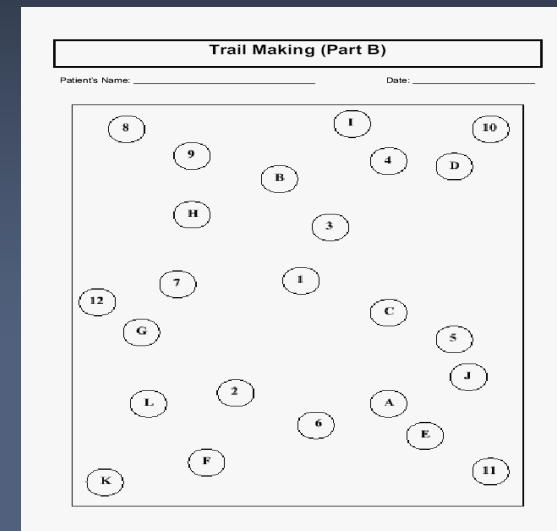
Our Case: Diabetes is under control with no end organ disease. However, the patient screens positive for dementia. She is referred to a subspecialty clinic.

Step 3a: Physical Examination

- Visual Acuity
- Visual Fields
- Contrast Sensitivity
- Cognitive Testing
 - Clock Drawing Task
 - Trail Making Tests A/B
 - Mazes
- Motor Examination
 - Muscle Strength
 - Range of Motion



Freund, B., Gravenstein, S., Ferris, R., et al.
Drawing clocks and driving cars.
J Gen Intern Med. 2005; 20:240–244



Our Case: The patient has an abnormal clock
Score of 2. The patient takes 70 seconds to complete
Trail Making Test A. She is unable to complete
Trail Making Test B.

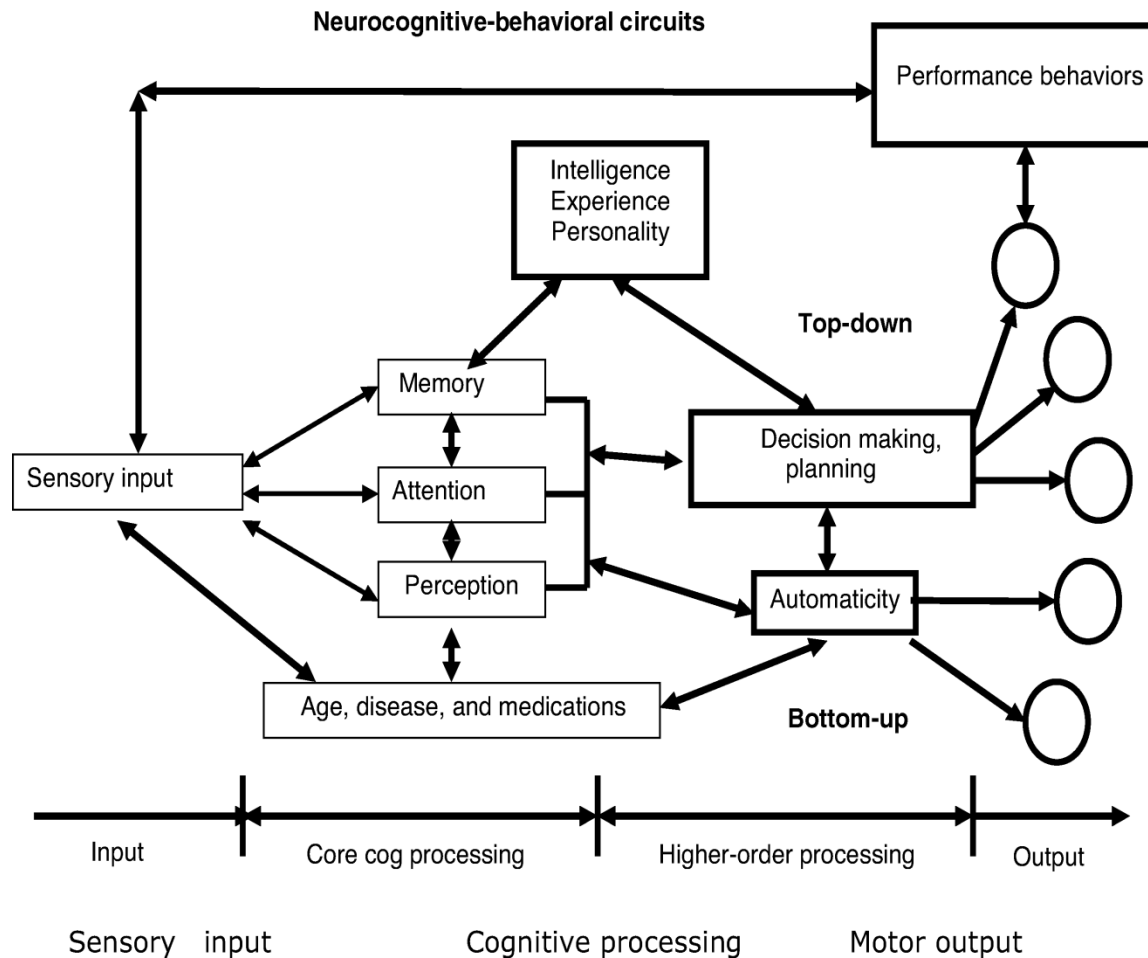
Mononita R and Molnar F. Systematic review
of the evidence for Trails B cut-off.

Canadian Geriatrics Journal 2013; 16: online



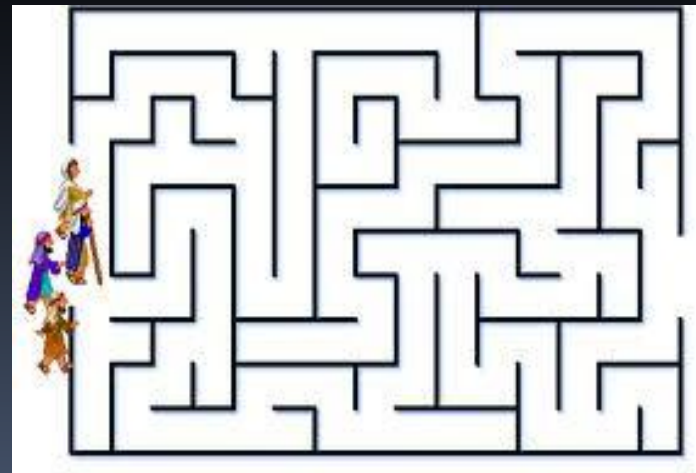
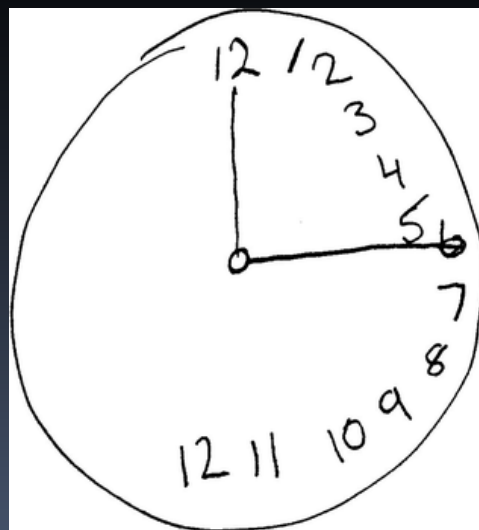
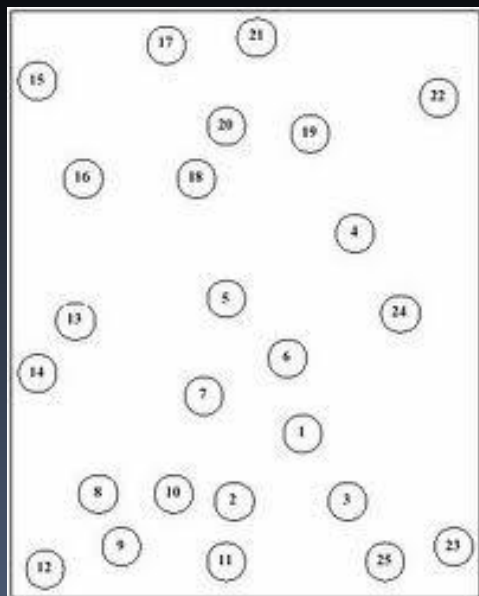
Step 3: Physical Exam Psychometric Performance

- **Interaction of basic and higher-order abilities in driving performance** Akinwuntan et al., *J Stroke Cerebrovasc Dis* 2012



Slides courtesy of Dr. Abiodun Akinwuntan with permission

Trails A Clock Drawing Snellgrove Maze®



Maze Task

- 1) Not language based
- 2) Not covered by Psychological Practice Acts
- 3) Supported by additional studies

For information about the Snellgrove Maze Task® please contact
Dr Carol Snellgrove at; carol.snellgrove@police.sa.gov.au

Computerized Tests of Driving Performance

The DrivingHealth Inventory with UFOV/DriveABLE

Peak valid *at-fault* OR

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

Staplin L, et al. MaryPODS revisited.
Journal of Traffic Safety, 2003: 389-397
Dobbs AR. Accuracy of DriveABLE.
Canadian Family Practice 2013; 59: e158-161.

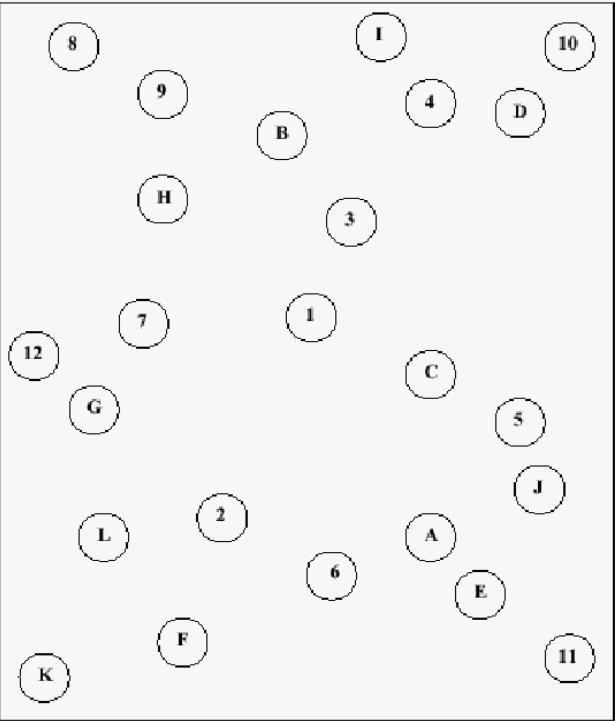


Trail Making Test, Part B

- Tests attention, working memory, visual processing, visuospatial skills, and psychomotor coordination
- Patient connects numbers and letters in alternating pattern
- Test is scored by time (sec) to complete and number of errors requiring correction
- Greater than 180 sec signals a need for intervention

Trail Making (Part B)

Patient's Name: _____ Date: _____



The grid contains 14 numbered and lettered circles arranged in a non-linear pattern. The numbers are 8, 9, 10, 4, 3, 7, 1, 5, 2, 6, 12, and the letters are B, H, I, C, G, A, E, J, L, F, K, 11. The sequence starts with 8, then 9, then 10, then 4, then 3, then 7, then 1, then 5, then 2, then 6, then 12, then B, then H, then I, then C, then G, then A, then E, then J, then L, then F, then K, then 11.

Mononita R and Molnar F. Systematic review of the evidence for Trails B cut-off Scores in assessing fitness-to-drive. *Canadian Geriatrics Journal* 2013; 16: online

Step 4: Rating Disease Severity/Function

Clinical Measure of Dementia Severity	No Dementia (CDR=0)	Questionable or Very Mild Dementia (CDR=0.5)	Mild Dementia (CDR=1.0)	Moderate to Severe Dementia (CDR=2.0)
For the Dementia Specialist: Clinical Dementia Rating	No memory loss or inconsistent memory loss Fully oriented Judgment intact Function intact Personal care intact	Consistent slight forgetfulness Slight difficulty with orientation or judgment Slight impairment in community activities or home activities Personal care intact	Memory loss interferes with everyday activities Geographic disorientation Moderate impairment in judgment Mild but definite impairment of community or home activities Needs prompting for personal care	Severe memory loss Severe difficulty with time relationships and judgment No longer independent in activities Only simple chores preserved Needs assistance in personal effects
For the Clinician: Short Blessed Test Mini-Mental Status Exam	N (SD) 1.2 (1.9) 28.9 (1.3)	N (SD) 4.8 (5.9) 23.1 (2.5)	N (SD) 15.4 (5.2) 20 (3.9)	N (SD) 18.5 (5.5) 16.1 (4.7)
For the Psychologist: Logical Memory	8.8 (2.9)	4.3 (2.7)	1.9 (1.7)	1.5 (2.3)
Block Design	30.1 (8.6)	22.2 (9.8)	12.0 (9.6)	3.2 (6.6)
Digit Symbol	45.6 (11.5)	31.7 (13.6)	17.0 (13.3)	8.3 (8.7)
Trailmaking A	40.9 (20.0)	70.2 (39.2)	108.3 (50.5)	???
Benton Copy	9.6 (.88)	9.1 (1.6)	7.3 (2.7)	???

Mobility and Safety Issues in Demented Drivers Carr DB and O'Neill D

Assessment of Dementia: AD8

- Detect change compared to previous level
 - No need for baseline assessment
 - Patients serve as their own control
 - Not biased by education, race, gender
- Brief (< 2 min), Yes/No format
 - 2 or more “Yes” answers highly correlated with presence of dementia

The *Eight-item Informant Interview to Differentiate Aging and Dementia (AD-8)* is a copyrighted instrument of the Alzheimer’s Disease Research Center, Washington University, St. Louis, Mo. The AD8 is not a substitute for clinical judgment.

Galvin JE, et al. A brief informant interview to detect dementia.
Neurology 2005; 65: 559-564

Alzheimer's Detection: AD8

Remember, "Yes, a change" indicates that you think there has been a change in the last several years cause by cognitive (thinking and memory) problems	YES, A change	NO, No change	N/A, Don't know
Problems with judgment (e.g. falls for scams, bad financial decisions, buys gifts inappropriate for recipients)			
Reduced interest in hobbies/activities			
Repeats questions, stories or statements			
Trouble learning how to use a tool, appliance or gadget (e.g. VCR, computer, microwave, remote control)			
Forgets correct month or year			
Difficulty handling complicated financial affairs (e.g. balancing checkbook, income taxes, paying bills)			
Difficulty remembering appointments			
Consistent problems with thinking and/or memory			
TOTAL AD8 SCORE			

NACC Uniform Data Set (UDS) – Initial Visit Packet
Form B7: Functional Assessment – Functional Assessment Questionnaire (FAQ¹)

Center: _____ ADC Subject ID: _____ Form Date: ___/___/____ ADC Visit #: _____

NOTE: This form is to be completed by the clinician or other trained health professional, based on information provided by informant. For additional clarification and examples, see UDS Coding Guidebook for Initial Visit Packet, Form B7. Indicate the level of performance for each activity by circling the one appropriate response.

Examiner's initials: _____

In the past four weeks, did the subject have any difficulty or need help with:

	Not applicable (e.g., never did)	Normal	Has difficulty, but does by self	Requires assistance	Dependent
1. Writing checks, paying bills, or balancing a checkbook.	8	0	1	2	3
2. Assembling tax records, business affairs, or other papers.	8	0	1	2	3
3. Shopping alone for clothes, household necessities, or groceries.	8	0	1	2	3
4. Playing a game of skill such as bridge or chess, working on a hobby.	8	0	1	2	3
5. Heating water, making a cup of coffee, turning off the stove.	8	0	1	2	3
6. Preparing a balanced meal.	8	0	1	2	3
7. Keeping track of current events.	8	0	1	2	3
8. Paying attention to and understanding a TV program, book, or magazine.	8	0	1	2	3
9. Remembering appointments, family occasions, holidays, medications.	8	0	1	2	3
10. Traveling out of the neighborhood, driving, or arranging to take public transportation.	8	0	1	2	3

¹ Pfeffer RI, Kurosaki TT, Harrah CH, et al. Measurement of functional activities of older adults in the community. *J Gerontol* 37:323-9, 1982. Copyright© 1982. The Gerontological Society of America. Reproduced by permission of the publisher.

The 4 C's: Screening Tool for At- Risk Drivers

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

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

CRASH/CITATION (past two years)	CONCERN (Family Report)	CLINICAL STATUS (Medical History)	COGNITION (Family Report and Clinical Impressions)
1. No crashes/citation	1. No driving concerns	1. Overall good health	1. Intact cognition
2. One or more fender bender	2. Mild concerns: family has talked with patient about driving safety	2. Medical condition/mild impact on vision, attention, motor (e.g., frailty, arthritis, neuropathy)	2. Mild cognitive decline/ Intact daily functions
3. Citation for dangerous violation	3. Moderate concerns: family restricts patient from driving with passengers	3. Medical issues/moderate impact on vision, attention, motor (e.g., stroke, early stage Alzheimer's disease, Parkinson's disease, multiple sclerosis)	3. Moderate cognitive decline/decline in daily functions
4. Crash or crashes	4. Extreme concerns: family wants patient to stop driving immediately	4. Medical issues/severe impact on vision, attention, motor (e.g., advanced Alzheimer's disease, Parkinson's disease, multiple sclerosis)	4. Severe cognitive decline/dependence on others for daily functions

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

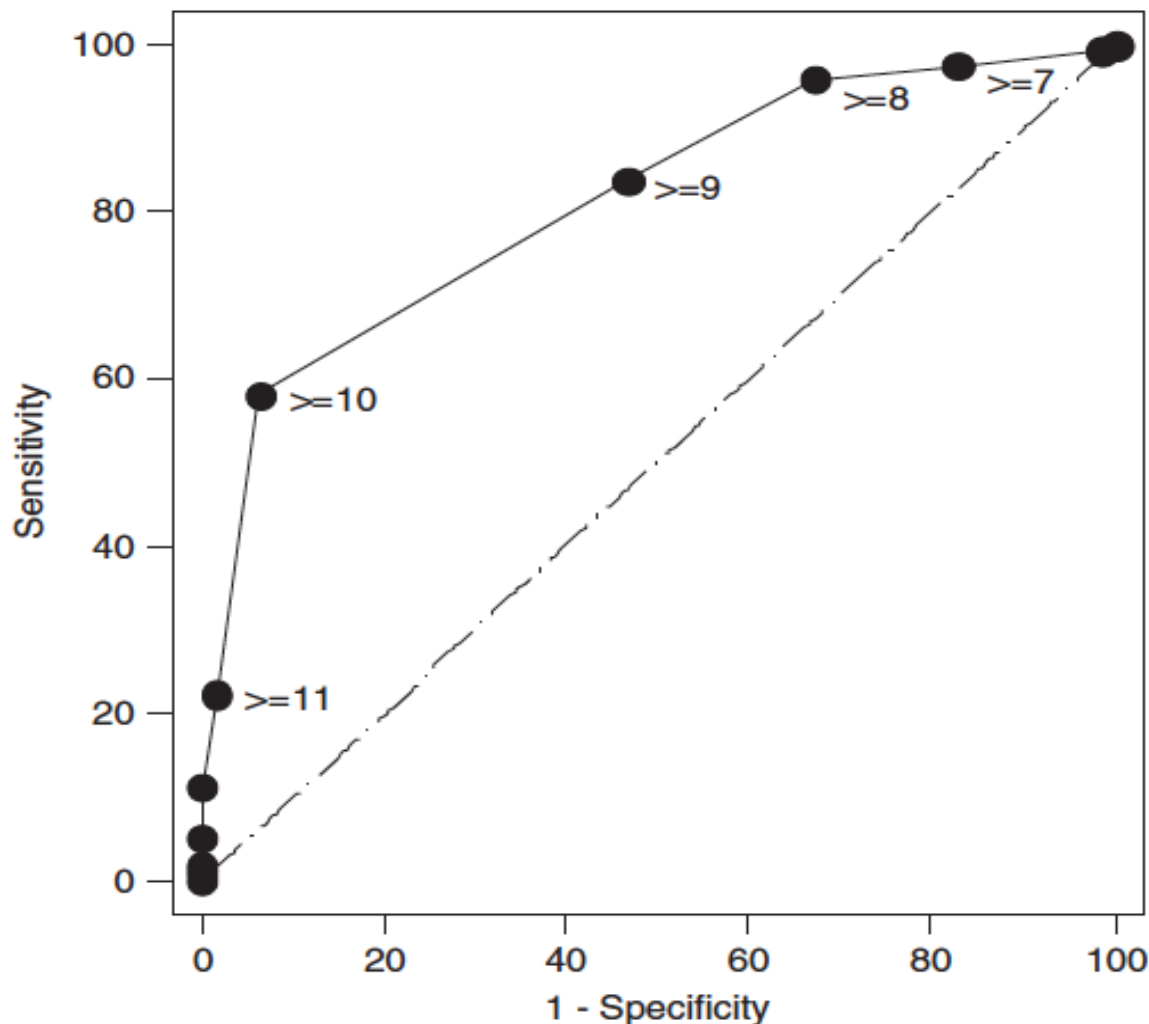
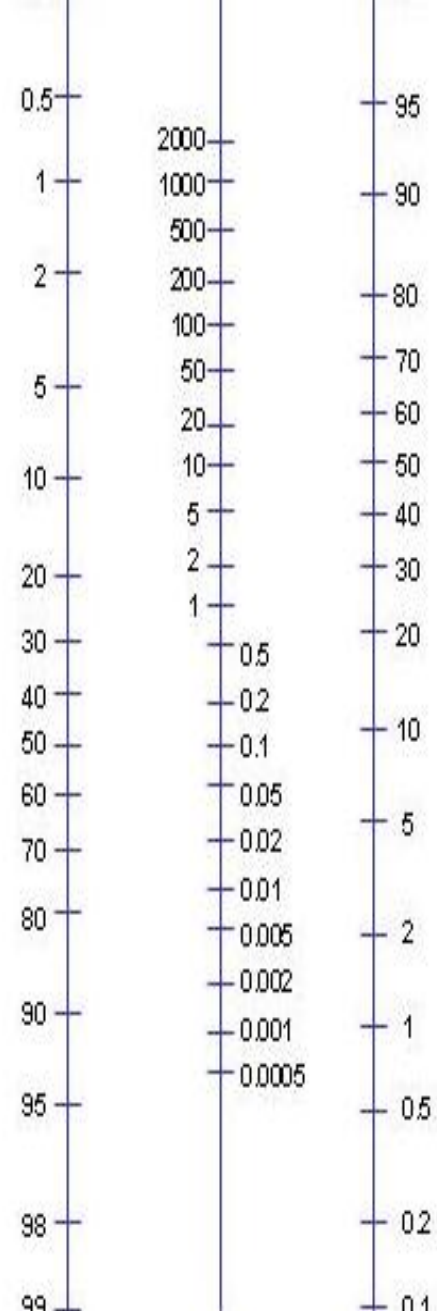


Figure 2. Receiver operating characteristic curve for total 4Cs score. The outcome is a final clinical rating of fail or marginal versus pass. The predictor is the total 4Cs score. Selected cut points are noted.

Likelihood Ratios

- LR+ is simply the % of “sick” people with a given test result divided by the % of “well” people with same result
- Ex: $LR+ = \text{Sens}/(1-\text{Spec})$: LR+ 2-5 small, 5-10 moderate, >10 large ↑
- Ex $LR- = (1-\text{Sens})/\text{Spec}$: LR- .2-.5 small, .1-.2 moderate, < .1 large ↓
- Predictive values of tests are driven by the prevalence of dx
- Best when prior probability 30-70%
- Uses all four cells of the 2x2 table, can apply to a specific patient
- 95% confidence intervals can calculate the precision of the estimate.

Grimes DA, Schulz KF. Refining clinical diagnosis with likelihood ratios. *Lancet* 2005; 365: 1500-5



Dementia Model 1: HIGH Probability of Failure >82 %

Based on Trails A, CDT-F, and AD-8 scores

“You can’t drive, no road test needed”

	Unfit to Drive (Fails Road Test)	Fit to Drive (Passes Road Test)	
Test Combo \geq .82	a (37)	b (1)	a + b (38)
Test Combo $<$.82	c (26)	d (33)	c + d (59)
	a + c (63)	b + d (34)	97T

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

Sensitivity (TPF)= $a/(a+c) = 59\%$

Specificity= $d/(b+d) = 97\%$

LR +: 19.7

NOTE: 38% of sample characterized (high specificity/low false +)
37 patients correctly ID as unfit, 1 incorrectly classified

Dementia Model 1: LOW Probability of Failure <30%

Based on Trails A, CDT-F, and AD-8 scores

“You can drive: No road test needed”

	Unfit to Drive (Fails Road Test)	Fit to Drive (Passes Road Test)	
Test Combo \geq .3	a (62)	b (23)	a + b (85)
Test Combo < .3	c (1)	d (11)	c + d (12)
	a + c (63)	b + d (34)	97T

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

Sensitivity (TPF)= $a/(a+c) = 98\%$

Specificity= $d/(b+d) = 32\%$

LR-: .06

NOTE: 12% of sample characterized (high sensitivity, low false -)
11 patients correctly ID as fit, 1 incorrectly classified

Probability of Failing Road Test Calculator

Probability of Failing Driver Test

	Intercept	trlA	AD8TOT	CDTf			
coefficient	-1.7594	0.0283	0.5516	-0.3643			
Observed Value	<table border="1"> <tr> <td>70</td> <td>5</td> <td>2</td> </tr> </table> <p>Change values in box above.</p>				70	5	2
70	5	2					
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?

$$Prob(\text{Fail}) = \frac{e^{X\beta}}{1 + e^{X\beta}}$$

where

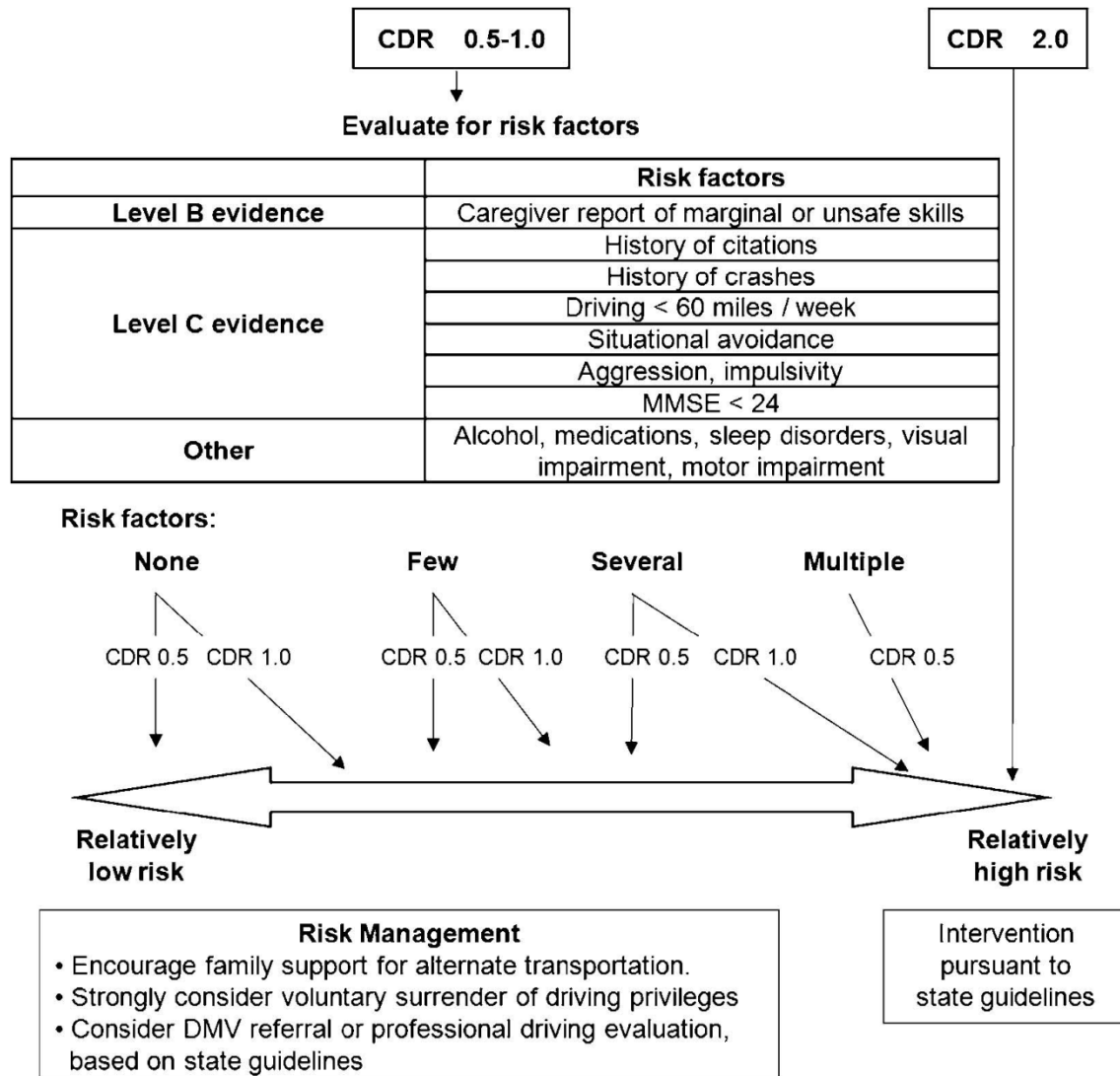
Carr DB, Barco PP, et al. JAGS 2011

$$X\beta = -1.7594 + (0.0283 * TRLA) + (-0.3643 * CDTF) + (0.5516 * AD8TOT)$$

and

$$e = 2.718282.$$

Algorithm: Evaluating Driving Risk



Algorithm

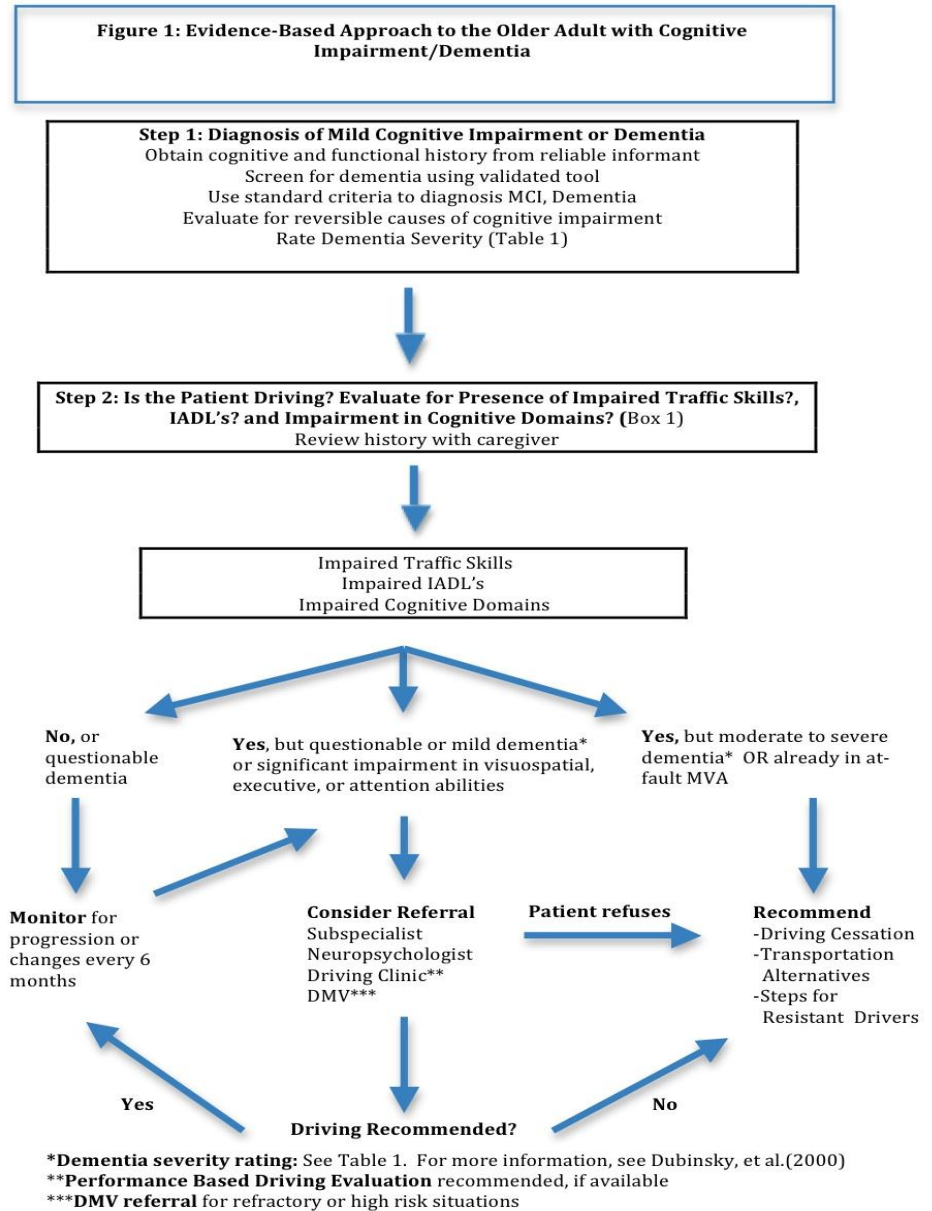
CLINICIAN'S CARE OF THE AGING PATIENT: FROM EVIDENCE TO ACTION

THE OLDER ADULT DRIVER WITH COGNITIVE IMPAIRMENT:

"It's a Very Frustrating Life"

David B. Carr, MD
Brian R. Ott, MD

B. Carr, MD. Brian R. Ott, MD.
JAMA 2010; 303: 1632-1641



Step 5: Referral and Counseling

- **Green Light**

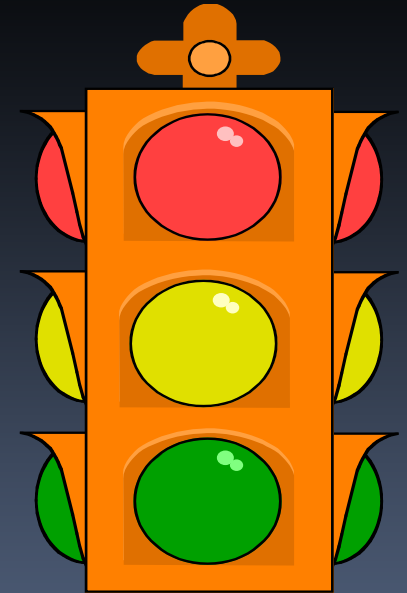
- No red flags
- Monitor at intervals
- Full speed ahead!

- **Yellow Light**

- Red flags/co-morbid illnesses
- Decline in traffic skills
- Deficits on office screening
- Consider referral and caution!
- Driving Rehab Specialist

- **Red Light**

- Driving Retirement/Counseling
- **Stop! Case Manager, MSW!**



Referral

- Primary Care
- Subspecialist
- Neuropsychologist
- Occupational Therapists
- Driving Specialist

Table 3. Predictive Value of Ratings by Participant, Informant, and Physician for the Categorical Rating of “Safe” by Driving Instructor

Rater Characteristic	Participant Self-Rating	Informant Rating	Physician Rating
		%	
Sensitivity	100	81.8	90.9
Specificity	10.7	47.8	60.7
Positive predictive value	46.7	60.0	64.5
Negative predictive value	100	73.3	89.5
Correctly classified	53.2	64.4	74.0

Prediction of On-Road Performance in Patients with Early Alzheimer’s Disease.
Brown LB, Ott BR, Papandonatos GD, et al. JAGS; 2005; 53; 94-98

A Driver Rehabilitation Specialist

- One who plans develops, coordinates and implements driving services for individuals with disabilities
- These individuals are often Occupational Therapists with specialized training in driver assessment and rehabilitation



Disabilities and Driving Aids

Lack of range of motion--neck

- Wide angle mirrors or additional rear and side mirrors

Nonfunctional lower extremity

- restraint for disabled leg, hand-operated parking brake, automatic transmission

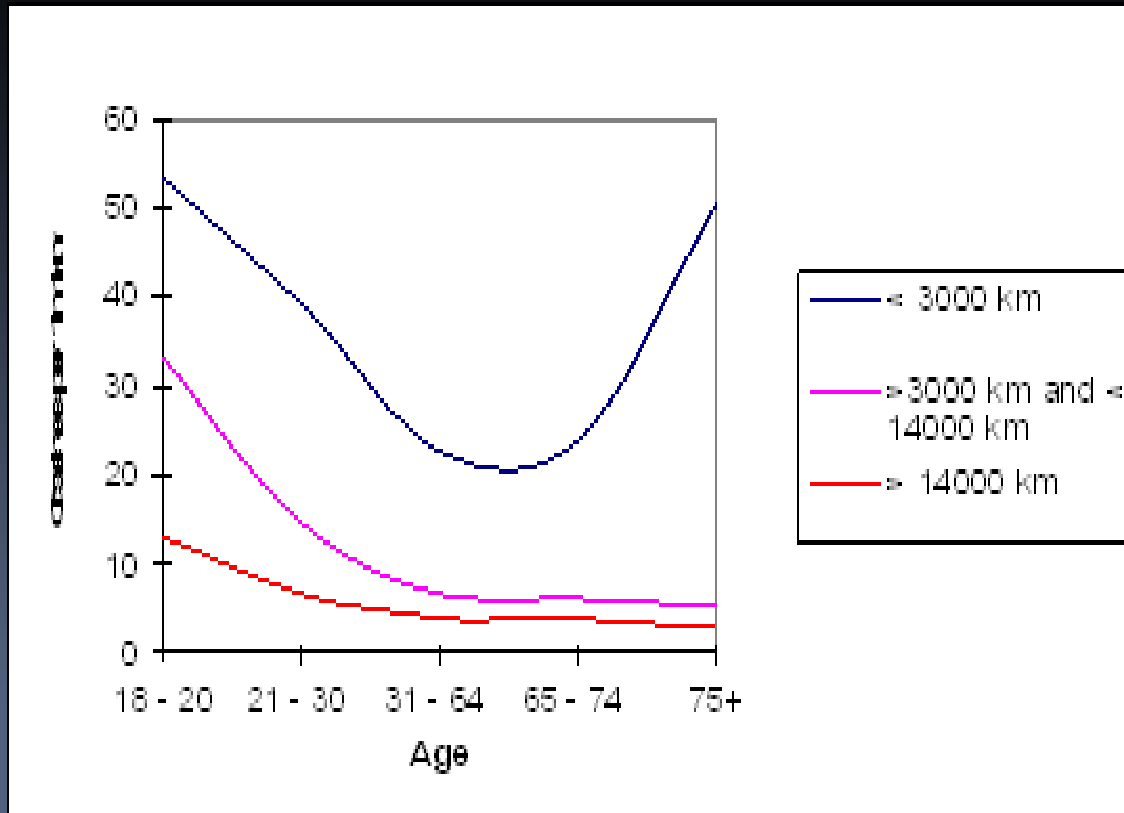
All or partial loss strength on 1 side of body

- spinner knob, left foot accelerator, right-side turn signal



Photograph courtesy of
Rod Schmall

WHICH TYPE OF OLDER ADULT IS AT RISK?



Langford J, et al. 2006 Accident Analysis and Prevention, 28(3), pp. 574-578

IS DRIVING RESTRICTION THE ANSWER?



Restrictions based on speed, radius, time of day, time per trip, in-vehicle technologies... Most older adults would accept restriction. Very few (<5%) have restricted licenses.

Not clear whether license restriction or the natural reduction in exposure with aging is cause for crash reduction. It is also not clear how to enforce restriction with dementia.

Nasvadi GC and Wister A. Do Restricted Driver's License Lower Crash Risk Among Older Drivers. *The Gerontologist* 2008 49; 474-484.

REMOVING THE RESISTANT DRIVER

- Ask physician to “prescribe” driving retirement orally/writing
- Focus on other medical conditions as the reason to stop driving
 - (e.g. vision too impaired, reaction time too slow)
- Use a contract (see THE HARTFORD At the Crossroads guide)
- Vehicle-Related Tactics
 - Hiding/filing down keys
 - Replacing keys
 - Do not repair the car/ send car for “repairs” but do not return
 - Remove the car by loaning, giving or selling
 - Disable the car
- Discuss financial implications of crash or injury
- Revoke license

When Should You Refer to the State?



MISSOURI DEPARTMENT OF REVENUE
 DRIVER LICENSE BUREAU, P.O. BOX 200
 301 WEST HIGH STREET, ROOM 470
 JEFFERSON CITY, MO 65105-0200
DRIVER CONDITION REPORT

Reset

Print

TELEPHONE: (573) 751-2730
 FAX: (573) 522-8174
 WEB SITE: www.dor.mo.gov

FORM
4319
 (REV 8-2006)

Please complete the Driver Condition Report if you have personal knowledge about a driver you believe is no longer able to safely operate a motor vehicle.

- ▶ You should report only your firsthand knowledge of the driver.
- ▶ You should complete the entire form and sign your name on the reverse side.
- ▶ After reviewing this report, the Director of Revenue may require the driver to take certain tests such as a medical, vision or driving test.
- ▶ All information contained in this report shall be kept confidential, unless released by a court order.

PERSONAL INFORMATION ON PERSON BEING REPORTED:

Please complete all available information.

NAME (LAST, FIRST, MIDDLE)		SOCIAL SECURITY NUMBER OR DRIVER LICENSE NUMBER	
LICENSE PLATE NUMBER	STATE OF ISSUANCE	DATE OF BIRTH	TELEPHONE NUMBER
ADDRESS		CITY	STATE ZIP CODE

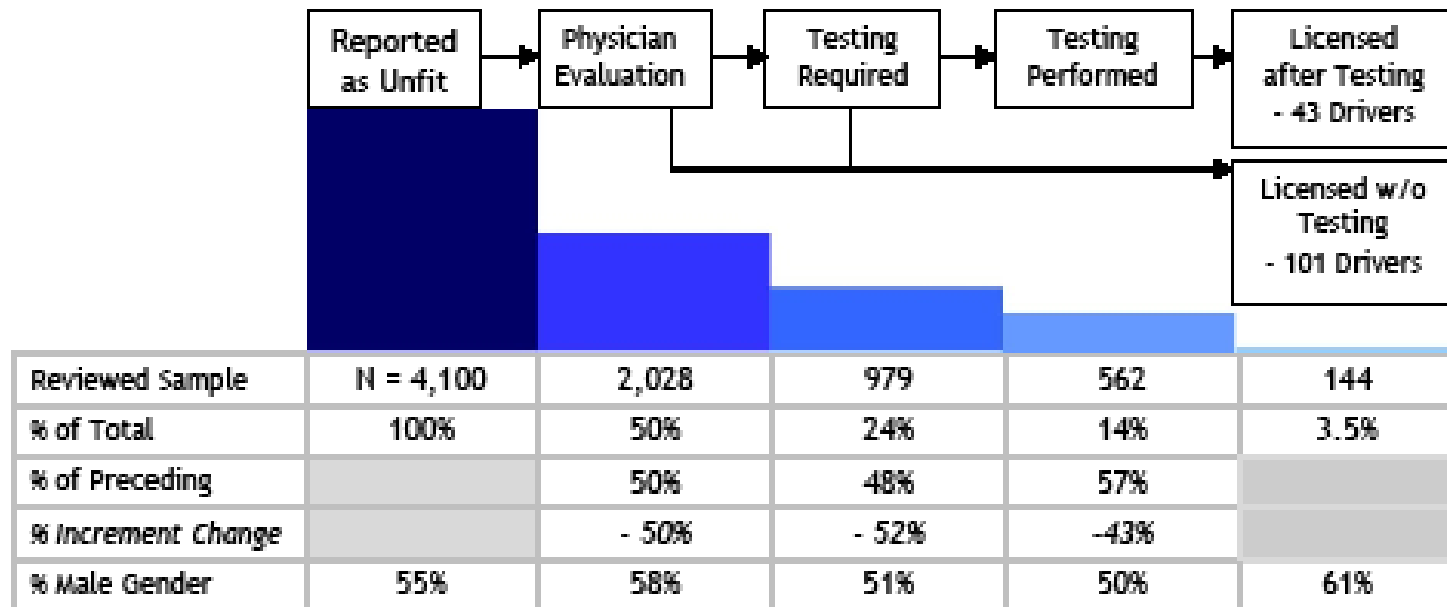
Describe in detail incidents or conditions about this driver. Give specific information such as dates, places, accident reports and all other available information to support the need for re-examination. You should report only information of which you have personal knowledge or physical evidence. Do not report what you have been told or heard.

DRIVER BEHAVIOR



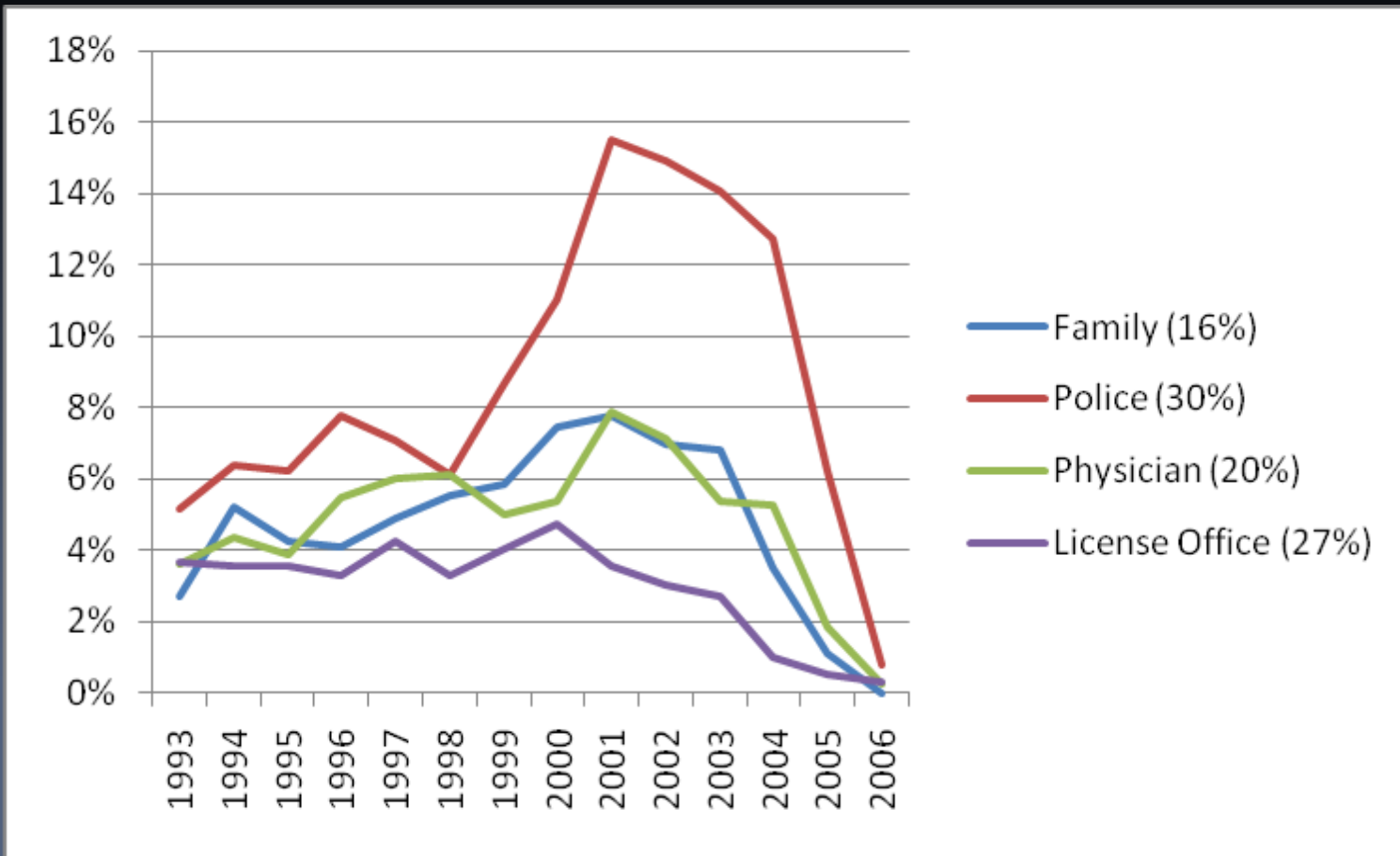
Please check appropriate boxes based on personal knowledge of incident if applicable. Please give a detailed description of incident. Age alone is not a sufficient reason for retesting.

SUMMARY OF LICENSING OUTCOMES



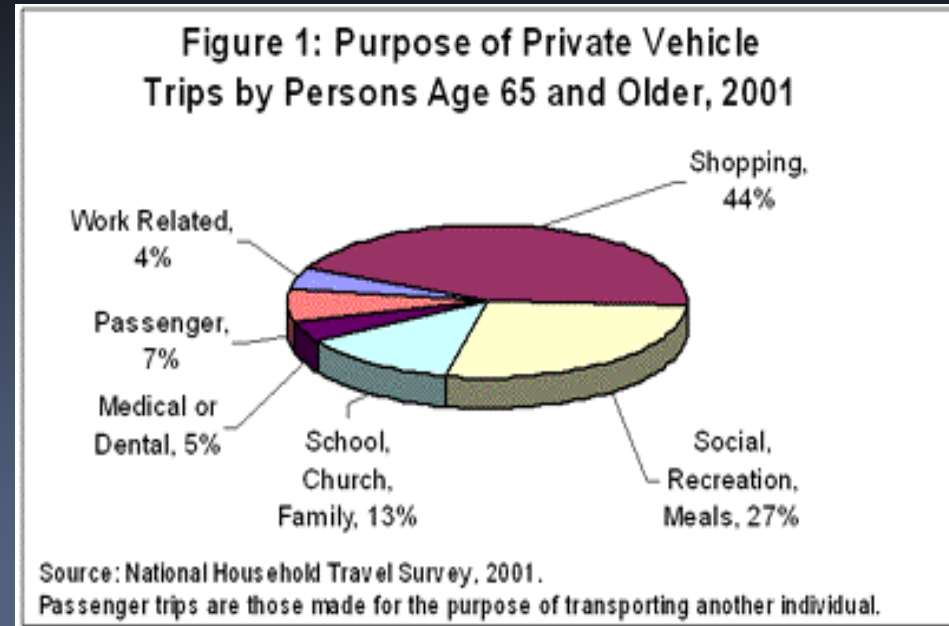
Meuser T, Carr DB, Ulfarsson GF. Motor-Vehicle Crash History and Licensing Outcomes for Older Drivers Reported as Medically Impaired in Missouri Accident Analysis & Prevention. *Accident Analysis & Prevention* 2009; 41: 246-52

Crash Involvement by Report Source



The Importance of the Automobile

- The Transportation Method of Choice
- Autonomy
- Identity
- Social Connectedness
- Psychological and Physical Health Correlates
- Private cars account for over 90% of trips made by seniors



Mobility Counseling Transportation Alternatives



- St. Louis Options
 - Social Work Referral
 - CORP
 - Call-A-Ride
 - Good Shepherd
 - Metro
 - Bus
 - Taxi
 - ITNAmerica
 - Other



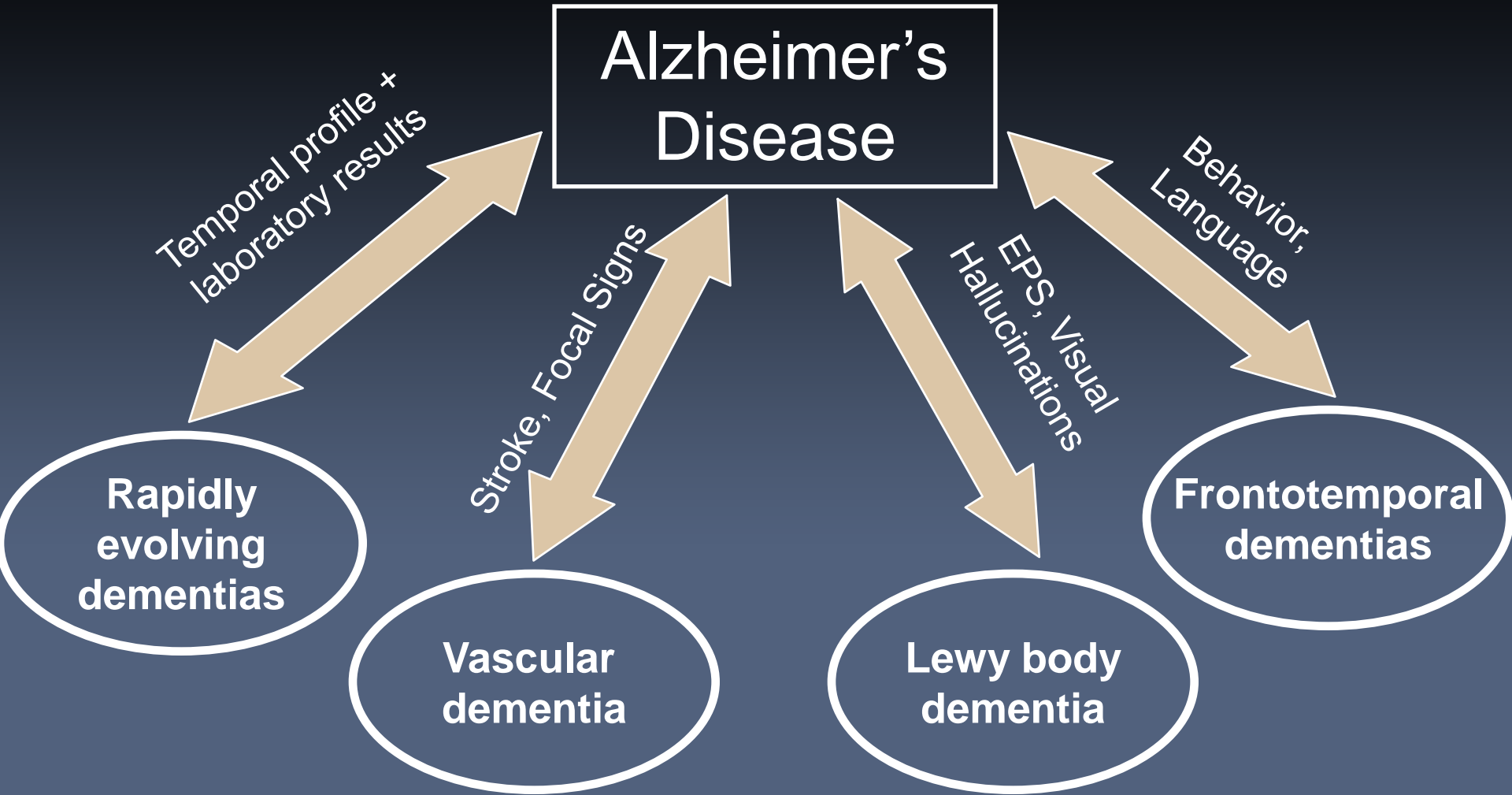


SUMMARY: STEPS TO CONSIDER



- Consider driving in the context of the disease
- Consider involving your physician or specialist
- Consider referral to a driving clinic
- Consider referral to the state DMV's
- Consider list of resources/handouts
- Consider self-help courses (AARP, AAA, etc)
- Consider transportation alternatives

CLUES TO SPECIFIC NEURODEGENERATIVE DISEASES



Driving Longitudinal Studies

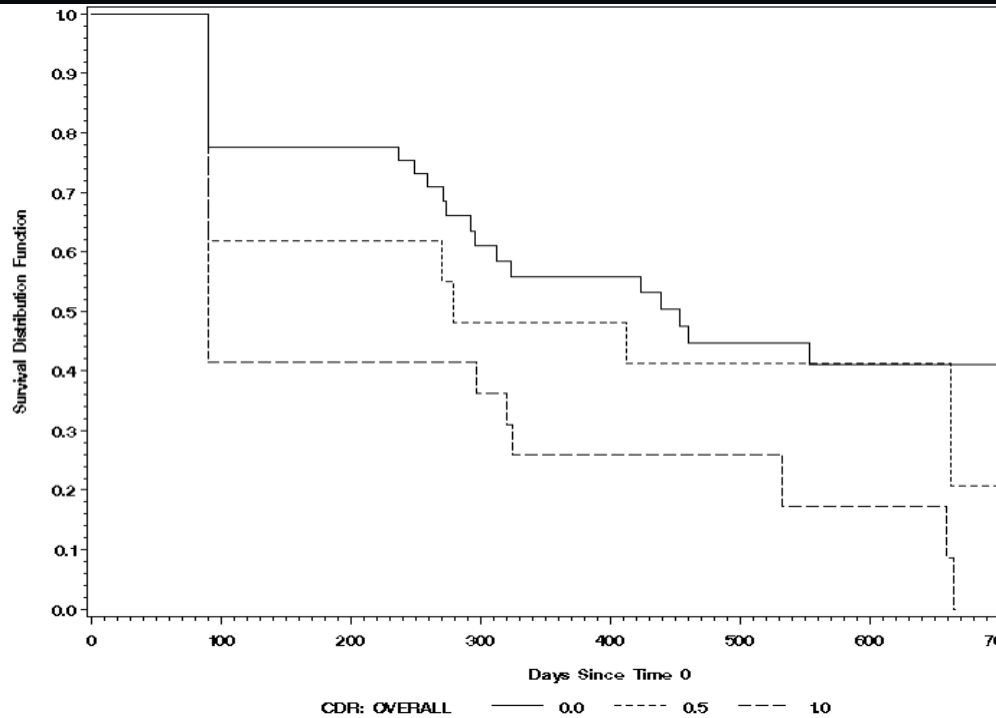
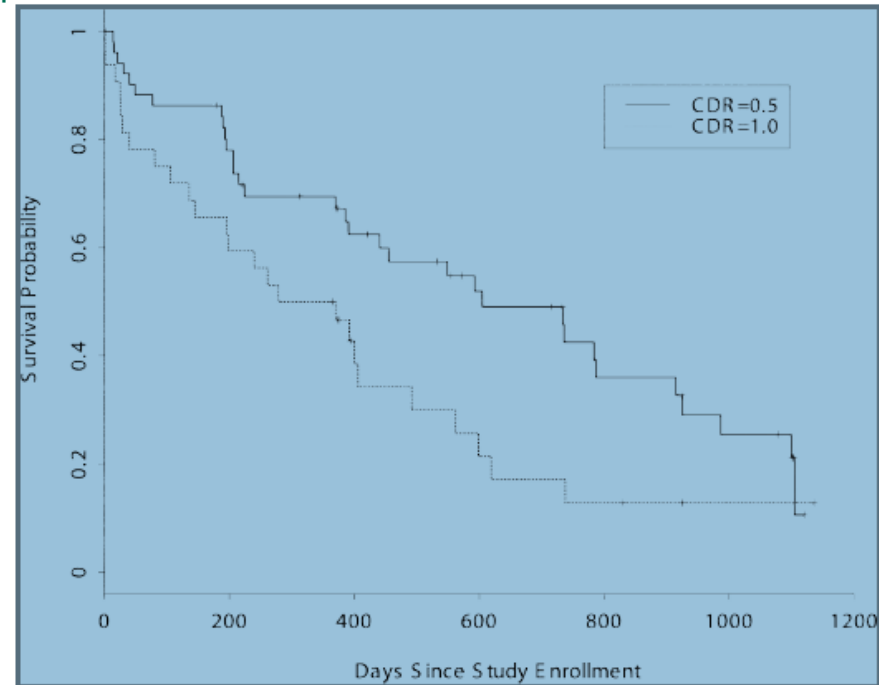


Figure Survival plot

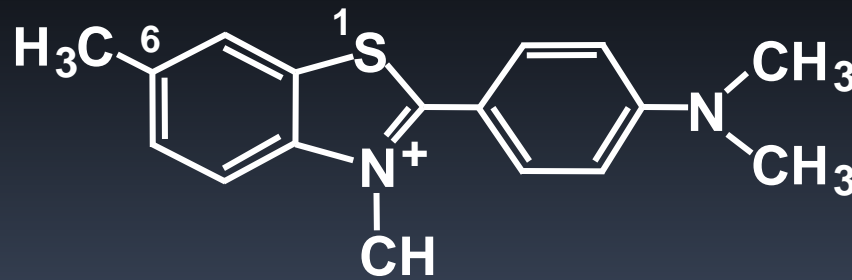
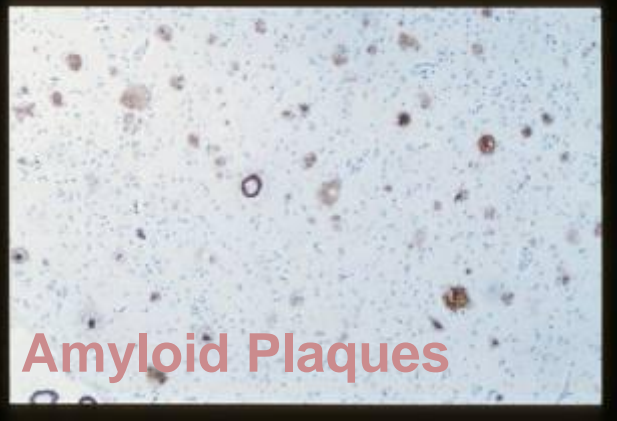


Time to driving restriction among patient group due to failure on road tests, at-fault motor vehicle accidents, or dementia progression.

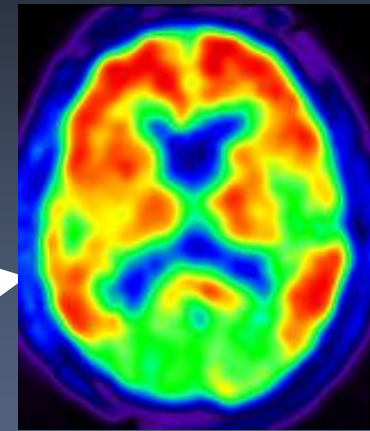
Duchek JM, Carr DB, Hunt L, et al.
Longitudinal performance in early-stage dementia
Of the Alzheimer's type. JAGS 2003; 51: 1342-7.

Ott BR, Heinel WC, Papandonatos GD, et al.
A Longitudinal Study of Drivers with AD. Neurology
2008; 70: 1171-8

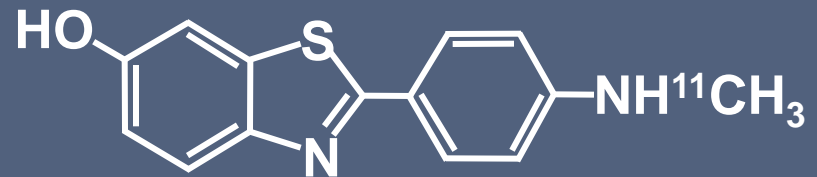
In vivo Amyloid Imaging Pittsburgh Compound B (PIB) (Klunk et al, Ann Neurol 2004)



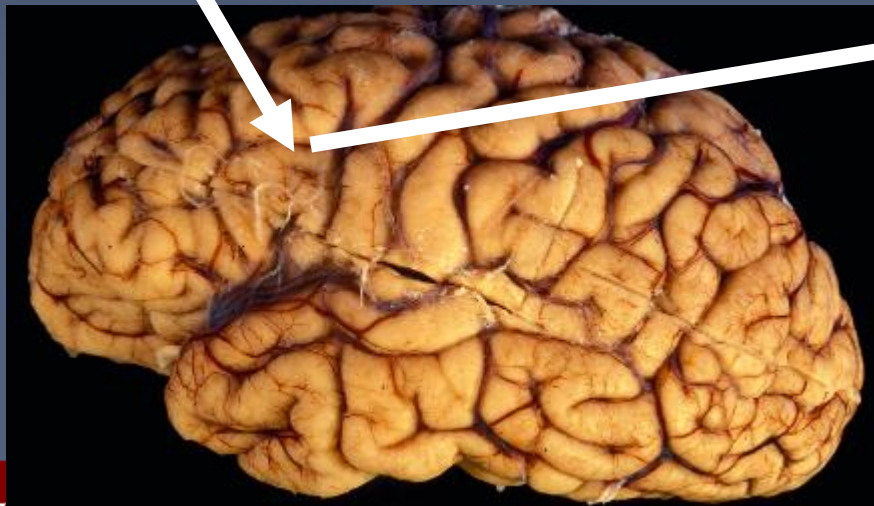
Histology - Thioflavin T



PET Imaging -
[¹¹C]6-OH-BTA-1 (PIB)



Courtesy of William Jagust



Fitness-to-Drive in Older Adults

Funded by the Division of Highway Safety/MoDOT 2007-2014

Core Team WUSTL

Peggy Barco, MS, OTR/L, BSW

PI and Co-PI WUSM

Instructor

Program of Occupational Therapy

Mike Wallendorf, PhD

Statistician

ADRC

Cathy Roe, PhD

PI/Research Assistant Professor

Knight ADRC

Annie Johnson

Project Coordinator, CCS

Katie Rutowski, BS, OTR/L, RA

Core Team WUSTL

Lily Hu, PhD

System Analyst and RedCap Database

Program of Occupational Therapy

TRISL

Kathy Dolan, OTR/L

Pat Storie, COTA

Jefferson Barracks VA

Pat Niewoehner, OTR/L

UMSL

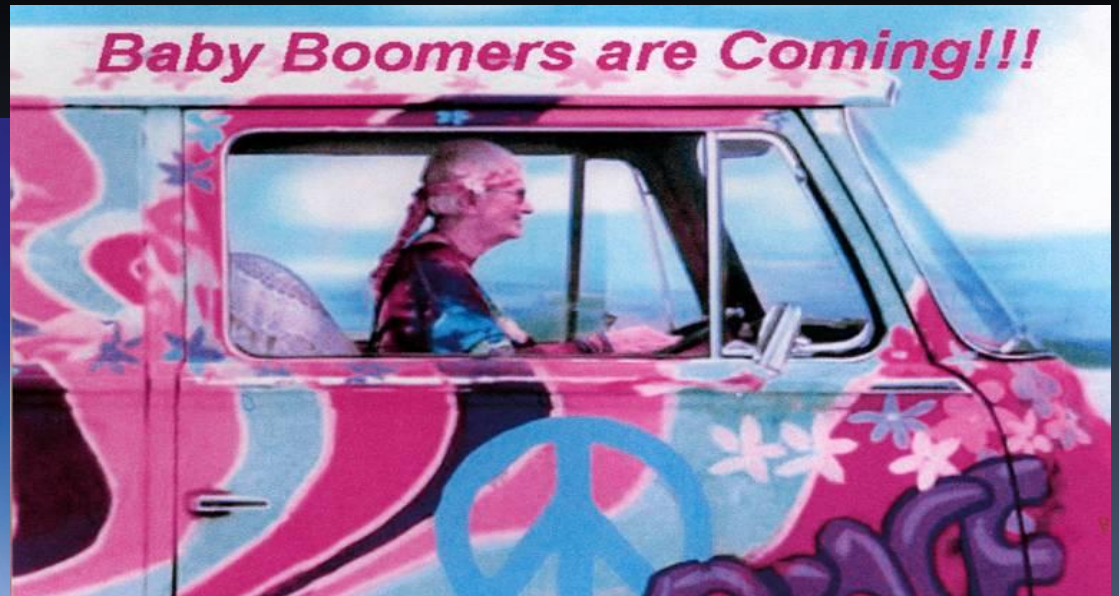
Tom Meuser, PhD

Collaborators

Brian Ott, MD Brown

Abiodun Akiwantun, PhD GMC

Contact Information/Discussion



David Carr, MD
dcarr@wustl.edu

