Stroke and Commercial Motor Vehicle Driver Safety

Findings of Evidence Report

Presented by

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Stroke and Potential Crash Risk

- Stroke: a sudden neurological deficiency resulting from cerebral infarction or hemorrhage
  - Stroke has the potential to impair cognitive and motor skills required for safe driving
- Transient ischemic attack (TIA): a brief episode of neurological deficit, having a vascular cause that resolves without any residual effect within 24 hours
  - Individuals who have had a TIA may also be at greater risk for a subsequent stroke

Stroke and CMV Driving Regulations

- Potential risk to public safety requires regulation
  - Do individuals who have experienced a stroke present a threat to road safety?
  - Should these individuals be precluded from driving a CMV?

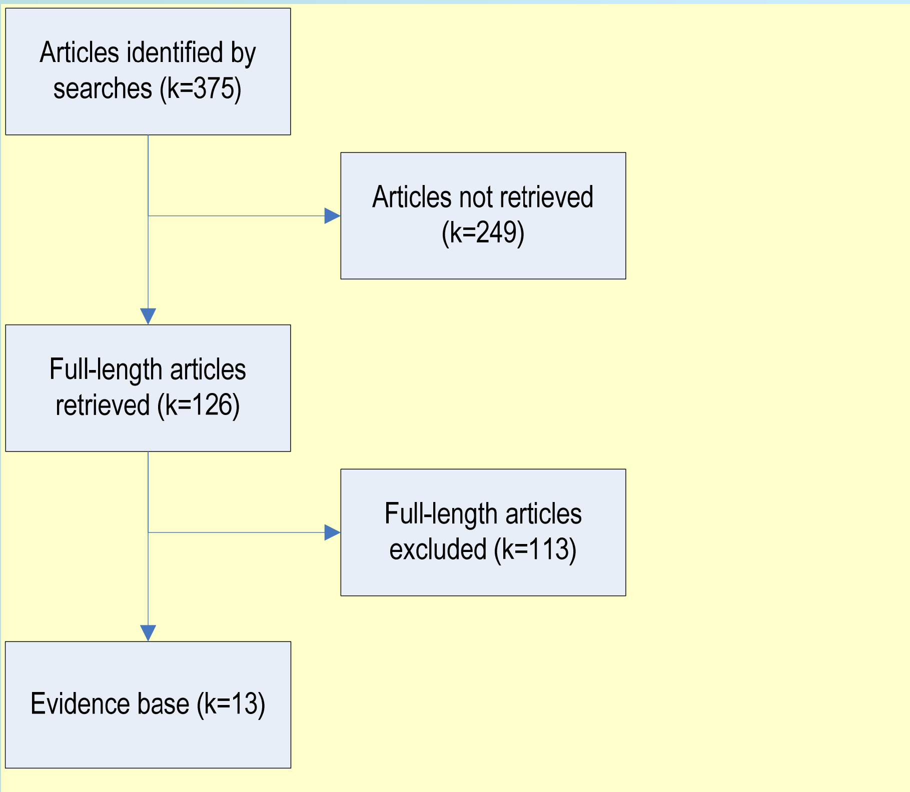
Key Questions

- **Key Question 1**
  - Among individuals who have experienced a TIA, what is the risk of experiencing a future stroke?
- **Key Question 2**
  - Are individuals who have experienced a stroke at an increased risk for a motor vehicle crash (crash risk or driving performance)?
- **Key Question 3**
  - If so, can neuropsychological testing of individuals who have experienced a stroke predict crash risk?

Searches

Name of database	Date limits	Platform/provider
CINAHL (Cumulative Index to Nursing and Allied Health Literature)	Through January 10 2008	OVID
Cochrane Library	Through 2007 Issue 4	www.thecochranelibrary.com
Embase (Excerpta Medica)	Through January 10 2008	OVID
Medline	Through September 12 2007	OVID
PubMed (Pre Medline)	Searched January 10 2008	www.pubmed.gov
TRIS Online (Transportation Research Information Service Database)	Searched December 18 2007	http://trisonline.bts.gov/search.cfm
PsycINFO	Through January 10 2008	OVID
National Guideline Clearinghouse™ (NGC™)	Searched December 13 2007	www.ngc.gov
Health Technology Assessment Database (HTA)	Through 2007 Issue 4	www.thecochranelibrary.com

Key Question 1: Risk of Stroke Following Transient Ischemic Attack



- 13 studies included
- None specifically enrolled CMV drivers

Key Question 1: Study Characteristics

- 8 case-control studies, 5 cohort studies
- Case-controls compared prevalence of TIA among individuals who had or had not experienced a stroke
- Cohorts compared incidence of stroke among individuals who had or had not experienced a TIA
- Most studies included patients with recurrent TIAs

Key Question 1: Study Characteristics

- Most studies assessed all types of strokes; 1 study included only ischemic stroke, 1 included only hemorrhagic stroke
- Follow-up of individual patients varied considerably between studies (2 days to 28 years)

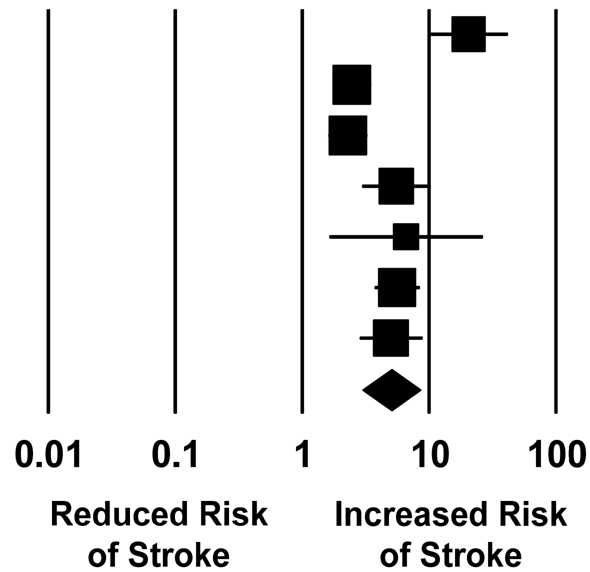
Key Question 1: Study Quality

- Overall quality of case-control studies was low
- Overall quality of cohort studies was moderate
- Because case-control and cohort studies used different effect size measures (odds ratios vs. risk ratios) and differed in quality, they were analyzed separately

Key Question 1: TIA and Stroke - Results (Case-Control Studies)

Study name	Statistics for each study				
	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value
Hajat 2004	20.500	10.008	41.991	8.256	0.000
Rodgers 2004	2.460	1.726	3.506	4.981	0.000
Champvallins 2001	2.290	1.595	3.289	4.489	0.000
Kaarisalo 2000	5.516	2.944	10.337	5.329	0.000
Zodpey 2000	6.580	1.622	26.698	2.637	0.008
Whisnant 1996	5.600	3.690	8.498	8.096	0.000
Herman 1983	5.016	2.816	8.932	5.477	0.000
Summary	**NC**	**2.965**	**8.360**	**6.069**	**0.000**

Odds ratio and 95% CI



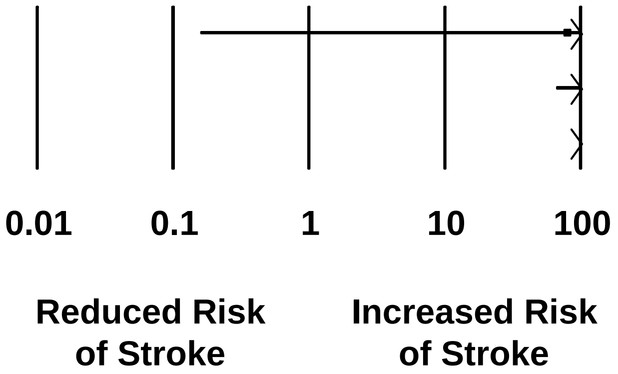
Key Question 1: TIA and Stroke – Results (Cohort Studies)

1 month risk of stroke following TIA

Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value
Dennis 1990	80.000	0.157	40751.395	1.378	0.168
Whisnant 1987	119.403	65.378	218.071	15.562	0.000
Summary	**NC**	**65.318**	**216.659**	**15.623**	**0.000**

Statistics for each study

Risk ratio and 95% CI

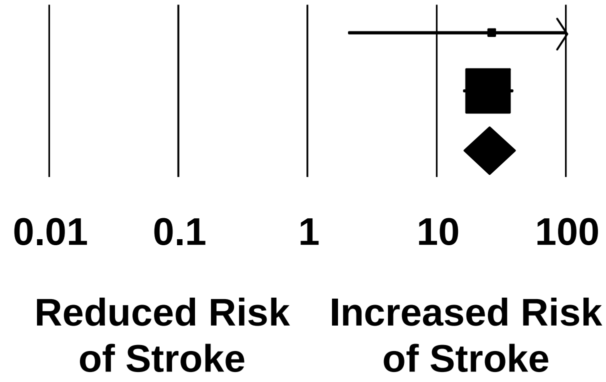


Key Question 1: TIA and Stroke – Results (Cohort Studies)

6 month risk of stroke following TIA

Study name	Statistics for each study				
	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value
Dennis 1990	26.667	2.043	348.142	2.505	0.012
Whisnant 1987	25.000	15.838	39.463	13.820	0.000
Summary	**NC**	**15.981**	**39.264**	**14.046**	**0.000**

Risk ratio and 95% CI

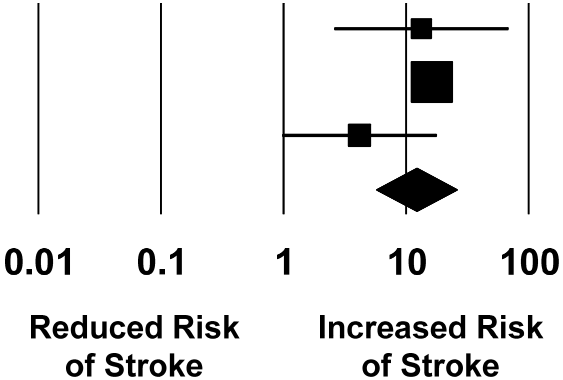


Key Question 1: TIA and Stroke – Results (Cohort Studies)

1 year risk of stroke following TIA

Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value
	Statistics for each study				
Dennis 1990	13.333	2.569	69.191	3.083	0.002
Whisnant 1987	16.250	11.033	23.934	14.113	0.000
Howard 1994	4.167	0.968	17.932	1.917	0.055
Summary	**12.018**	**5.657**	**25.529**	**6.468**	**0.000**

Risk ratio and 95% CI



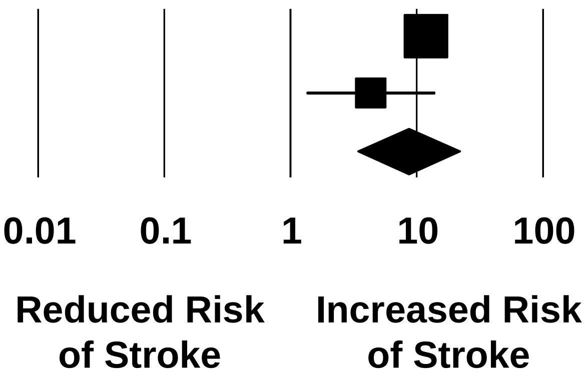
Key Question 1: TIA and Stroke – Results (Cohort Studies)

2 year risk of stroke following TIA

Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value
Whisnant 1987	11.875	8.738	16.137	15.813	0.000
Howard 1994	4.333	1.328	14.137	2.431	0.015
Summary	**NC**	**3.345**	**21.540**	**4.502**	**0.000**

Statistics for each study

Risk ratio and 95% CI

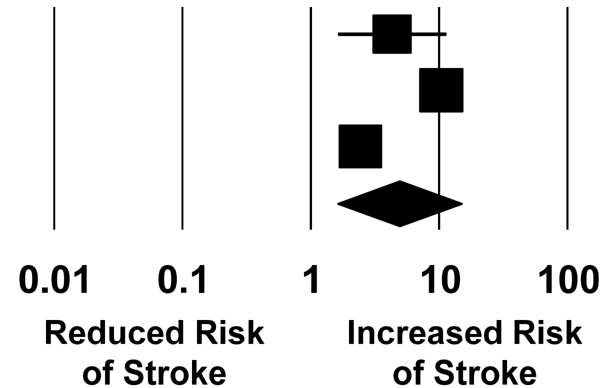


Key Question 1: TIA and Stroke – Results (Cohort Studies)

3 year risk of stroke following TIA

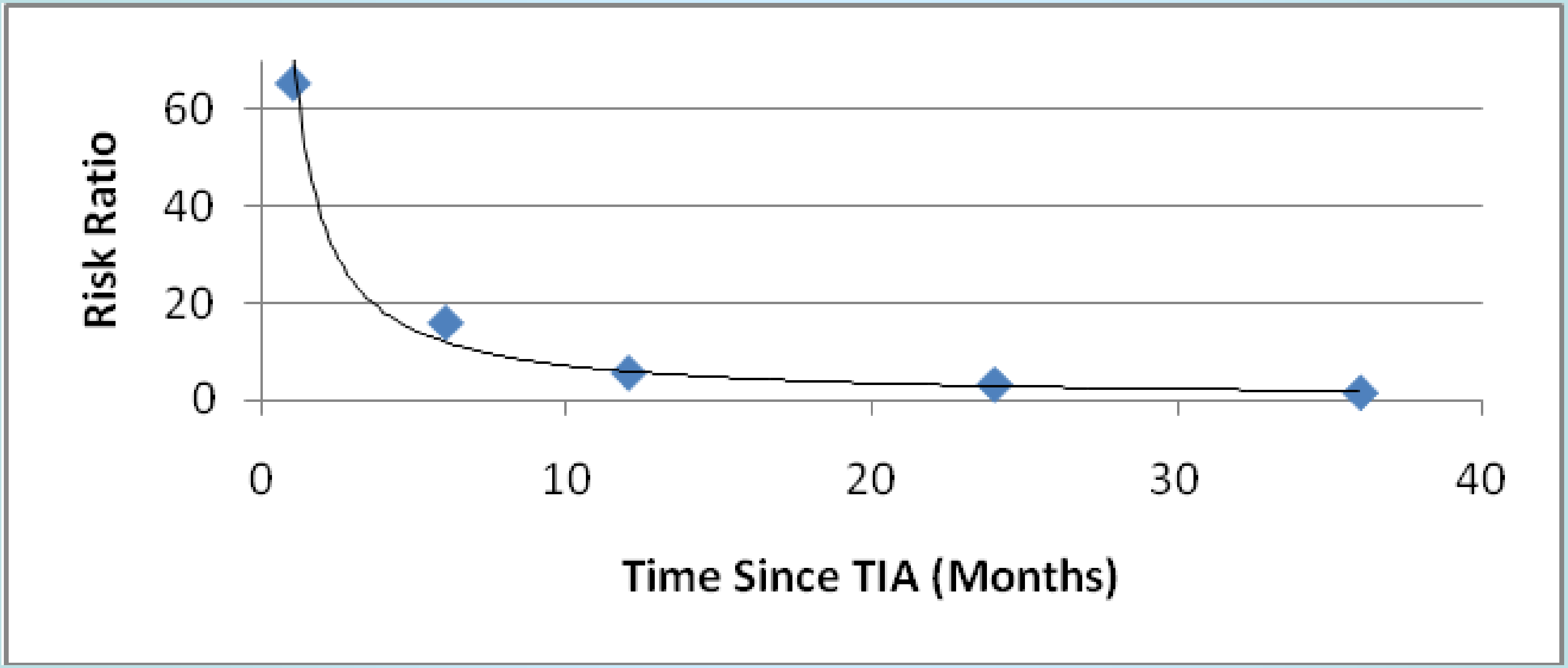
Study name	Risk ratio	Lower limit	Upper limit	Z-Value	p-Value
	Statistics for each study				
Howard 1994	4.308	1.615	11.488	2.918	0.004
Whisnant 1987	10.417	8.057	13.467	17.881	0.000
Ostfeld 1973	2.443	1.661	3.593	4.536	0.000
Summary	**NC**	**1.599**	**14.717**	**2.789**	**0.005**

Risk ratio and 95% CI



Key Question 1: TIA and Stroke – Results (Cohort Studies)

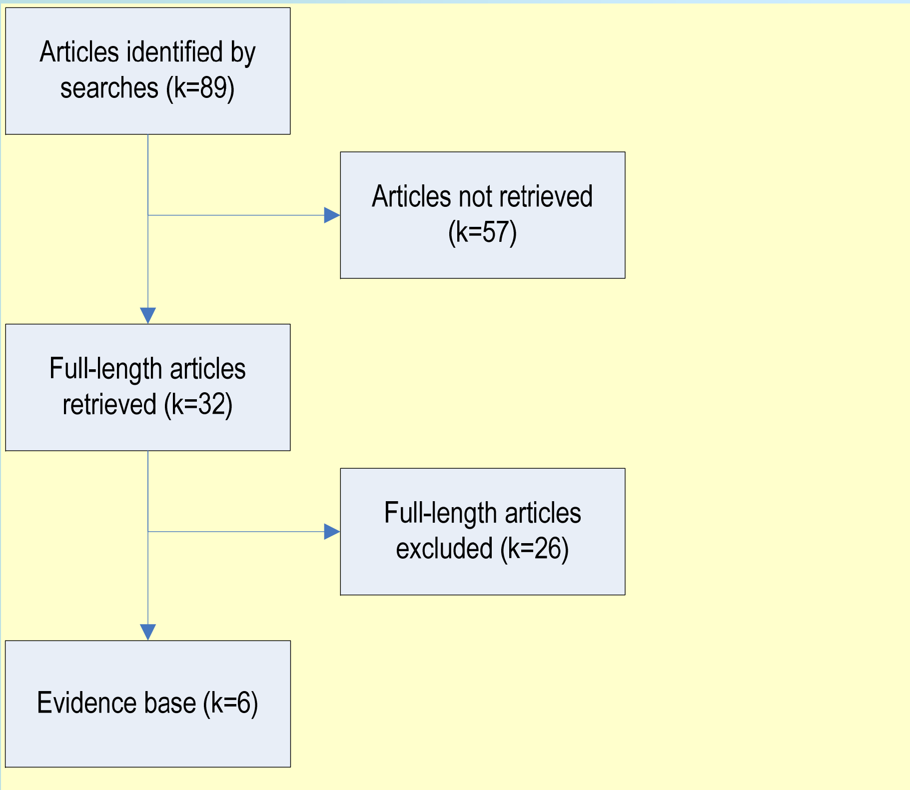
Minimum risk ratio for stroke vs. time since TIA



Key Question 1: TIA and Stroke – Overall Findings

- **Individuals are at an increased risk for stroke following a TIA (transient ischemic attack) when compared to their counterparts who did not experience a TIA (Strength of Evidence: Strong).**
- **The increased stroke risk is highest immediately following TIA (within one month) and decreases exponentially following TIA (Strength of Evidence: Moderate).**

Key Question 2: Stroke and Crash Risk



- 6 studies included
- 3 crash, 3 simulated driving or road test performance
- No CMV drivers
- 5 Cohort, 1 Case control

Key Question 2: Study Characteristics

Reference	Study design	Comparison	Severity of stroke	Driving exposure controlled for?	Outcome(s) self-reported?
Crash studies					
McGwin et al. 2000	Case-control	Drivers with stroke vs. drivers with no history of stroke	Not reported	Yes	No
Sims et al. 2000	Cohort	Drivers with stroke vs. drivers with no history of stroke	Not reported	Yes	No
Haselkorn et al. 1998	Cohort	Drivers with stroke vs. non-hospitalized drivers	Not reported	No	No
Driving performance studies (road test or simulated driving)					
Lings and Jensen 1991	Cohort	Drivers with stroke vs. drivers with no history of stroke	Not reported (all had hemiparesis)	NA	No
Lundqvist et al. 2000	Cohort	Drivers with stroke vs. drivers with no history of stroke	Not reported	NA	No
Wilson and Smith 1983	Cohort	Drivers with stroke vs. drivers with no history of stroke	Not reported	NA	No

Key Question 2: Results

- Direct Evidence (Crash Studies)
  - Overall quality was moderate
  - Two cohort studies reported incidence rate ratios, the case-control study reported odds ratios
  - The two studies that adjusted for mileage driven (Sims and McGwin) found a significantly elevated rate ratio or odds ratio indicating increased crash risk for drivers who had experienced stroke. The remaining study (Haselkorn et al.) found no significant between-group difference in stroke rate.

Key Question 2: Results

Reference	Units	Crash rate (stroke)	Crash rate (controls)	Rate ratio (95% CI)	p-value
Sims et al. 2000	Crashes per million miles driven	21.1	10.0	2.71 (1.11-6.61)	0.03
Haselkorn et al. 1998	Proportion of drivers with stroke who crashed to proportion of drivers without stroke who crashed per person year	2.6 (50/1,910)	3.1 (116/3,732)	0.8 (0.6-1.2)	0.303

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Key Question 2: Results

Reference	Units	At-fault in crash	Not in crash	Odds ratio (95% CI)	p-value
McGwin et al. 2000	Proportion of stroke among drivers involved in crashes to drivers not involved in crashes	7.3% (18/249)	4.1% (19/454)	1.8 (0.9-3.7) Unadjusted	0.088
				1.9 (1.0-3.9) Adjusted for age, race, annual mileage	$\leq$0.05

Key Question 2: Results

- Indirect Evidence (Road Test or Simulated Driving Studies)
  - Quality of all 3 studies was low
  - Two studies reported road test outcomes, two reported simulated driving outcomes (one study reported both)

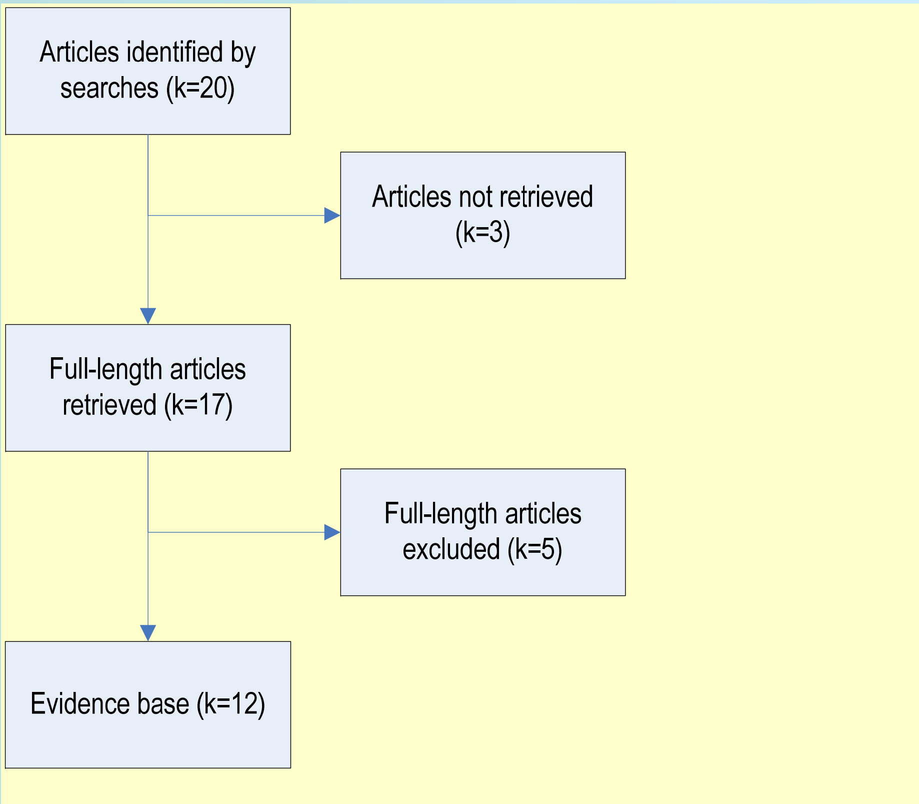
Key Question 2: Results

- Indirect Evidence (Road Test or Simulated Driving Studies)
  - Two studies of on-road driving tests (Lundquvist et al., 2000; Wilson & Smith, 1983) provide consistent, albeit weak evidence that suggests that individuals who have suffered stroke are more likely to perform poorly on a road test
  - Findings from two simulator studies are conflicting (Lundqvist et al., 2000; Lings & Jensen, 1991)

Key Question 2: Stroke and Crash Risk

- **Evidence suggests that drivers who have suffered a stroke are at an increased risk of crash (Strength of Conclusion: Minimally Acceptable).**
- **The size of this risk could not be determined.**

Key Question 3: Neuropsychological Testing as Predictor of Crash Risk



- 12 studies included
- None specifically enrolled CMV drivers
- None specifically examined crash as an outcome

Key Question 3: Study Characteristics

- Studies used a cohort design (one was an RCT, but control group was not relevant)
- No studies evaluated crash as an outcome
- Studies evaluated neuropsychological test scores and outcomes of road tests or driver evaluations (compared pass vs. fail groups)
- No two studies used an identical array of tests
- Most studies did not report severity of stroke

Key Question 3: Results

- Indirect Evidence (Road Test or Driving Evaluation)
  - Overall study quality was moderate
  - Findings could not be combined in a meta-analysis (each study used a different array of neuropsychological tests and a different set of potential predictor variables)
  - Eleven of 12 studies found that one or more neuropsychological tests were significant predictors of the outcome of road tests or driving evaluations among stroke patients

Key Question 3: Results

- Neuropsychological tests found to be significant outcome predictors (pass vs. fail) in more than one study
  - Figure of Rey (significant in 3 out of 5 studies)
  - Dot Cancellation Test (significant in 3 out of 4 studies)
  - Road Sign Recognition Test (significant in 2 out of 4 studies)
  - What Else is in the Square Test (significant in 2 out of 3 studies)
  - Motor-free Visual Perception Test (significant in 2 out of 3 studies)

Key Question 3: Results

- Caveat: Prediction of driving test outcomes is not the same as prediction of crash risk
- Patients who failed road tests would be unlikely to drive, and thus would not be at risk for crash
- Whether neuropsychological testing can identify stroke patients at increased risk of crash who were able to pass a road test has not been evaluated in the currently available literature

Key Question 3: Neuropsychological Testing as Predictor of Crash Risk

- Certain neuropsychological tests may predict the outcome of driving performance measured by a road test or in-clinic driving evaluation (Strength of Conclusion: Moderate).
- Whether neuropsychological tests can predict actual crash risk cannot be determined from currently available evidence.

Summary

- **KQ1: Individuals are at an increased risk for stroke following a TIA and this increased risk is highest immediately following the TIA (one month) and then decreases exponentially**
  - **At three years post TIA, the level of risk still remains higher compared to individuals who have never experienced a TIA**

Summary

- KQ2: Evidence suggests that drivers who have suffered a stroke are at an increased risk of crash

- KQ3: Certain neuropsychological tests may predict the outcome of driving performance measured by a road test or in-clinic driving evaluation; however, whether these tests can predict actual crash risk is unknown at this time