CLINICAL NEURO SCIENCES
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Driving and epilepsy: crystal clear or clear as mud?

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Faculty/Presenter Disclosure

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  - Consulting fees: Nil
  - Other: Nil

Objectives

1. To provide the data on which guidelines are based
2. To review driving guidelines in Canada
3. To provide a road map to the future

Why is this important?

Source	Participants` characteristics[a]	Average illness duration (years)[b]	Sample size	In the past n year(s)[c]	Seizure-related[d]	Violate restrictions[e]	Prevalence (95% CI), %
UK 1993, Dickey	?	?	17	?	?	?	0
Canada 1984, Broughton	?	15	19	?	?	?	0
Finland 2005, Sillanpaa	Childhood onset, unprovoked	45	52	1	?	×	0
USA 2017, Ma	?	?	240	1 to 5	2	?	1 (0 to 2)
Italy 1980, Quattrini	?	?	153	?	√	?	2 (0 to 4)
Denmark 2001, Lings	Had drivers` license	?	159	0.02 to 10	?	?	6 (2 to 10)
USA 1996, Wass	After the surgery	16	152	?	√	?	7 (3 to 11)
Japan 1991, Takeda	?	?	1,713	?	28	?	7 (6 to 8)
Italy 2012, Fattouch	Not new-onset, >1 seizure	?	38	1	?	?	8 (–1 to 17)
China 2014, Chen	?	11	130	?	√	?	8 (3 to 13)
France 1979, Beaussart	Driving for ≥5 years	?	448	?	?	?	8 (5 to 11)
Japan 19908&1991, Hashimoto	?	?	98	5	×	?	9 (3 to 15)
Canada 2007 McLachlan	?	19	210	1	?	?	9 (5 to 13)
France 1997, Beaussart	?	?	951	?	?	?	10 (8 to 12)
Sri Lanka 1998, Seneviratne	?	?	104	?	√	?	14 (7 to 21)
USA 1988, Popkin	?	?	112	2	?	?	14 (8 to 20)
USA 1993, Hansotia	?	17	241	4	?	?	17 (12 to 22)
France 1991, Raimondeau	Had drivers` license	?	100	?	√	?	18 (10 to 26)
UK 1996, Taylor	?	?	16,396	3	?	?	19 (18 to 20)
USA 2011, Webster	Presurgical evaluation, had drivers license	19	51	?	√	?	20 (9 to 31)
Brazil 2010, Tedrus	?	21	56	?	1	?	20 (10 to 30)
Japan 1989, Sasagawa	?	16	52	?	?	?	21 (10 to 32)
Japan 1994, Hashimoto	Temporal lobe	28	18	?	1	?	22 (3 to 41)
Thailand 2014, Saengsuwan	?	?	203	?	√	?	22 (16 to 28)
Japan 1991, Hasegawa	?	?	72	?	√	?	25 (15 to 35)
USA 2008, Elliott	?	20	207	?	√	?	27 (21 to 33)
Brazil 2012, Bicalho	?	?	55	?	?	?	31 (19 to 43)
Korea 2011, No	?	15	173	5	?	15	31 (24 to 38)
German 1967, Janz	?	?	131	?	25	?	39 (31 to 47)
USA 2000, Berg	Intractable, ≥1 seizure per month	?	237	?	√	√	41 (35 to 47)
USA 1996, Wass	Before the surgery	13	80	?	?	?	61 (50 to 72)

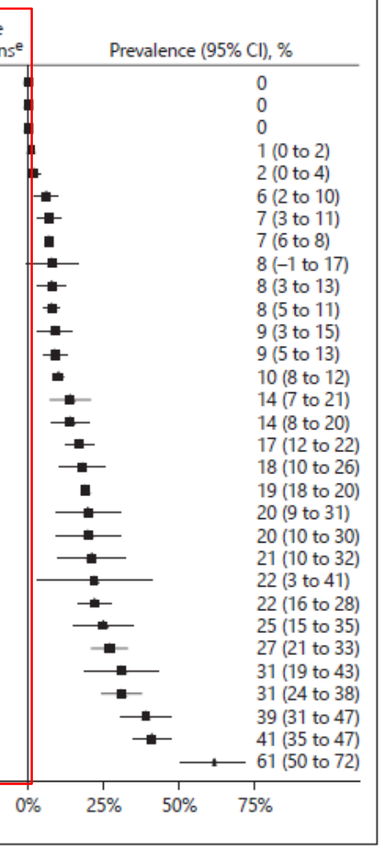


Fig. 5. Prevalence of traffic accidents among people with seizures who drove (30 studies). [a] ?, No specific epilepsy- or driving-related characteristics. [b] ?, Not reported; numbers are average years after a first seizure or the diagnosis of epilepsy. [c] ?, Not reported; numbers are traffic accidents occurred in the past number of years. [d] ?, Not reported; numbers are the number of participants who had seizure-related traffic accidents; √, seizure-related; ×, not seizure-related. [e] ?, Not reported; ×, not in violation, numbers are the number of participants who had traffic accidents that were driving in violation; √, in violation.

People with epilepsy are up to 2 times more likely to have a serious MVC (requiring ER visit or death) compared to peers

<u>Factors leading to MVCs:</u>

Compliance with driving regulations:

Accidents –

Non-compliance: 54% Compliance: 46%

No accidents –

Non-compliance 34%

Compliance 66%

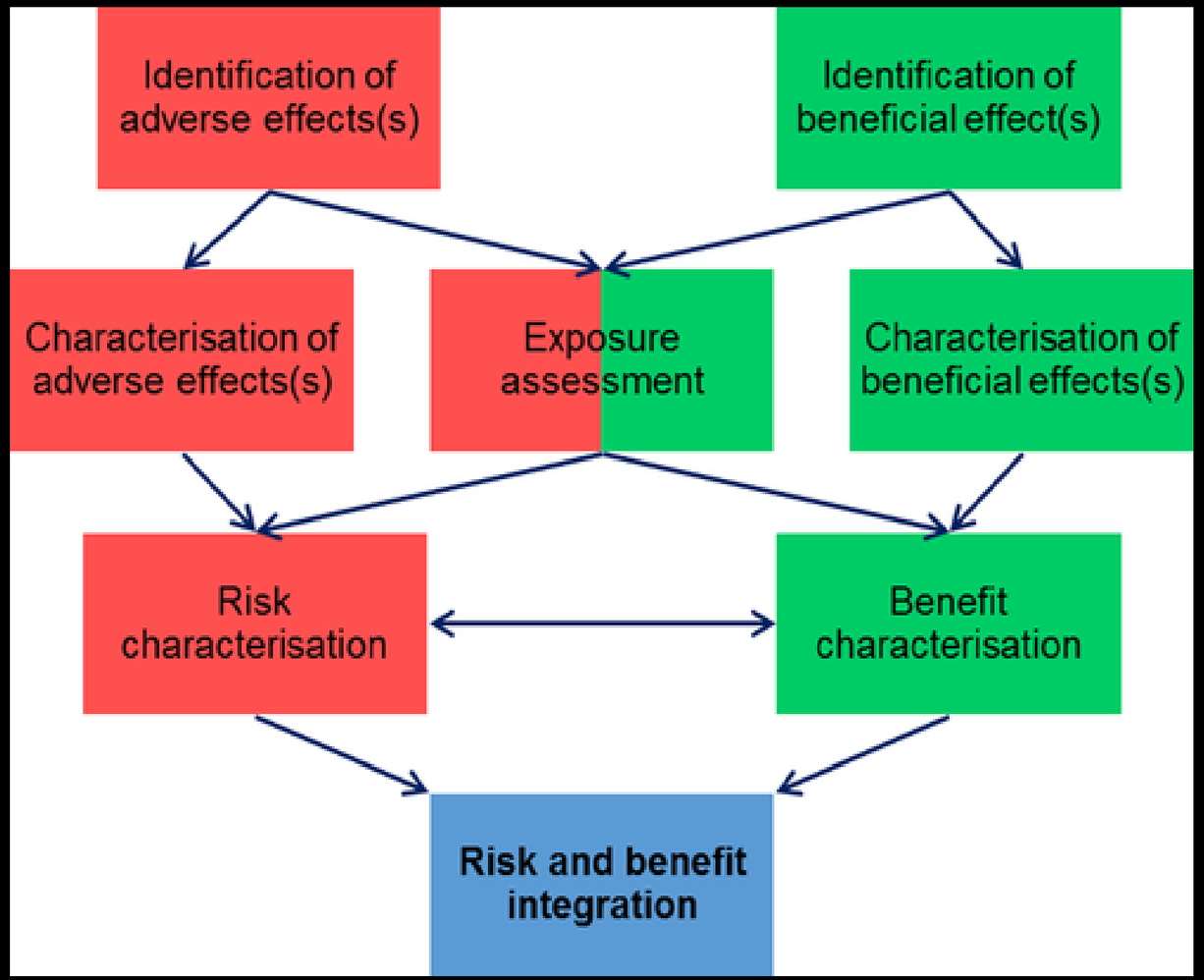
Seizure frequency:

Seizures <1/month is associated with a risk ~1/4th that with more frequent seizures

Joshi et al., Epilepsy Currents, 2019, Xu et al., Neuroepidemiology, 2019; Krauss et al., Neurology, 1999

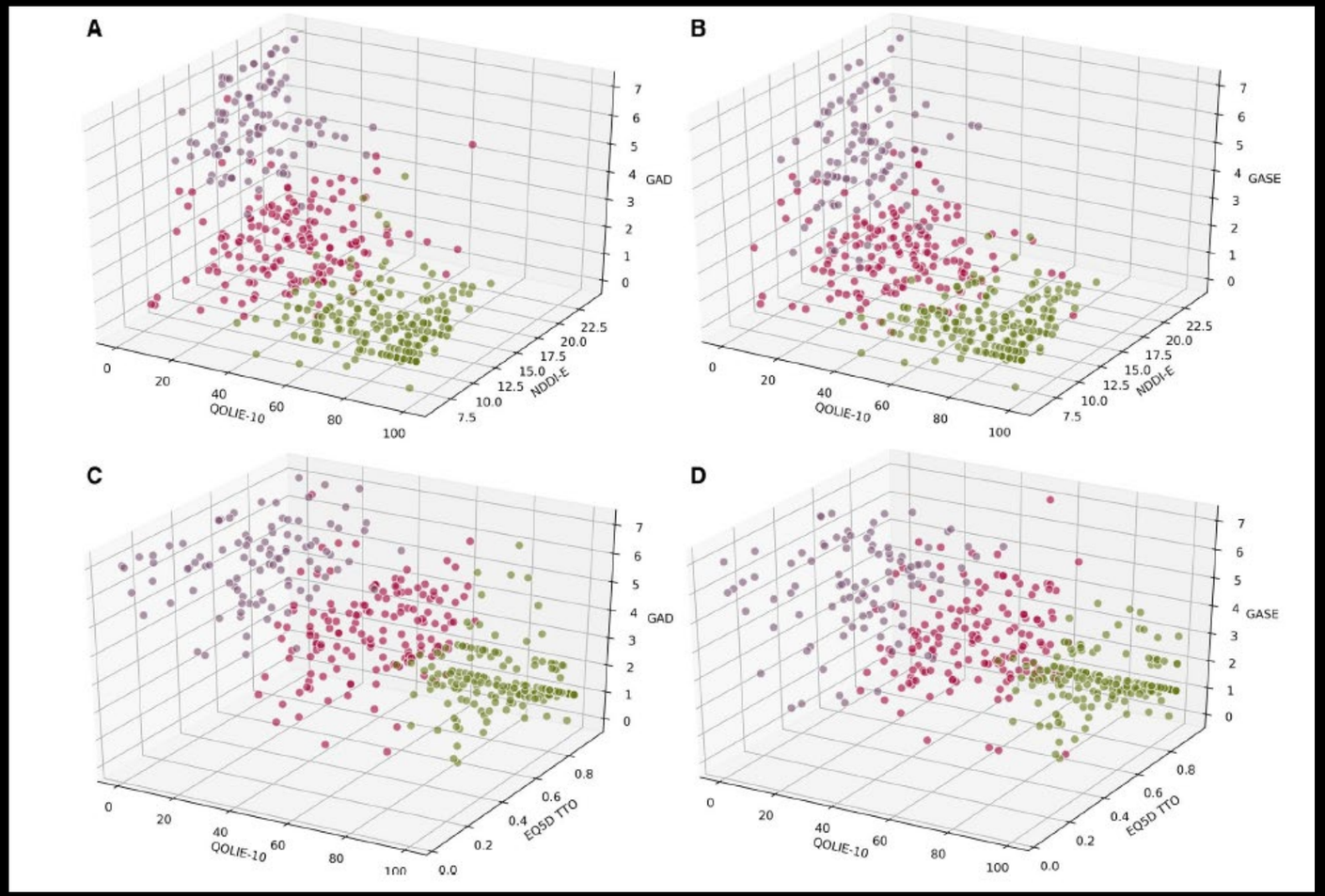
Clear as mud – making the continuous binary

- What is a risk we are willing to accept?
- What is the ideal risk threshold with which we can define ‘safe’?



https://efsa.onlinelibrary.wiley.com/doi/full/10.2903/j.efsa.2019.e170917

Benefits of driving



Psychosocial health:
Intermediate vs. high cluster:
Current driver: RR = 0.58
(95%CI 0.32-1.06); p=0.07

Low vs. high cluster:
Current driver: RR = 0.24
(95%CI 0.10-0.62); p=0.003

Josephson et al., Epilepsia, 2020

Clear as mud – making the continuous binary

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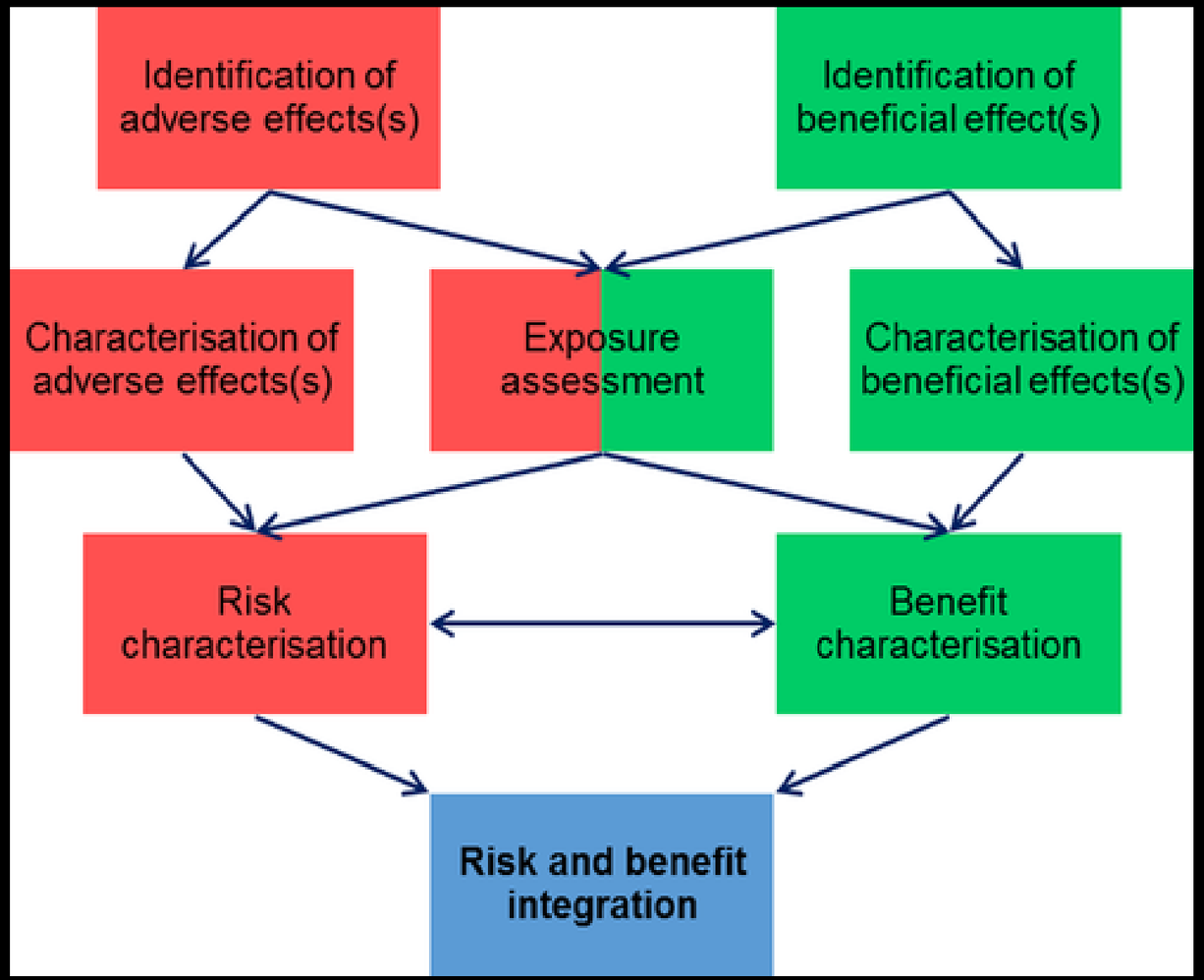

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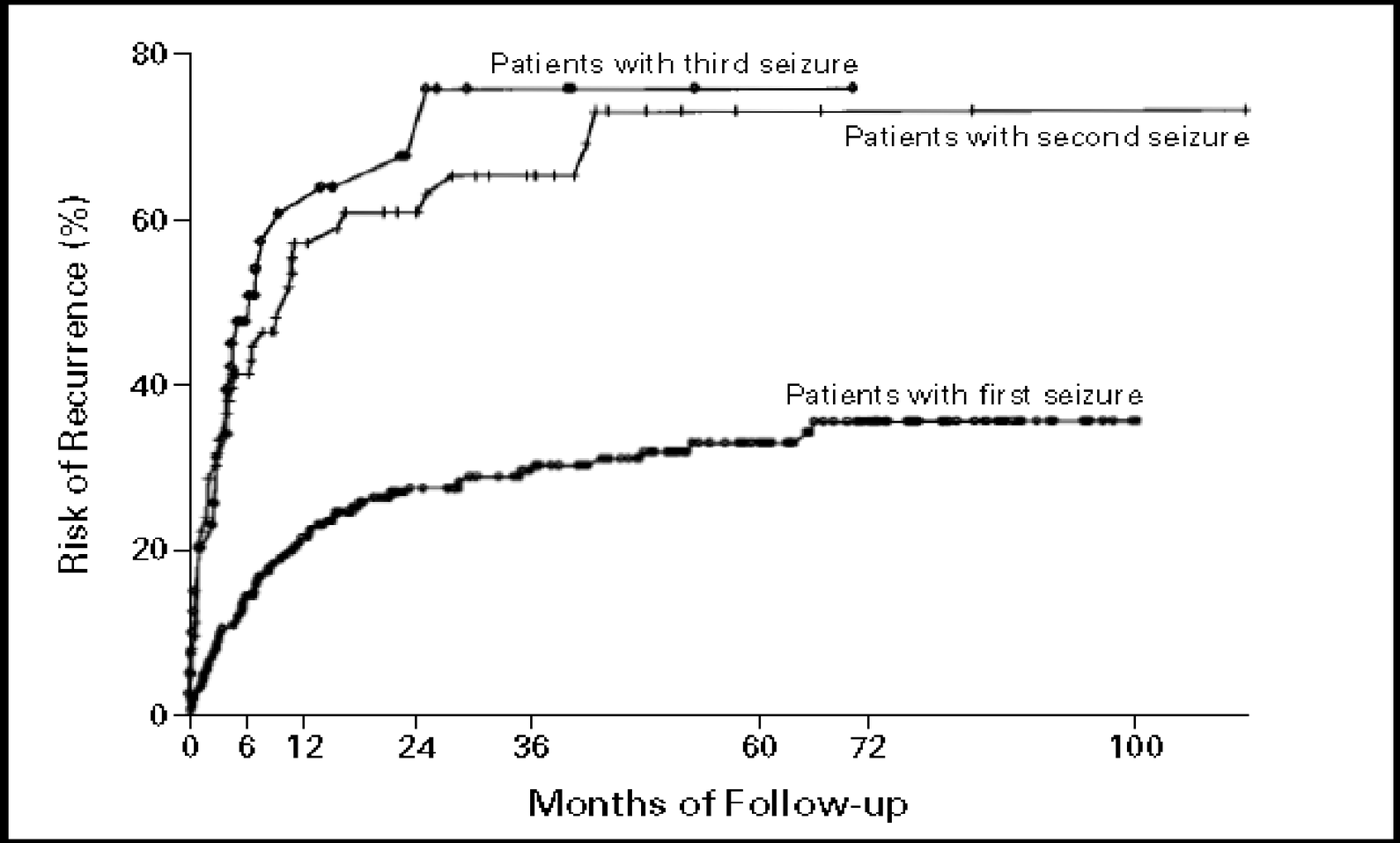
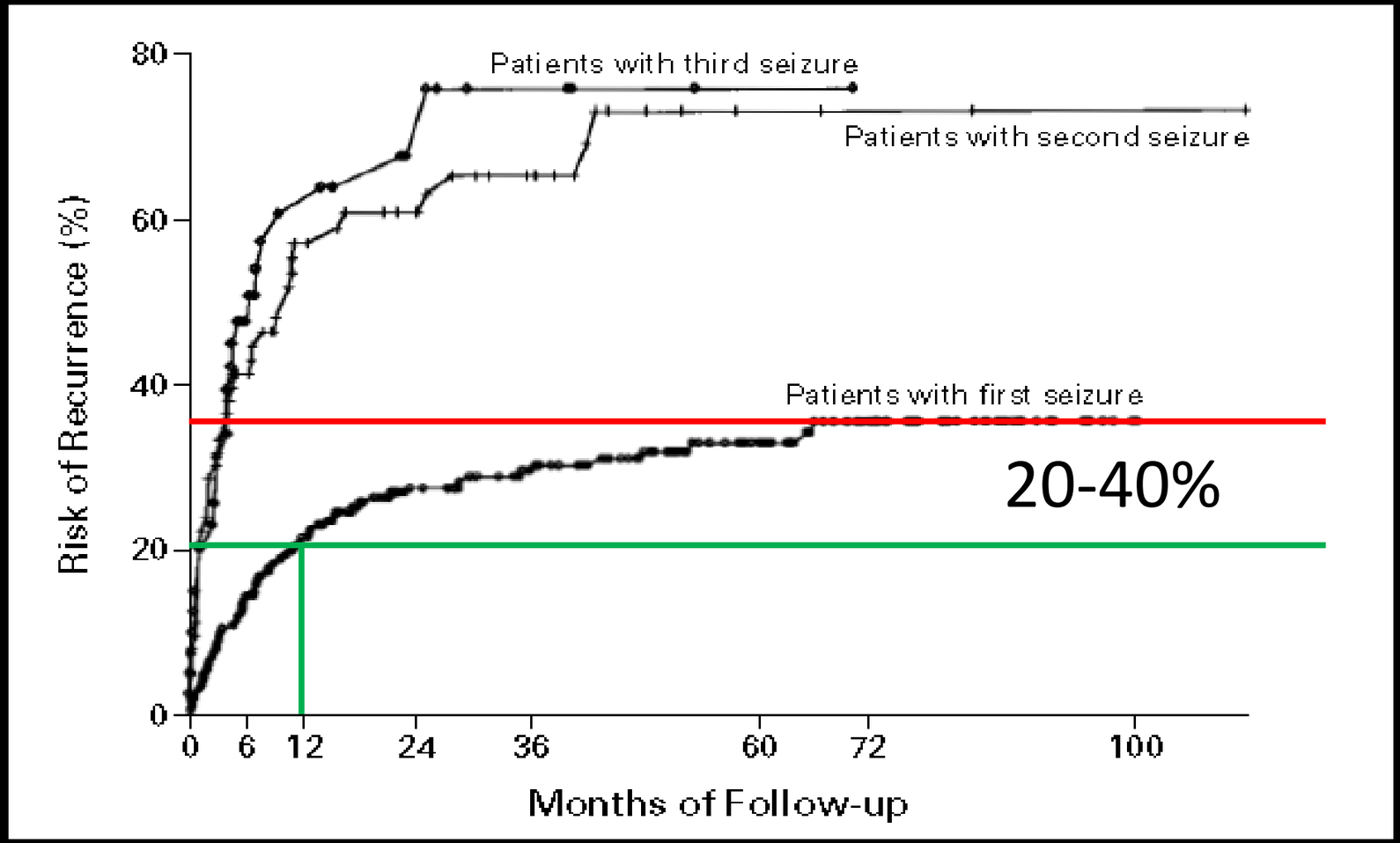
Risk of recurrence after a first seizure



*on no medication

Hauser et al., NEJM, 1998

Risk of recurrence after a first seizure



*on no medication

Hauser et al., NEJM, 1998

The magic 20% threshold

Table 5 | Risk of seizure recurrence in next 12 months estimated from multivariable model at specific seizure-free periods. Estimates presented assume seizures not confined to sleep and no first degree relative with epilepsy

	Test results			Immediate treatment		Delayed treatment	
Cause of seizure	EEG	CT/MRI	Months from index seizure	Risk of seizure in next 12 months (%, 95% CI)	Months from index seizure until annual risk falls <20%	Risk of seizure in next 12 months (%, 95% CI)	Months from index seizure until annual risk falls <20%
Not remote symptomatic	Normal	Normal	6	13 (10 to 16)*	1.2	16 (12 to 19)*	3.2
			12	7 (5 to 10)*		9 (6 to 12)*	
Not remote symptomatic	Abnormal	Normal	6	20 (16 to 23)	5.5	23 (20 to 26)	7.0
			12	11 (9 to 14)*		13 (11 to 16)*	
Not remote symptomatic	Normal	Abnormal	6	14 (11 to 17)*	2.1	17 (14 to 20)	3.6
			12	8 (5 to 11)*		10 (7 to 12)*	
Not remote symptomatic	Abnormal	Abnormal	6	21 (18 to 24)	6.1	25 (22 to 28)†	8.1
			12	12 (9 to 15)*		14 (12 to 17)*	
Remote symptomatic	Normal	Normal	6	17 (14 to 20)	3.6	20 (17 to 23)	6.0
			12	10 (7 to 12)*		12 (9 to 14)*	
Remote symptomatic	Abnormal	Normal	6	25 (22 to 28)†	8.7	30 (27 to 32)†	10.7
			12	15 (12 to 17)*		18 (15 to 20)	
Remote symptomatic	Normal	Abnormal	6	18 (15 to 21)	4.8	22 (19 to 25)	6.5
			12	10 (8 to 13)*		13 (10 to 15)*	
Remote symptomatic	Abnormal	Abnormal	6	27 (24 to 30)†	9.2	32 (29 to 34)†	11.3
			12	16 (13 to 18)*		19 (16 to 21)	

EEG=electroencephalogram; CT=computed tomography; MRI=magnetic resonance imaging.
*Confidence interval lies completely below 20%.
†Confidence interval lies completely above 20%.

<6 months

<12 months

Bonnett et al., BMJ, 2010

Medication withdrawal

Table 2 Probability of having a seizure in next 12 months at time points following antiepileptic drug withdrawal for patients who were seizure-free during drug withdrawal

Time postwithdrawal (months)	No at risk	No of events from baseline	Probability of seizure in next 12 months given seizure-free at stated time postwithdrawal (95% CI)
0	317	0	30 (25 to 35)
3	257	64	15 (10 to 19)
6	235	84	9 (5 to 13)
12	221	96	9 (5 to 14)
18	188	105	8 (3 to 13)
24	126	113	5 (0 to 11)

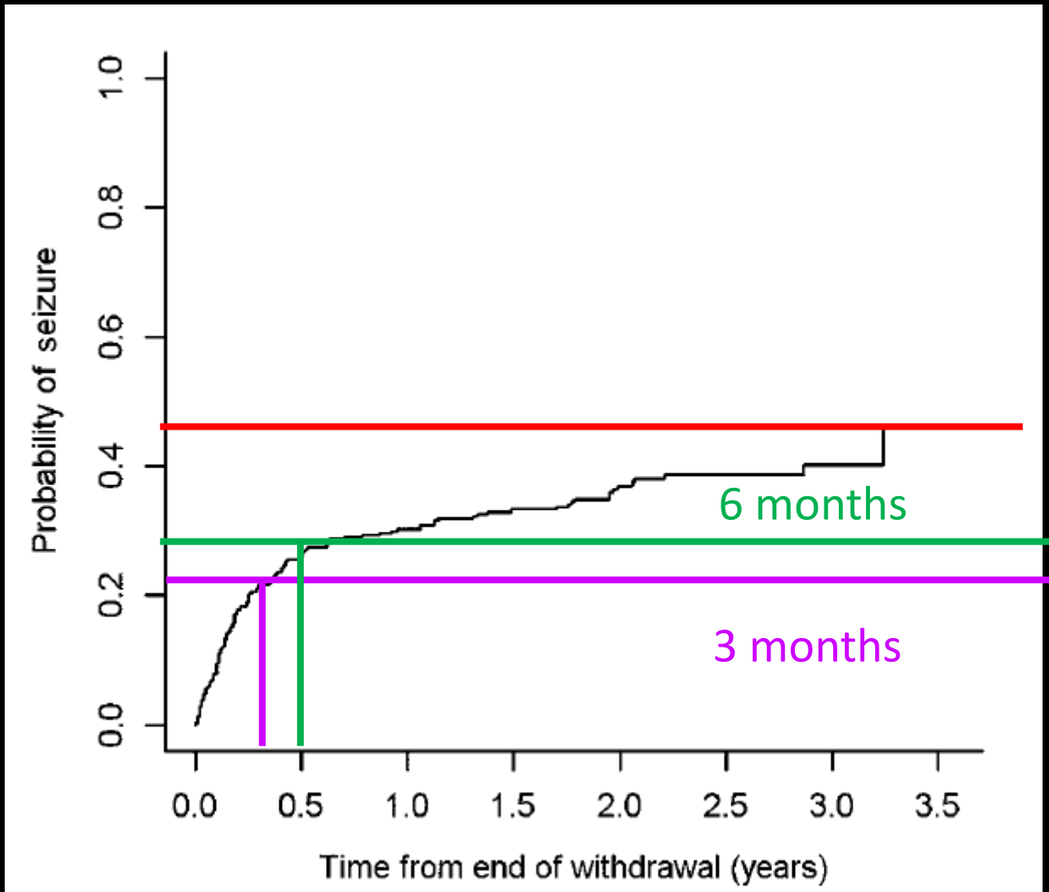


Figure 2 Time to first seizure post treatment-withdrawal

MEDICAL RESEARCH COUNCIL ANTIEPILEPTIC DRUG WITHDRAWAL STUDY GROUP, JNNP, 2011

Objectives

1. To provide the data on which guidelines are based
2. To review driving guidelines in Canada
3. To provide a road map to the future

The two guidelines

- Canadian Council of Medical Transport Administrators (CCMTA)
  - Council of Canadian medical experts and governmental transportation officials

- Canadian Medical Association (CMA)
  - Association of physicians and medical students
  - Publishes driving guidelines intended to help physicians assess and council patients on their fitness to drive

The mud gets even murkier…

	CMA	*CCMTA*
*New epilepsy diagnosis involving private driver with class V license**	Drive only if 6 months seizure-free and compliant on anti-seizure drug	Drive only if 6 months seizure-free and compliant on anti-seizure drug
*New epilepsy diagnosis in commercial driver, with class 1-4 driver's license**	Drive only if 5 years seizure-free	Drive only if 5 years seizure-free and favorable report from a physician
*Single unprovoked seizure with loss of awareness (private driver/class V license) ***	Drive only if 3 months seizure-free and a neurological assessment (including EEG and neuro-imaging) has been carried out	Drive only if satisfactory neurological assessment and EEG
*Juvenile Myoclonic Epilepsy diagnosis***	No driving of any vehicle unless taking anti-seizure drug	Not specifically addressed
*Epilepsy patient (private/class V license) undergoes a prescribed anti-seizure drug adjustment***	Drive only if 3 months seizure-free after medication is last changed	Not specifically addressed
*Epilepsy patient (private/class V license) has a seizure recurrence after a prescribed anti-seizure drug change or withdrawal***	Drive only if previously effective medication is resumed and 3 months seizure-free	Drive only if previous medication is resumed
*Epilepsy patient (private/class V license) has an epilepsy surgery***	Drive only if 12 months seizure-free after surgery and with therapeutic drug levels	Not specifically addressed

* CMA and CCMTA guidelines are concordant. ** CMA and CCMTA guidelines are

17.6.10 Epilepsy with medication change – Non-commercial drivers

This standard applies to non-commercial drivers with epilepsy who undergo a prescribed change to, or withdrawal of, an effective antiepileptic medication. This standard only applies where the driver's treatment was effective (i.e. their epilepsy was controlled) prior to the change to, or withdrawal from, medication. This means they should not have had a seizure for at least six months prior to the change or withdrawal of medication. If their treatment prior to the change was not effective, then guideline 17.6.6 applies.

STANDARD	Non-commercial drivers eligible for a licence if
	• it has been 3 months since the change or withdrawal and they have not had a seizure during that time, and • the conditions for maintaining a licence are met Non-commercial drivers who have a seizure after a change to, or withdrawal from, antiepileptic medication eligible for a licence if • they re-establish a previously effective treatment regime • the treating physician indicates that further seizures are unlikely, • it has been 3 months since the previously effective treatment regime was resumed and they have not had a seizure during that time • the conditions for maintaining a licence are met

17.6.9 Surgery for epilepsy – Non-commercial drivers

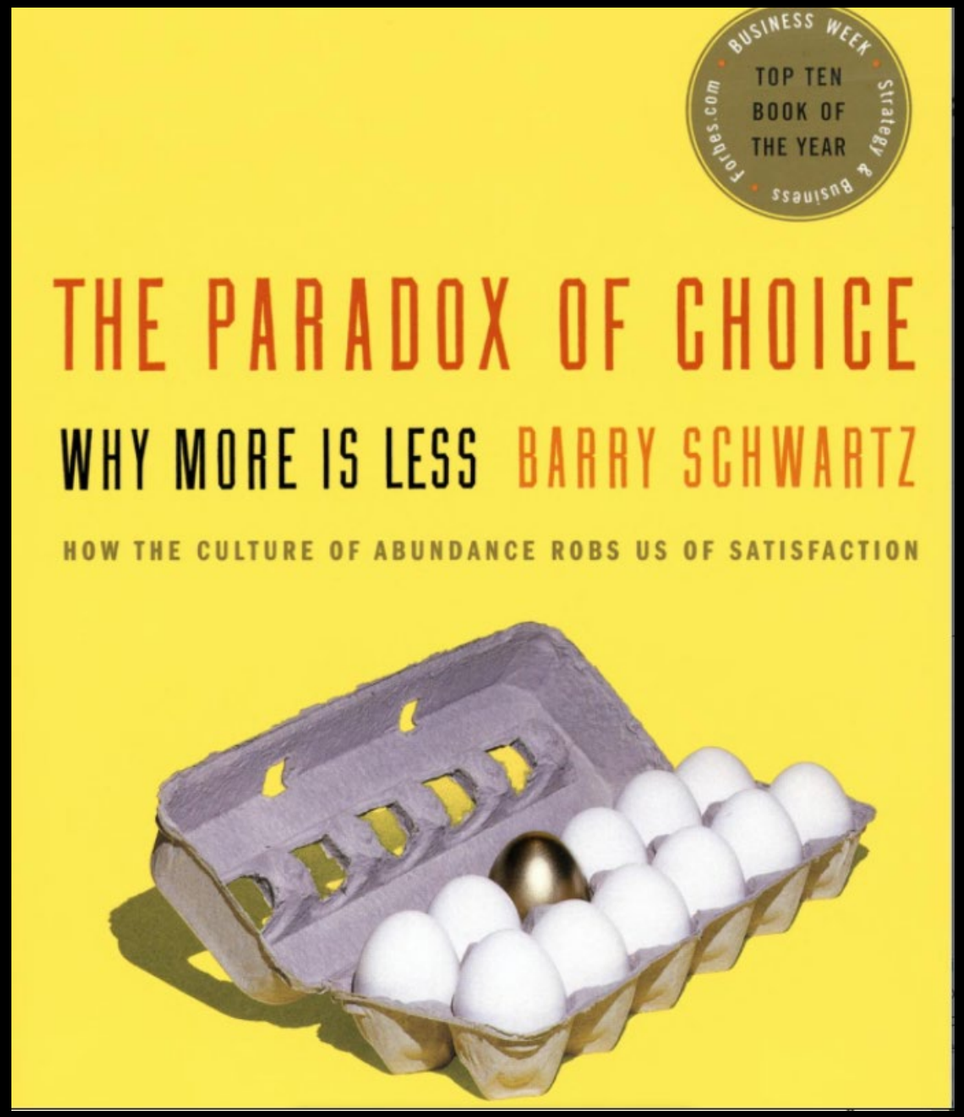
STANDARD	Non-commercial drivers eligible for a licence if
	• they have not had a seizure for 6 months after surgery • the conditions for maintaining a licence are met

Jirsch et al., CJNS, 2014

The problem with choice

Table 2: Characteristics of Canadian experts in epilepsy with active clinical practice in Adult Neurology (n=35)

	All provinces (n=35)
	n (%)
Epilepsy subspecialty training	33 (94.3)
Province located	
British Columbia	4 (11.4)
Alberta	10 (28.6)
Saskatchewan	2 (5.7)
Manitoba	1 (2.9)
Ontario	8 (22.9)
Quebec	7 (20.0)
Nova Scotia	3 (8.6)
Resources used to counsel patients	
CMA only	14 (40.0)
CCMTA only	5 (14.3)
CMA and CCMTA	9 (25.7)
Neither CMA nor CCMTA	4 (11.4)
CMA/CCMTA and Other	3 (8.6)



Jirsch et al., CJNS, 2014; https://www.google.ca/books/edition/The_Paradox_of_Choice/g422yyua-P8C?hl=en&gbpv=1

Application of CMA *versus* CCMTA

Table 3: Proportion of physicians' counseling in agreement with CMA recommendations for clinical scenarios where CMA guidelines are concordant vs. discordant with CCMTA guidelines

	All provinces (n=35)
CMA and CCMTA guidelines are concordant	n (%)
No driving ≥6 months with Class V license after diagnosis of epilepsy	31 (88.6)
No driving ≥5 years with Class I license after diagnosis of epilepsy	31 (88.6)
CMA and CCMTA guidelines are discordant	
Patients should not drive for a period of time after a first seizure	32 (91.4)
Patients need neuro-imaging after a first seizure before being allowed to drive	26 (74.3)
JME patients should always remain on anti-seizure medications in order to be fit to drive	10 (28.6) Ψ
Epilepsy patients should not drive ≥3months after any anti-seizure medication adjustment	12 (34.3) Ψ
Epilepsy patients withdrawn from medication should refrain from driving for a period of time after seizure recurrence	29 (82.9)
Patients should not drive for at least 12 months after epilepsy surgery	19 (54.3)
Patients require therapeutic drug levels following epilepsy surgery in order to drive	8 (22.9) Ψ

Ψ: Majority of respondents' counseling not consistent with CMA recommendations

Disagreed with CMA

Disagreed with both CMA and CCMTA

Table 4: Consistency in agreement with clinical scenarios on driving fitness decisions when CMA guidelines are concordant vs. discordant with CCMTA guidelines*

	All provinces (n=35)
	n (%)
CMA and CCMTA guidelines are concordant	
0-1	7 (20.0)
2	28 (80.0)
CMA and CCMTA guidelines are discordant	
1-3	18 (51.4)
4 or more	17 (48.6)
p-value	*<0.001*

* Cumulative agreement to concordant vs. discordant scenarios were split at the median (1 and 3, respectively) and analyzed using the Wilcoxon signed rank sum test

>50% applied different guidelines to different scenarios

Jirsch et al., CJNS, 2014

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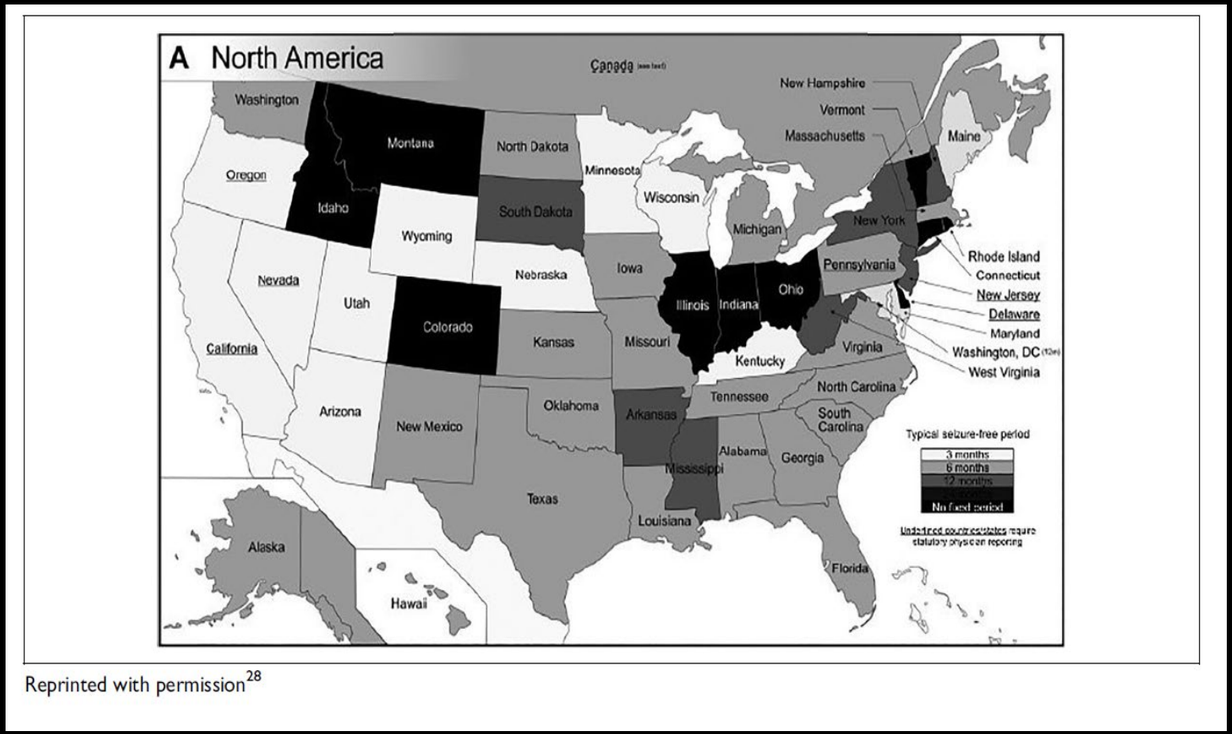
We are not the only one…



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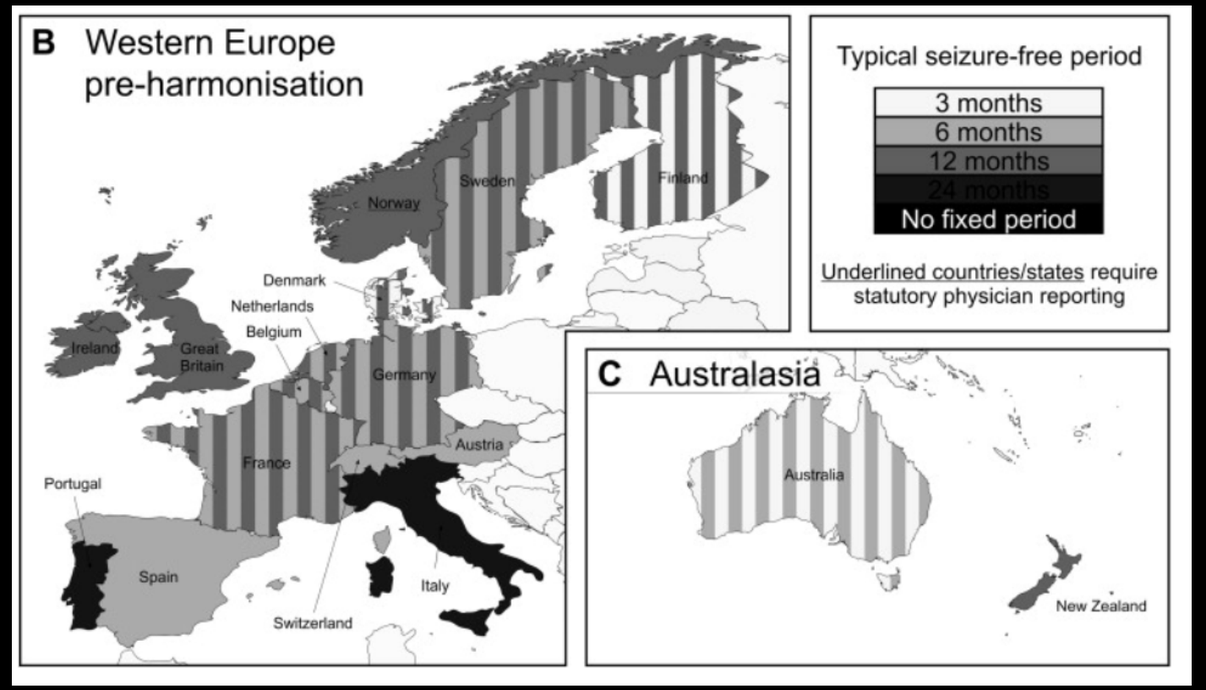


European Union and UK:

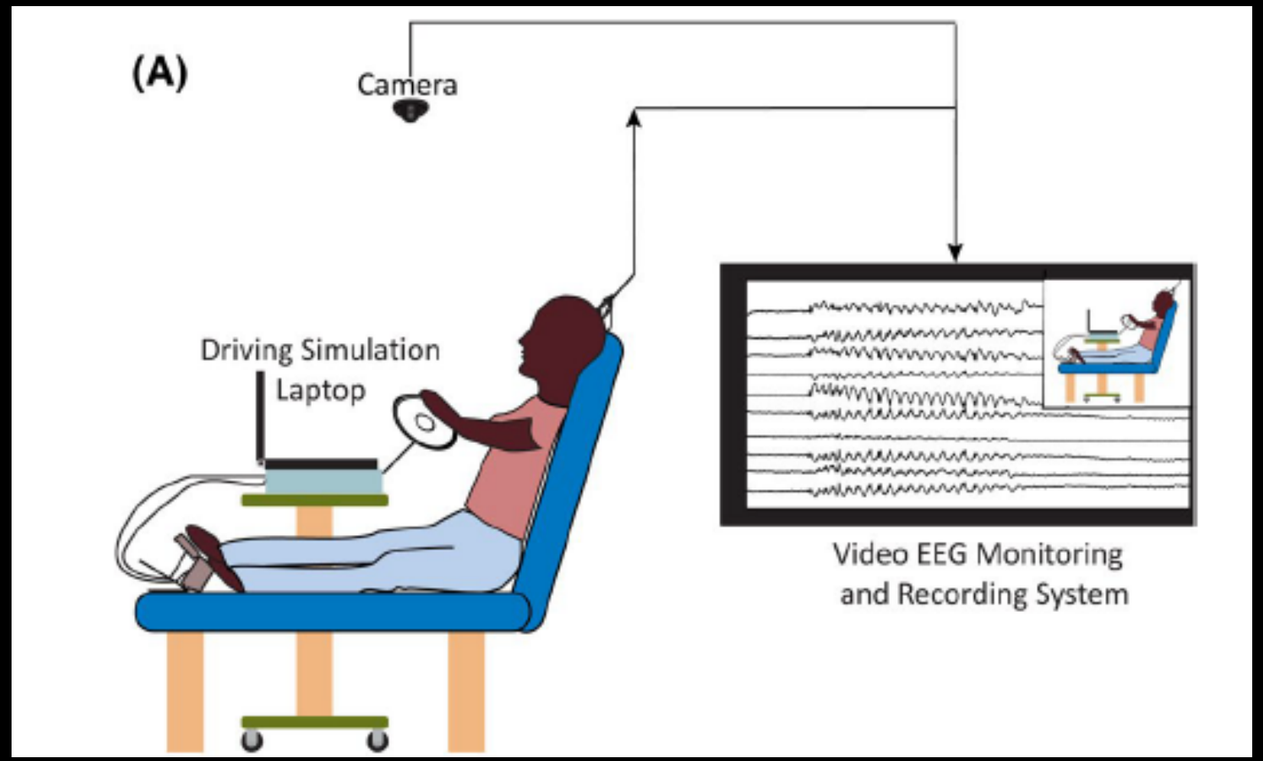
- Can drive after a single seizure if 6 months seizure free and risk of recurrence is <20% over the next 12 months

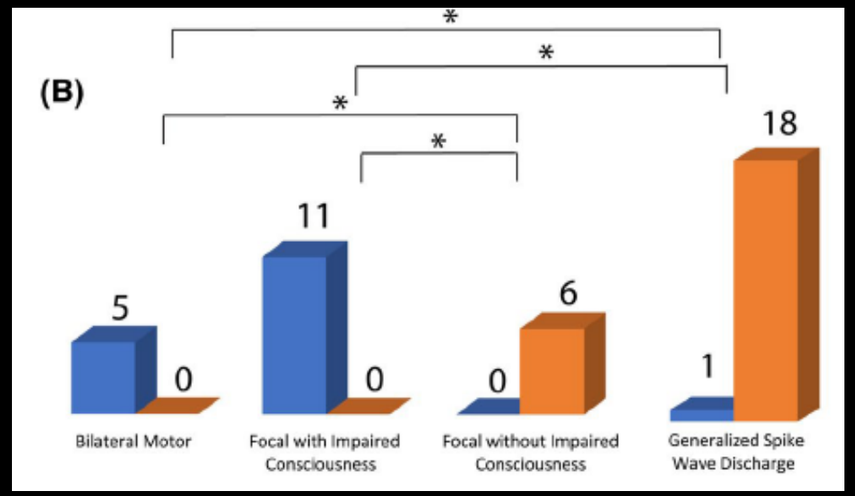
Winston and Jaiser, Seizure, 2012

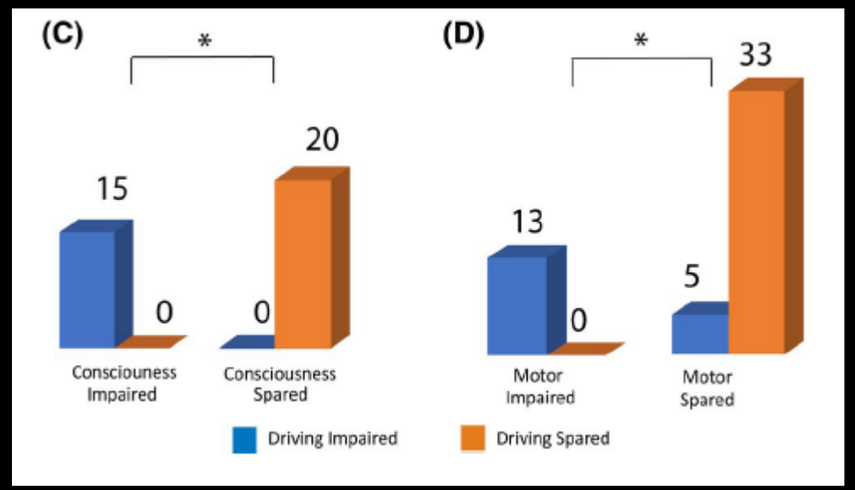
Personalised medicine

- ILAE task force is performing reviews to
  - Determine if there is an ideal universal risk threshold under which one can drive
  - Determine risk factors for MVCs in epilepsy
  - Determine if there is a combination of risk factors that predict individual risk
  - Are there interventions that decrease the risk

Simulators and Seizure Monitoring Units







Kumar et al., Epilepsia, 2022

Thank you and questions

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