ECT Skills Training Workshop
17/11/2022

The Royal Australian & New Zealand College of Psychiatrists

ECT Prescription: Stimulus Dosing, Pulse Width and Electrode Placement.

Medications and ECT.

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Introduction

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- Over the last 10 years ECT has become more complex.
- Strong evidence base to support its use, with response rates of 80-90% for major depression and remission rates often only slightly lower (Kellner, 2019)
- Emerging indications including self-injurious behaviour in autism and BPSD.
- Remains a life saving treatment in Catatonia and NMS.
- ECT-related mortality rate low at 2.1 per 100 000 treatments compared to 3.4 per 100 000 for GA for surgical procedures (Torring et al, 2017).

Kellner C. (2019) *Handbook of ECT A Guide to ECT for Practitioners.* Cambridge; UK: Cambridge University Press.

Torring et al. (2017) *Acta Psychiatrica Scandinavica.*135(5): 388-397.

Modern ECT Underused

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- Despite improvements, use remain low and uneven.
- In US only 1.5% of inpatients with severe mood disorder received ECT in index admission (Slade et al, 2017).
- Perhaps the biggest obstacle is the stigma (Sackeim, 2017).
- Some cases may be understood as a kind of 'collective archetypal PTSD' due to misuses in the past and ongoing negative representation in movies and TV (Bouckaert & Sienaert, 2018).
- Economic, cultural, and political factors also impact.

Slade et al. (2017) *JAMA Psychiatry.*74: 798-804
Sackeim. (2017) *JAMA Psychiatry.*74: 779-780.
Bouckaert & Sienaert. (2018) *J ECT.*34: 132-133.

Predictors of Response

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- ECT should be prescribed earlier in the course and not withheld until after numerous medication trials (Kellner et al, 2020).
- Depressed patients with psychosis and psychomotor retardation more likely to respond (Van Diermen et al, 2021).
- Higher pre-treatment mood score and older age independently associated with mood improvement (Waite et al, 2022)

Kellner et al. (2020) *Acta Psychiatr Scand*.141:304-315.
Van Diermen et al. (2021) *J Clin Psychiatry.* 82(1): 20m13287.
Waite et al. (2022) *J Psych Research*.155: 180-185.

APA Protesters

Citizens Commission on Human Rights

HEAD TO HEAD

MAUDSLEY DEBATE

Should we stop using electroconvulsive therapy?

Electroconvulsive therapy has no long term benefits compared with placebo and often causes brain damage, say **John Read** and **Sue Cunliffe**. But **Sameer Jauhar** and **Declan M McLoughlin** argue that evidence shows ECT is effective and safe in depression and that adverse side effects can be managed

John Read *professor of clinical psychology*[1], Sue Cunliffe *electroshock survivor*, Sameer Jauhar *senior research fellow*[2], Declan M McLoughlin *professor*[3]

But what does the evidence say?

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- ECT has profound restorative effects on the brain
- Recent findings indicate increased hippocampal neurogenesis and synaptogenesis in experimental animals and emerging evidence in humans (increased hippocampal volumes post ECT)
- Enhances dopaminergic, serotonergic and adrenergic neurotransmission
- Releases hypothalamic and pituitary hormones

Kellner C. (2019). *Handbook of ECT A Guide to Electroconvulsive Therapy for Practitioners.* Cambridge; UK: Cambridge University Press.

A Final Word on Countering Stigma

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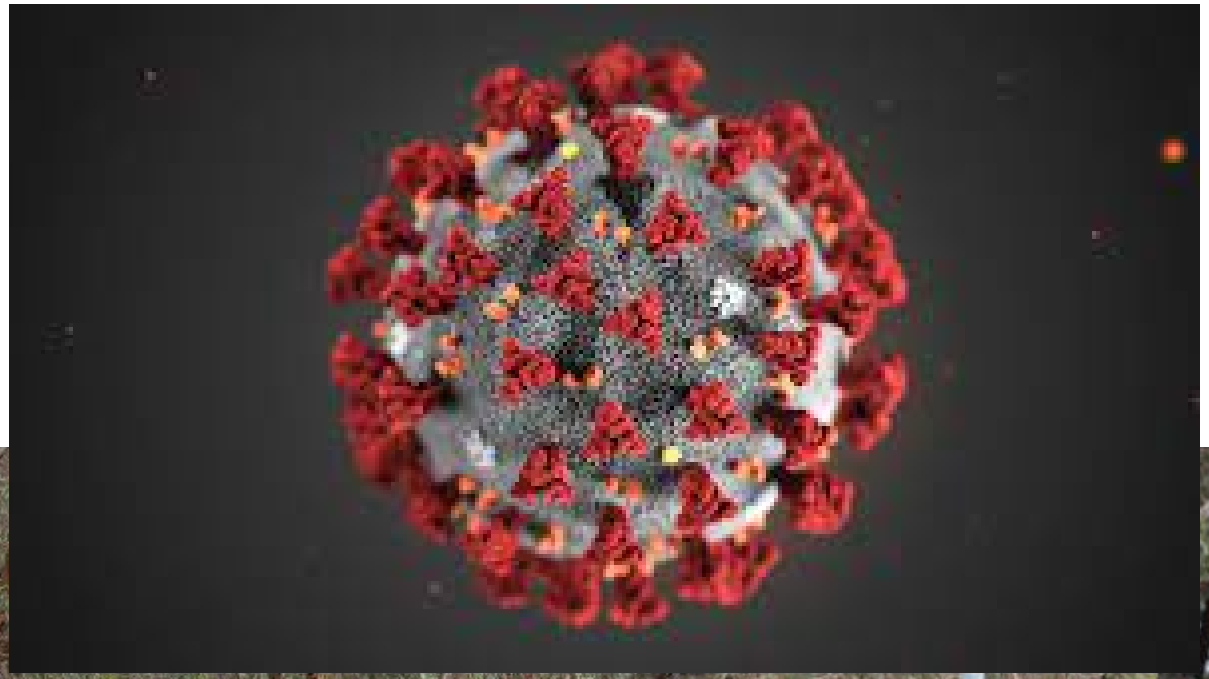
"The best way to counter stigma is to educate ourselves well and insist on high standards of care for ECT."

Kellner C. (2019). *Handbook of ECT A Guide to Electroconvulsive Therapy for Practitioners.* Cambridge; UK: Cambridge University Press.




KIRBY

FIGURE 1. The ECT team members in the St Patrick's University Hospital ECT treatment room are using PPE, including gowns, headgear, masks, goggles, and gloves. Nursing staff in the separate ECT recovery room are similarly attired.

Electroconvulsive Therapy Is an Essential Procedure

Daniel F. Maixner, M.D., Richard Weiner, M.D., Ph.D., Irving M. Reti, M.B.B.S., Adriana P. Hermida, M.D., Mustafa M. Husain, M.D., Dane Larsen, B.A., William M. McDonald, M.D.

Am J Psychiatry 178:5, May 2021

Despite a worldwide pandemic, the most vulnerable patients can receive ECT care with sophisticated safety protocols developed by health care providers.

Finding the Right Balance

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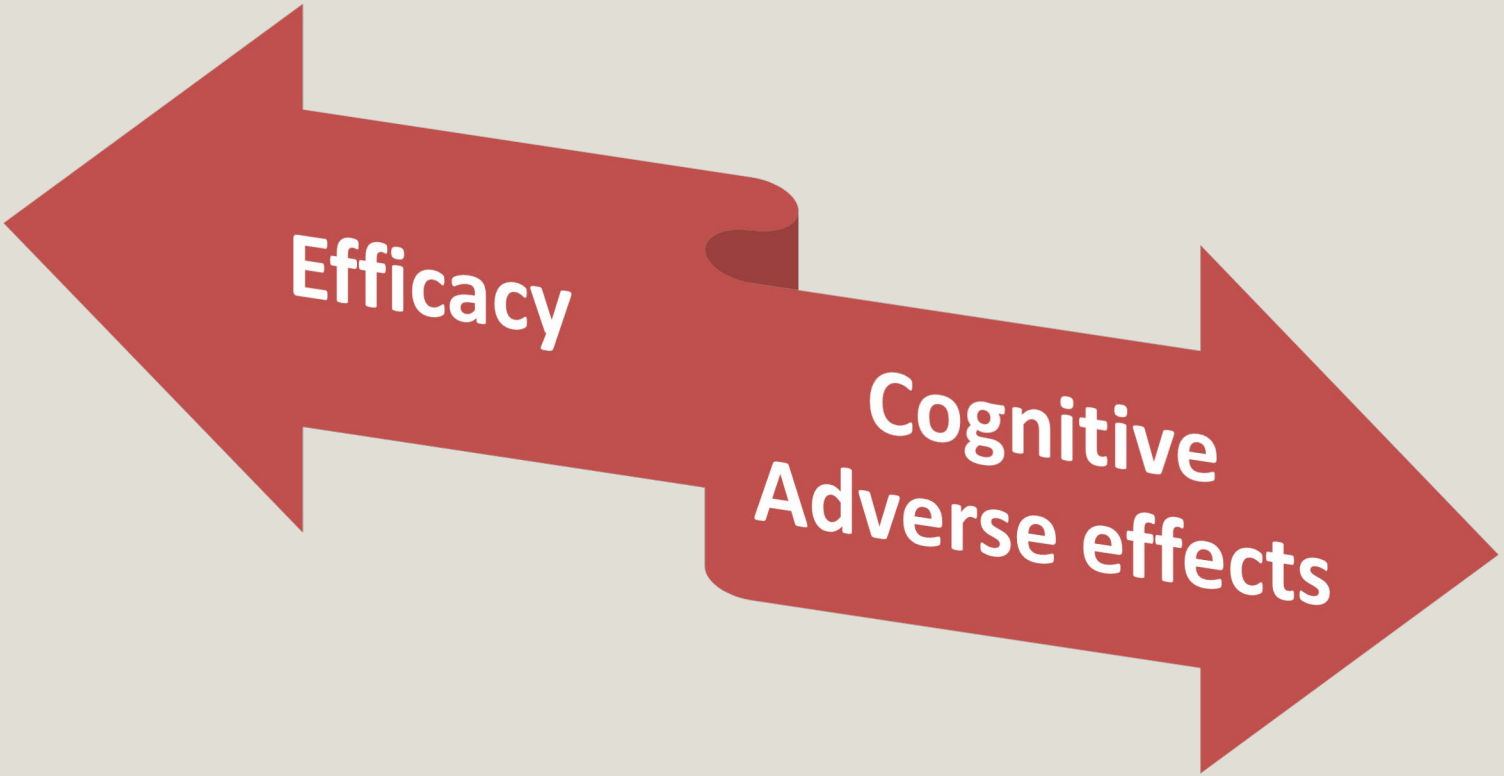

Electrical Stimulus

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Electrical charge= total quantity of electrons flowing through a conductor during a given period of time

Electrical charge (millicoulombs) = current (amperes) X pulses/second X pulse width (seconds) X stimulus duration (seconds)

Australian machines can deliver a maximum of 1008 mC or 200% (1% =5mC)

Ohm's Law

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$$\text{Current (amperes)} = \frac{\text{voltage (volts)}}{\text{resistance (ohms)}}$$

Voltage is like pressure, so as impedence of circuit increases, voltage increased to deliver set current

Impedence

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- Resistance (or impedence) determined by skin and skull impedence and electrode contact with scalp
- As voltage capped for safety reasons in fixed current devices, machine will deliver less charge that set on dial if impedence above 3000 ohms (actual dose delivered is shown on EEG trace)
- No need to get impedence very low, unless dose close to 200% (then aim to achieve impedence 1500 or less otherwise whole dose may not be not delivered)

Electrical Stimulus

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- **Charge** 0 -1008mC
- Square-wave Alternating Current
- **Voltage** approx. 200V (based upon 220 Ω impedance)
- **Current** 0.9A
- **Frequency** 30 - 70Hz
- **Pulse width** 0.25 – 1.5 msec (Ultra Brief- Brief)
- **Duration** 0.1 - 8 Sec

ECT Waveform

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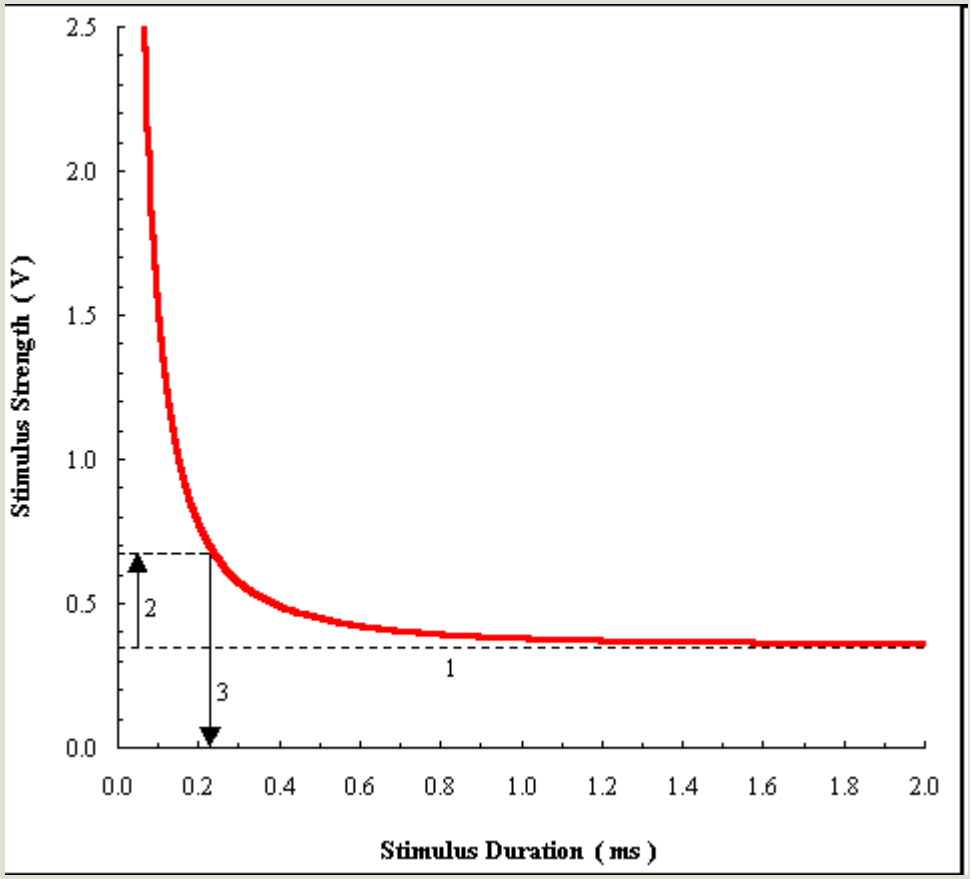
Chronaxie is the minimum time to electrically stimulate a nerve to elicit a threshold response.

Chronaxie of neurons : 0.1-0.2 ms.

Typical ECT pulse : 0.5 – 1.5 ms.

Lower seizure threshold if pulse width < 0.5 ms



Pulse Width

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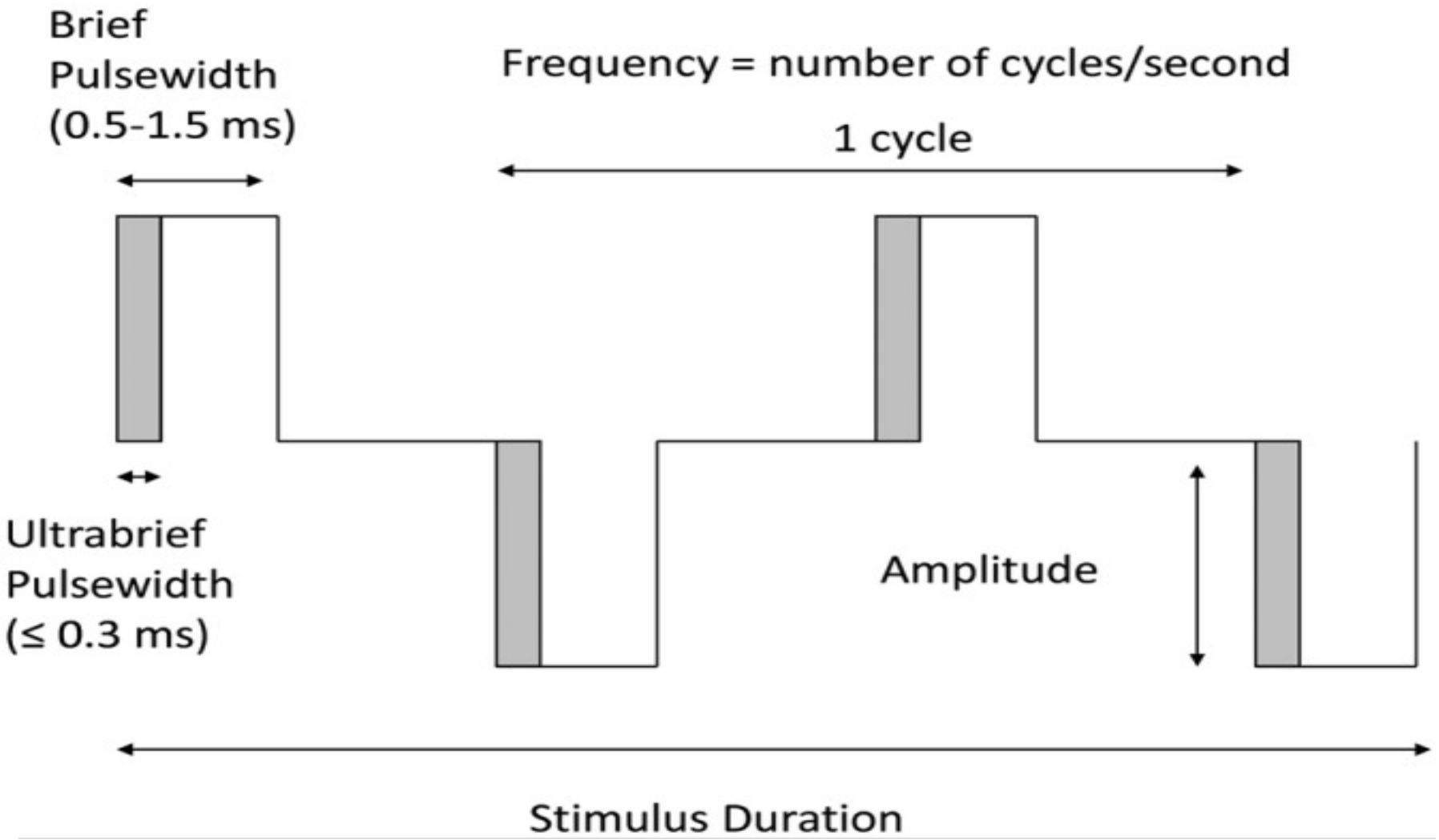
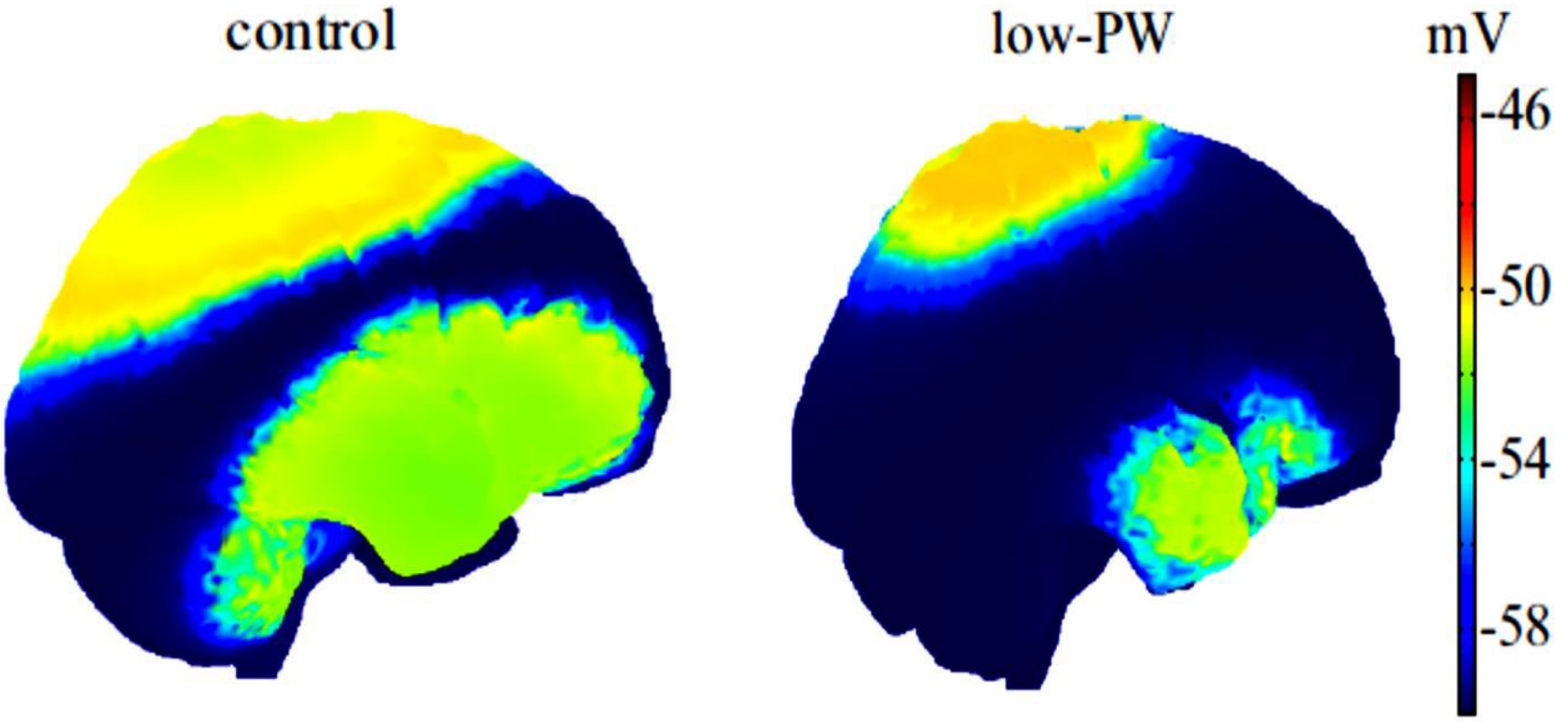


Brain Activation



Bai, Loo & Docos. (2012) Brain Stimulation. 5:408–421.

Electrode Placement: Computational Modelling

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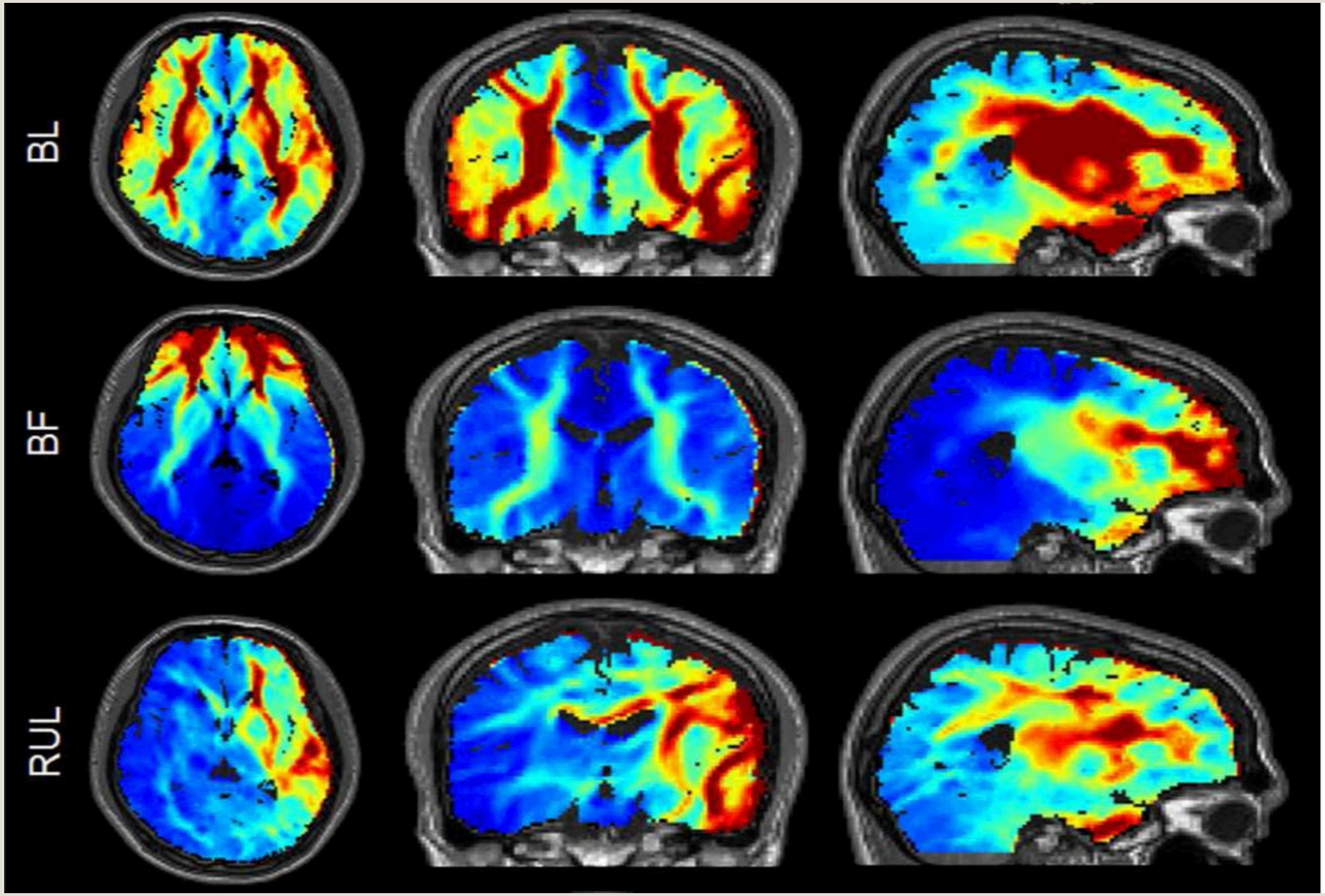

Brain Stimulation (2008) 1, 71–83

ELSEVIER

BRAIN
STIMULATION

www.brainstimjrnl.com

ORIGINAL RESEARCH

Effects of pulse width and electrode placement on the efficacy and cognitive effects of electroconvulsive therapy

Harold A. Sackeim, PhD, Joan Prudic, MD, Mitchell S. Nobler, MD,
Linda Fitzsimons, RN, Sarah H. Lisanby, MD, Nancy Payne, CSW,
Robert M. Berman, MD, PhD, Eva-Lotta Brakemeier, MA,
Tarique Perera, MD, D.P. Devanand, MD

RUL UB vs RUL BP

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- Meta-analysis of 6 studies **(689 patients)**
- RUL UB yields lower remission rates: **NNT of 12.1**
- Decrease in efficacy : ***SMD = 0.25***
  - Average **9.6 vs 8.7** ECT treatments
  - Response **55% vs 58%**
  - Remission **34% vs 45%**
- **Substantive decrease in neuropsychological SE:**
  - ***SMDs = 0.36***

Tor et al (2014) *J Clin Psychiatry.* 76(9)e1092-1098

Is RUL UB effective in real clinical settings?

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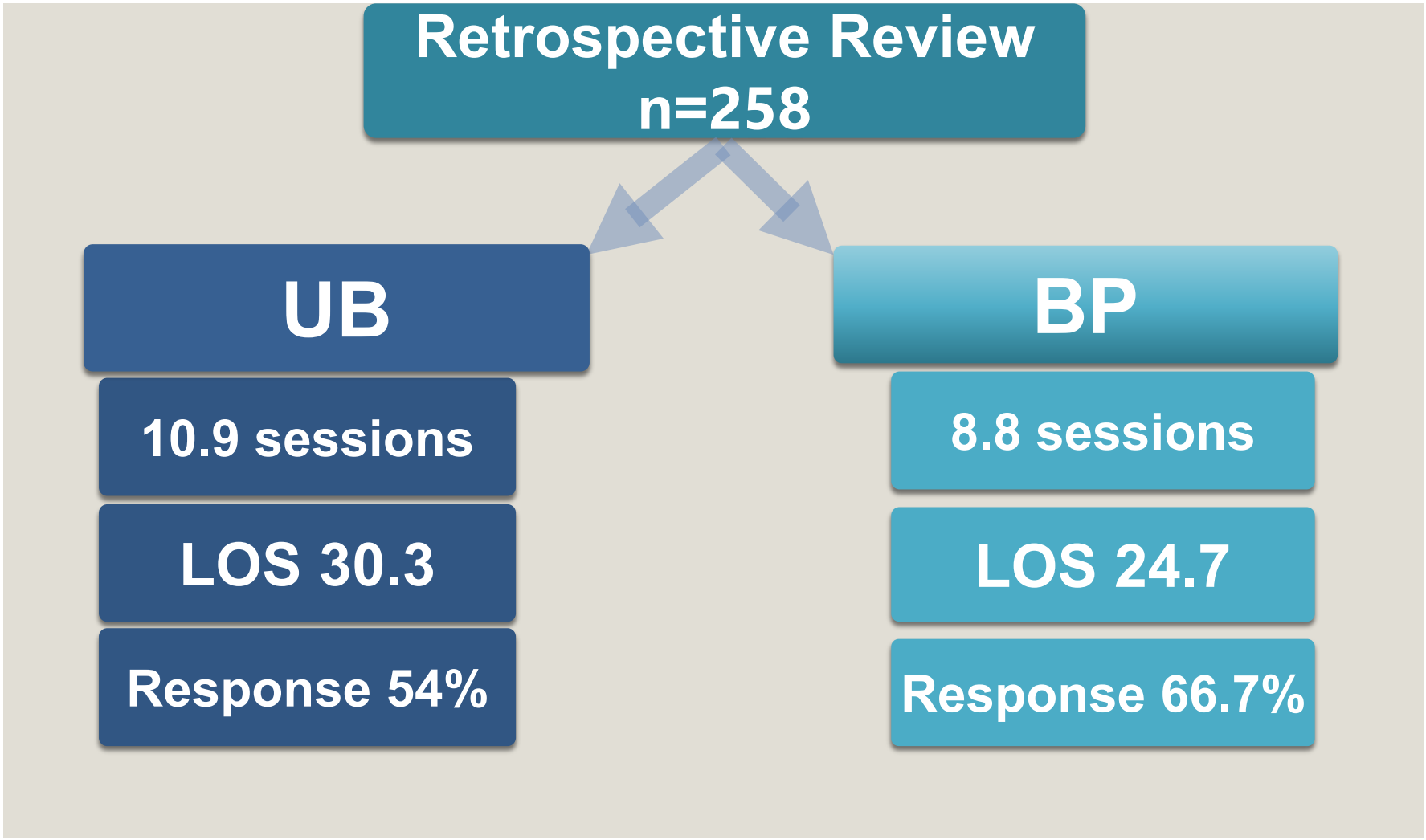

Galletly et al (2014) *Journal of ECT*. 30(1):10-14

Can Ultra Brief setting be applied to Bilateral ECT?

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	Electrode Placement & Pulse Width	Response	Remission	N	# sessions
Sackeim	**RUL UB 6XST**	**77%**	**77%**	22	8.7
	BT UB 2.5XST	**48%**	**43%**	23	8.9
Sienaert	**RUL UB 6XST**	**78%**	**44%**	32	8
	BF UB 1.5XST	**78%**	**34%**	32	10

Sackeim et al (2008) *Brain Stimulation*. 1: 71-83

Sienaert et al (2009) *J Affective Disorders*. 116: 106-112

Can Ultra Brief setting be applied to Bilateral ECT?

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	Electrode Placement & Pulse Width	Response	Remission	N	# sessions
Martin	**BT BP 1.5XST**	**61%**	**22%**	18	7.2
	BT UB 3XST	**33%**	**11%**	18	8.19

Dosing relative to seizure threshold needs to be substantially increased in Bitemporal UB to obtain comparable efficacy to Bitemporal BP and the cognitive advantage for UB needs further examination at these increased dose levels.

Martin et al. (2019) *Psychological Medicine*. 50: 1121-1128

Bilateral UB and QOL in Clinical Settings

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- QOL study- less improvement in QOL in BT and BF UB (proxy for efficacy) compared to RUL brief pulse
- → Bilateral UB not recommended routinely

Galvez, Oxley, Waite et al. (2016) *Journal of Affective Disorders.* 206: 268-272.

PRIDE Study

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- Depressed elderly patients received high-dose RUL UB (0.25-0.3 msec at 6 X ST) three times weekly + Venlafaxine.
- Of 240 patients who entered phase 1 of the study, 172 completed it.
- 61.7% (148/240) remitted
- 70% (169/240) responded
- Mean number of ECT treatments to remission was 7.3 (SD=3.1).
- Conclusion: RUL UB + venlafaxine, is a rapidly acting and highly effective treatment for depressed geriatric patients, with excellent safety and tolerability.

Kellner et al. (2016) *Am J Psychiatry.* 173:1101–1109.

↑ Dose over Course of UB ?

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- Previous studies inconsistent [ranging from no increase in dose in RCT (Sackeim et al, 2008) to 90% increase in clinical settings (Loo et al, 2008)
- ST retitration @ ECT #7→71%↑ in ST from initial ST (Suetani & Waite, 2013)
- Change in mid ictal amplitude from reference seizure to session 6 significant predictor of↑ in ST (Gálvez et al, 2017)

Loo et al. (20008) *Int J Neuropsychop.*11:883–890.
Suetani & Waite. (2014) *Journal of ECT.*30 (1): e1
Gálvez , Hadzi-Pavlovic, Waite & Loo. (2017) *Eur Arch Psychiatry Clin Neurosci.* 267(8): 795-801.

0.5 msec Pulse Width

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- Many people using this (widespread in Europe and 0.5 is the default factory setting for Thymatron machines) but little published evidence
- Dose above ST unclear ?1.5-3X Bilateral, 5-6X ST RUL
- No prospective study available comparing 0.3 with 0.5 ms stimuli.
- Evidence is insufficient to draw any definitive conclusion, perhaps it is a cognitive sparing option for Bilateral ECT.

Pulse Width >= 0.50 msec Increases Remission

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PW msec	Remission (%)
0.25-0.47	92 (29.0)
0.5	507 (44.4)
0.51-1.0	117 (55.5)
Electrode Placement	
Unilateral	625 (41.5)
Bitemporal	61 (57.5)
Bifrontal	30 (51.7)

Brus et al. (2017) *European Psychiatry.*45:154–160.

RUL D'Elia Position

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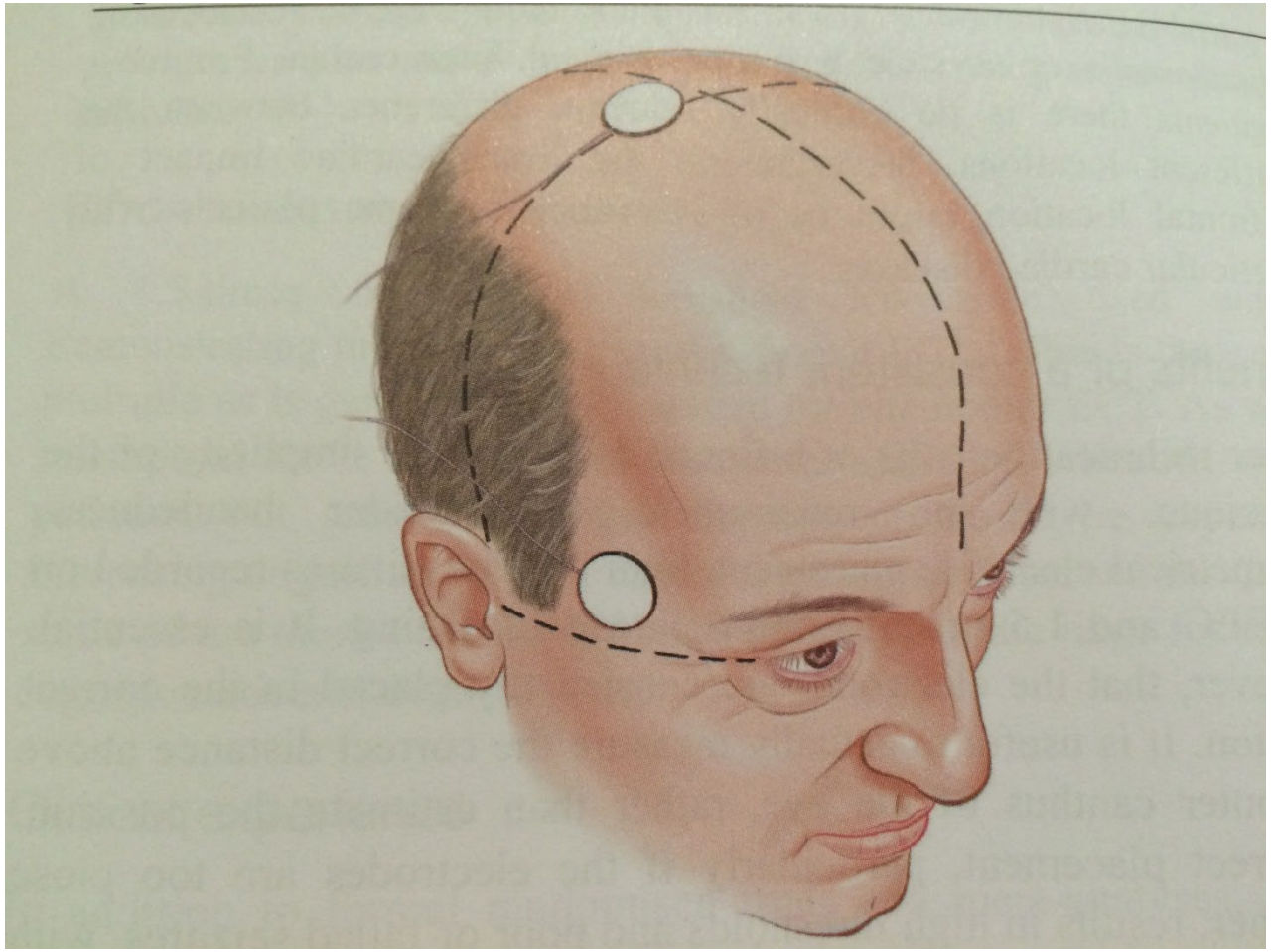
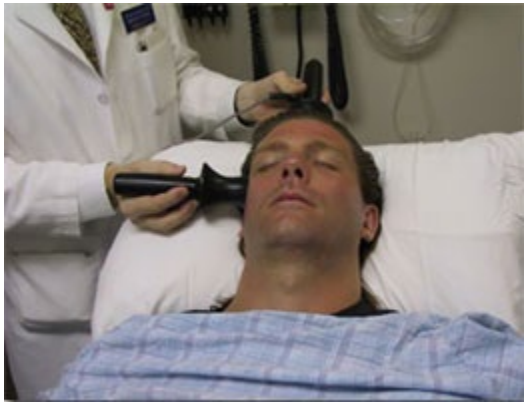
- Minimises stimulation of speech centres in dominant hemisphere.
- Temporal electrode (flat) placed over the right temporal fossa, with centre of electrode 2.5cm above the midpoint of a line drawn between the tragus and the external canthus of eye.
- The centre of the second electrode (concave) is placed slightly (1-2cm) to the right of the vertex (intersection of the line drawn between the nasion and inion), and the line connecting the two auditory tragi.





Evidence Base RUL 1.0 msec

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- Studies prior to 2000 concluded that RUL was moderately less effective than Bitemporal but were biased against RUL as dosing too low.
- Current evidence suggests that efficacy of adequately dosed (**6 times ST**) RUL ECT 1.0 ms pulse width is not inferior to bilateral ECT and is associated with less cognitive impairment than bitemporal placement (Kolshus et al, 2017; Semkovska et al, 2016)

Kolsus et al. (2017) *Psychological Medicine*.47: 518-530.

Semkovska et al. (2016) *American Journal of Psychiatry*.173(4): 408-417.

BT Versus High-Dose RUL ECT for Depression: a Systematic Review and Meta-analysis

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Study or Subgroup	Bitemporal Mean	SD	Total	Right unilateral Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year
Sackeim 2000	17.75	11.54	20	18.63	15.3	20	5.1%	-0.06 [-0.68, 0.56]	2000
McCall 2002	19.1	8	37	18.6	8.33	40	9.7%	0.06 [-0.39, 0.51]	2002
Ranjkesh 2005	24.3	7.76	14	24.8	6.62	12	3.3%	-0.07 [-0.84, 0.70]	2005
Sackeim 2008	19	8.47	23	21.5	8.47	22	5.6%	-0.29 [-0.88, 0.30]	2008
Sackeim 2009	16.7	11.8	164	17.3	12.1	155	40.3%	-0.05 [-0.27, 0.17]	2009
Kellner 2010	22.4	10.2	72	21	11.8	77	18.8%	0.13 [-0.20, 0.45]	2010
Semkovska 2016	17.48	9.39	69	18.33	8.44	67	17.2%	-0.09 [-0.43, 0.24]	2016
Total (95% CI)			**399**			**393**	**100.0%**	**-0.03 [-0.17, 0.11]**	

Heterogeneity: Tau² = 0.00; Chi² = 2.01, df = 6 (P = 0.92); I² = 0%
Test for overall effect: Z = 0.40 (P = 0.69)

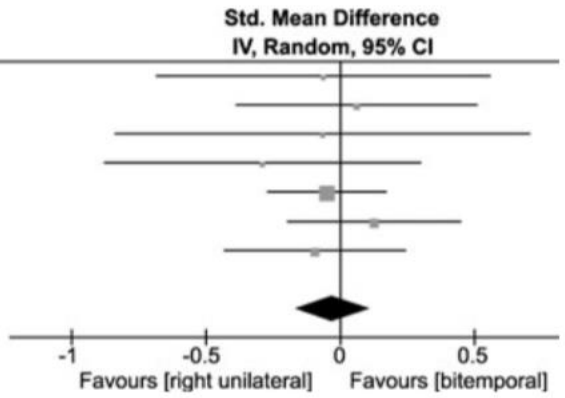

Fig. 1. Forest plot of standardized mean differences in HAMD-24 from baseline to end of treatment.

- BT ECT did not differ from RUL ECT on depression rating change scores or rate of relapse at 12 months.
- Advantage for RUL ECT on reorientation time after individual ECT sessions and retrograde autobiographical memory

Kolshus et al. (2017) *Psychological Medicine*.47: 518-530.

BT Versus High-Dose RUL Twice-Weekly Electroconvulsive Therapy for Depression

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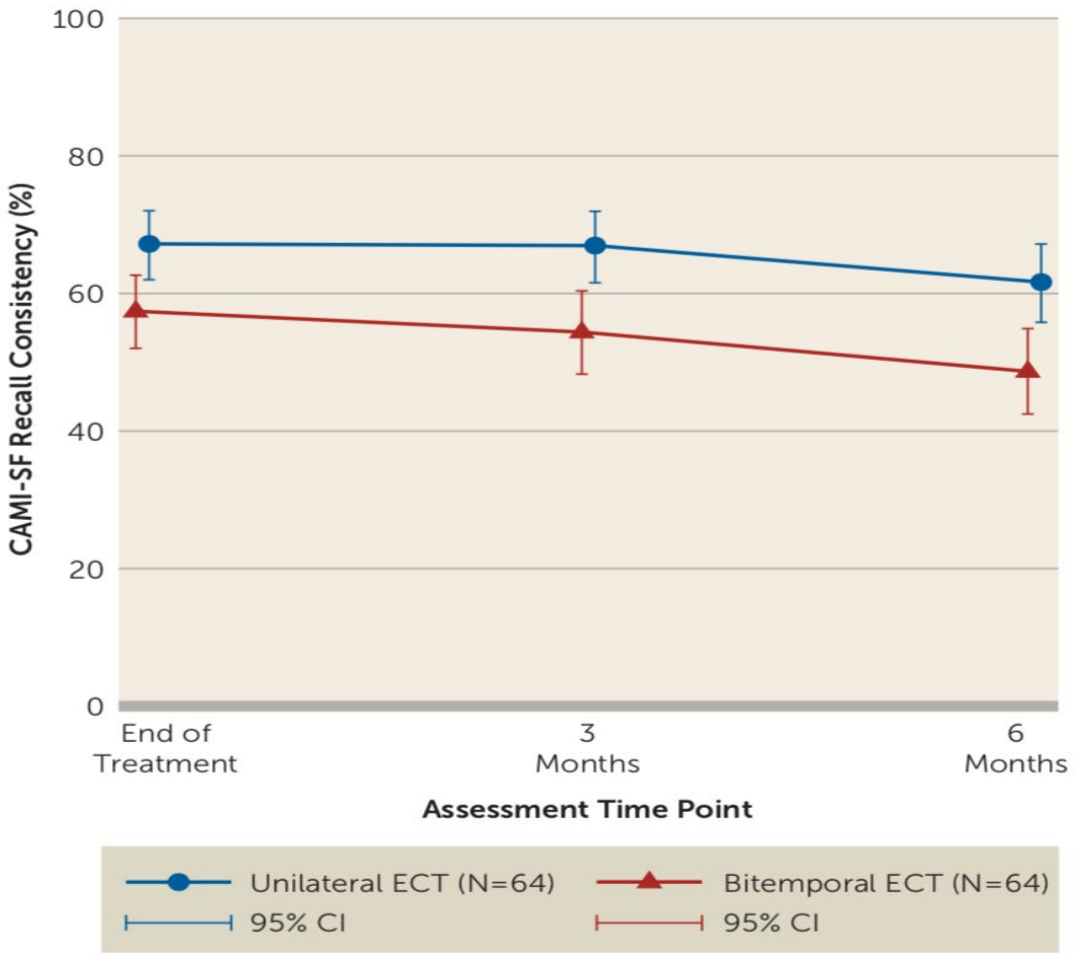
- No significant differences for response and re-mission or 6-month relapse status.
- RUL ECT had quicker recovery of orientation, better verbal learning, and fewer subjective cognitive side effects.
- BT had lower recall of autobiographical information.

FIGURE 3. Autobiographical Memory Following ECT: Recall Consistency (%) With Baseline Scores for Unilateral and Bitemporal ECT Groups[a]



[a] CAMI-SF=Columbia Autobiographical Memory Interview-Short Form.

Semkovska et al. (2016) *AJP*. 173(4): 408-417.

LUL Placement

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- Left hemisphere is typically dominant for language and verbal processing.
- Lateralization is partially related to handedness with 95% of right-handed people and 75% of left-handed people left dominant.
- 15% mixed-handers right dominant and 27% strong left-handers are most likely right dominant.
- So, if severe post-ictal dysphasia, confusion or memory loss in left handers post ECT, consider LUL or BF.

Evidence Base LUL 1.0 msec

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- Efficacy of LUL electrode placement similar to RUL and BL.
- Patients receiving LUL ECT tend to experience more verbal memory impairment than patients receiving RUL ECT, but less than patients receiving BL ECT.
- In contrast, patients receiving LUL ECT tend to experience the least visual and nonverbal memory impairment, compared to patients receiving RUL or BL ECT.

Kellner et al (2017) *Acta Psychiatr Scand*. 1–11.

Bilateral (Bitemporal) Placement

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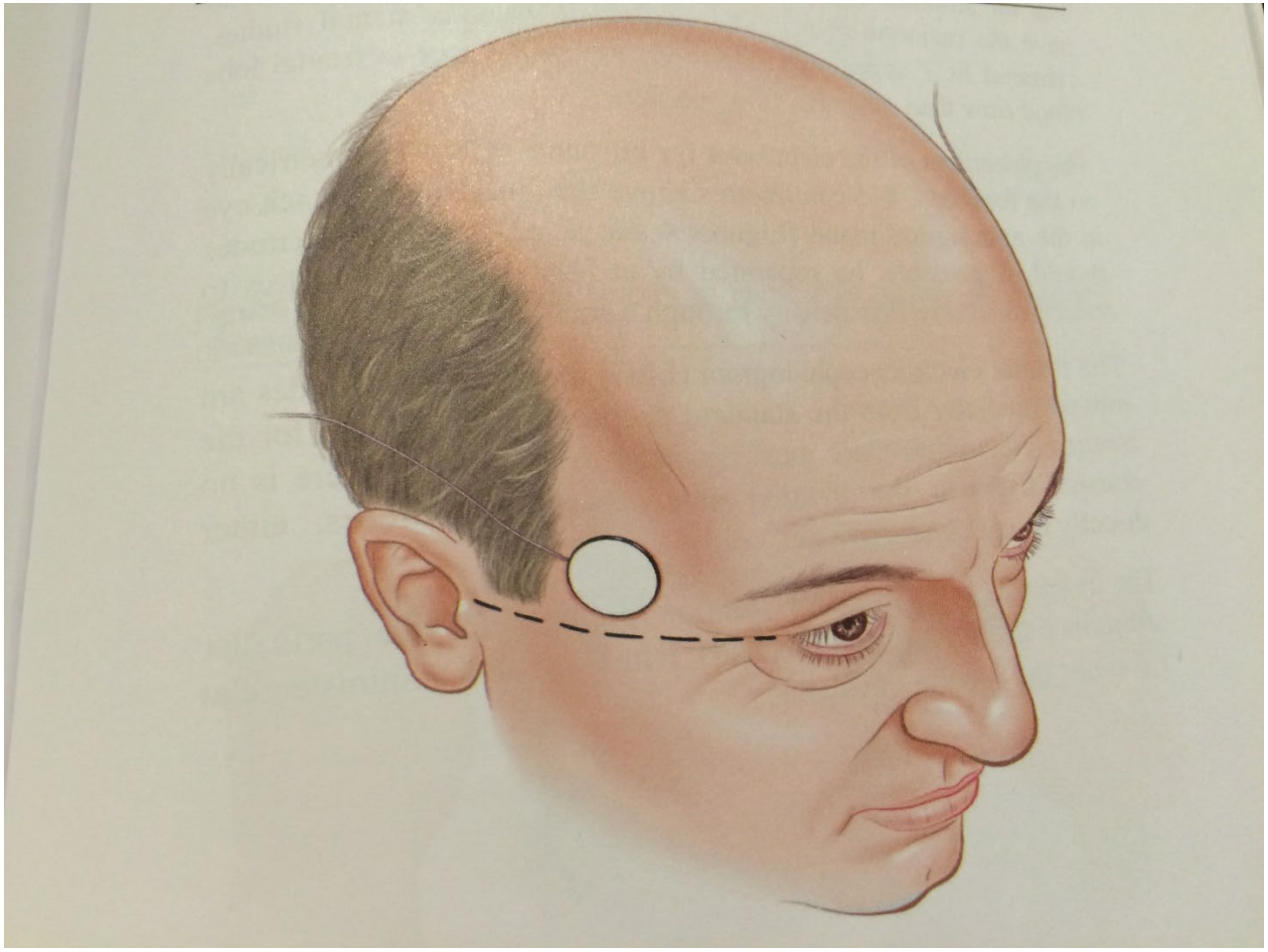
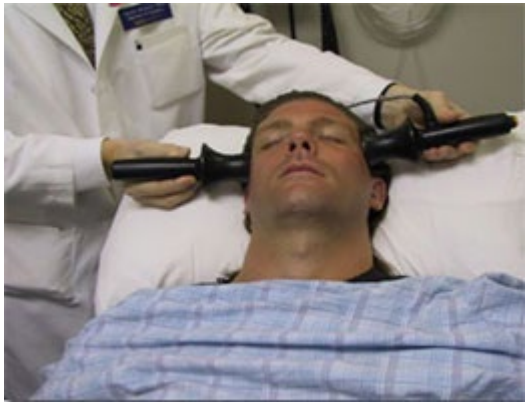
- Each electrode (flat) is placed in the temple bilaterally, as for the unilateral placement.





Evidence Base Bitemporal 1.0msec

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- Bitemporal placement is generally regarded as the most effective form of ECT (but evidence is lacking) and it is also associated with the greatest amount of cognitive impairment, particularly retrograde memory loss.
- Still to be considered when need for urgent response as patients may respond faster to BT ECT (Kellner et al, 2010).

Kellner et al. (2010) *British J Psych.*196 (3): 226-234.

BF, BT and RUL electrode placement in ECT

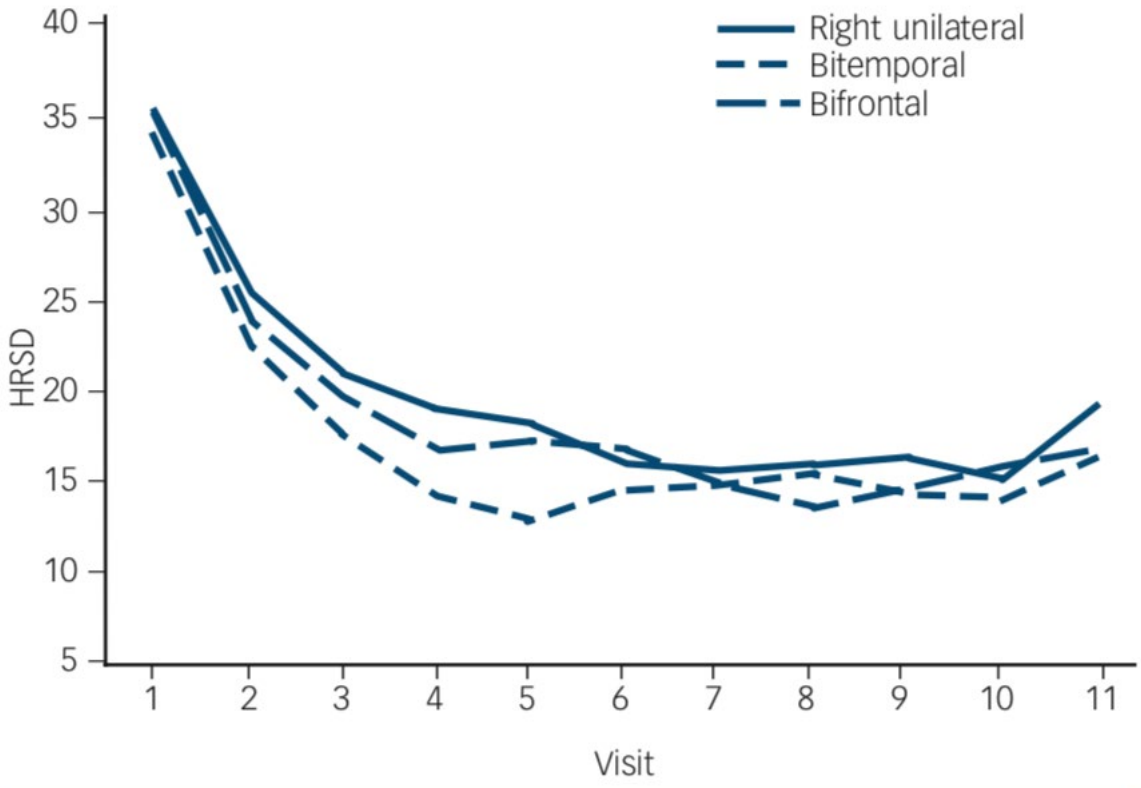

Fig. 2 Observed Hamilton Rating Scale for Depression–24 (HRSD–24) total score means.

HRSD scores: 0-7 normal, 8-13 mild depression, 14-18 moderate, 19-22 severe depression, >23 very severe

Kellner et al. (2010) *British J Psych.*196 (3): 226-234.

Bifrontal ECT

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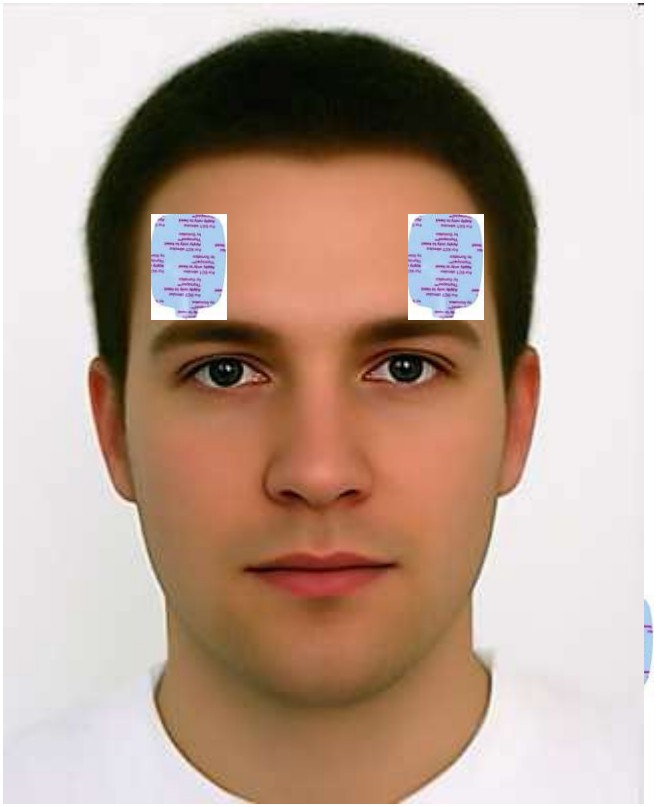
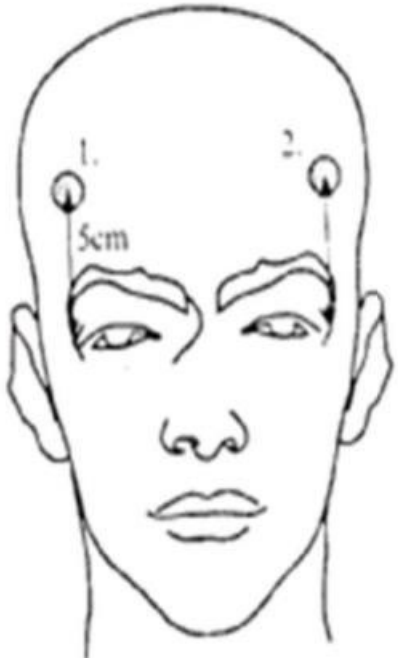
- Midpoint of e-pad or treating electrode (concave) is placed 5cm above the outer canthus of the each eye.
- Use marker for correct position.
- Can move frontal EEG electrodes medially.
- Avoid contact between treating and EEG electrodes as excess gel which can create a short circuit and skin burns.




1.
2.
5cm

Evidence Base Bifrontal 1.0msec

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- BF placement less studied than the other electrode placements, with Kellner 2010 study showing cognitive side effects similar to BT and efficacy similar to RUL.
- However, a meta-analysis showed BF to have equivalent efficacy to BT, but with fewer cognitive side effects. BUT BF had no advantage in either efficacy or cognitive side effects over RUL ECT delivered with a 1 ms pulse width and 4-6x seizure threshold (Dunne & McLoughlin 2012)

Dunne & McLoughlin. (2012) *World Journal of Biological Psychiatry.* 13(4): 248-258.

Systematic review and meta-analysis of BF ECT versus BT and RUL ECT in Depression

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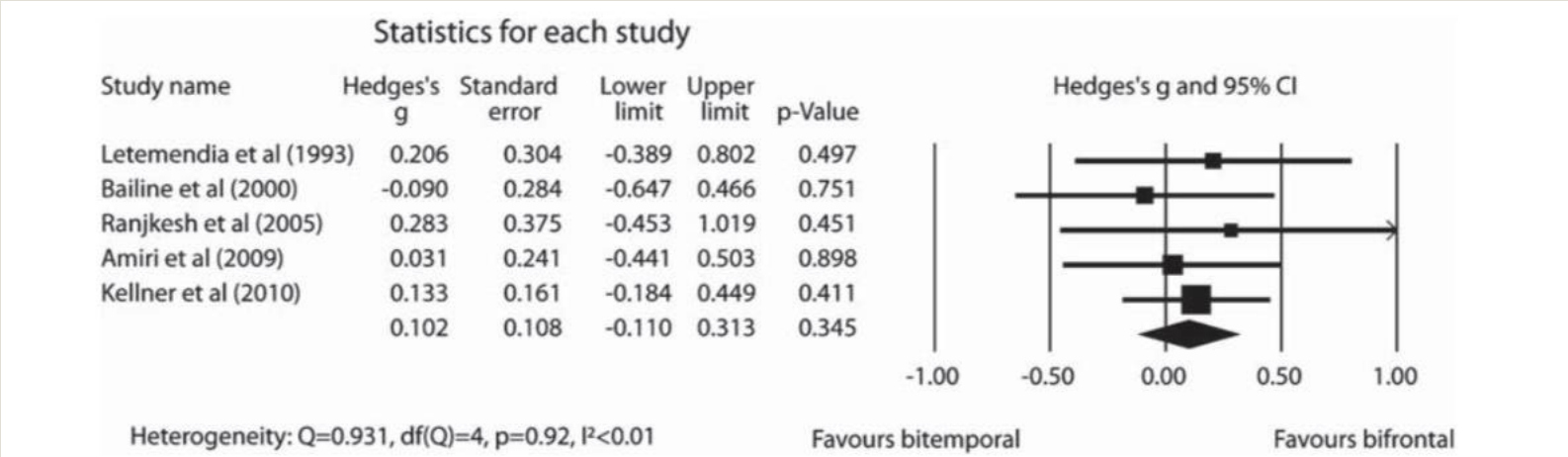

Figure 1. Hamilton Depression Rating Scale (HDRS) score change across treatment for bitemporal versus bifrontal ECT. Effect size is measured as Hedges's *g*; positive values represent an improvement in HDRS score after treatment that is relatively greater for bifrontal ECT while negative values favour bitemporal ECT.

- No significant difference in efficacy between all electrode placements
- BT ECT caused a greater decline in global cognition scores
- RUL ECT demonstrated smaller decline in immediate verbal memory score
- BF ECT displayed smaller decline in visual memory scores
- RUL and BF were equal in other cognitive domains tested on MMSE

Dunne & McLoughlin. (2012) *World Journal of Biological Psychiatry.*13(4): 248-258.

Is there an ideal placement and pulse width?

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- Debate continues about relative merits of BT, BF and RUL placements.
- No ‘one side fits all’ model.
- Need to individualise based on patient and illness factors, balancing the need for speed of response, urgency of the clinical situation, the patient’s previous response and concern regarding potential cognitive side effects.
- Importance of education, informed consent and involvement of carers/family.

When to Consider RUL 0.3msec

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- Good first line option, particularly in less urgent cases.
- Patient preference to preserve cognitive functioning.
- Side effects to standard ECT in past.
- Elderly +/- cognitive decline.
- Psychotic and melancholic depression (as will respond better to all forms of ECT).

When to Consider RUL 1.0 msec

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- Good first line option, particularly when likelihood and speed of response paramount.
- Suboptimal response RUL UB ECT in past.

When to Consider Bitemporal 1.0 msec ECT

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- Very high risk emergency situations e.g. catatonic, dehydrated, acutely suicidal patients.
- If poor response to other electrode placements.
- If previous good response only to BT ECT.

When to Consider BF 1.0msec

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- In cases of poor response to RUL ECT.
- In cases switched to BT ECT because of poor response who have unacceptable cognitive side-effects.
- Less likely to cause asystole so good option in patients with cardiac comorbidity.
- In cases with medical comorbidity where the aim is to minimise the number of treatments (i.e. switching from RUL) but also reduce cognitive risk.
- May be good alternative in Mania and Schizophrenia as better tolerated and equally as efficacious as BT.

Clinical and Cognitive effects of BF and BT ECT in Schizophrenia

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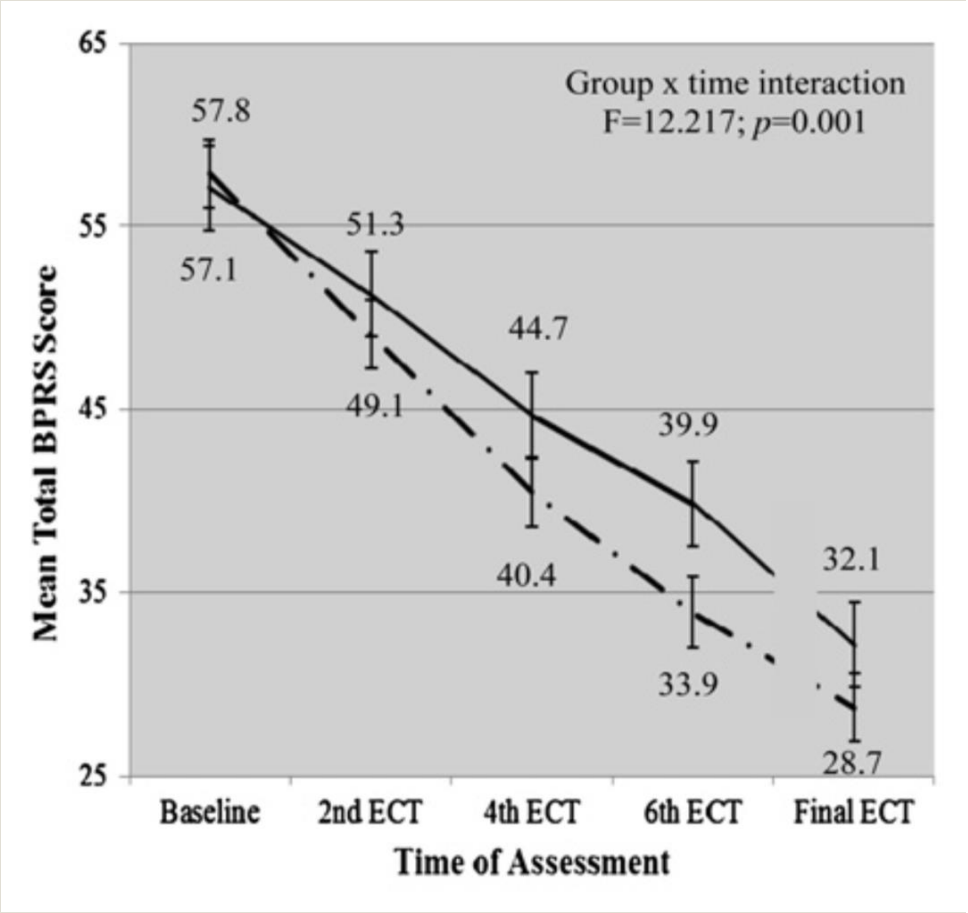
- BF performed better in terms of faster clinical response, greater improvement overall and better cognitive outcomes



Phutane et al. (2013) *Brain stimulation*.6(2): 210-217.

Clinical and Cognitive effects of BF, BT and RUL ECT in Schizophrenia

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- Improvement in positive symptoms were comparable between BF and BT ECT and slightly less with RUL.
- BT ECT produced greater impairment in autobiographical memory and cognitive outcomes.
- BF ECT was associated with the best profile of efficacy and cognitive safety in patients with schizophrenia.

Bansod et al. (2018) *Journal of ECT.*34: 26–30.

BF and BT ECT in Acute Mania

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- YMRS scores showed faster decline in the BF ECT than in the BT.
- No significant differences between groups in cognitive function.

Hiremani et al. (2008) *Bipolar Disord.*10(6):701-7.

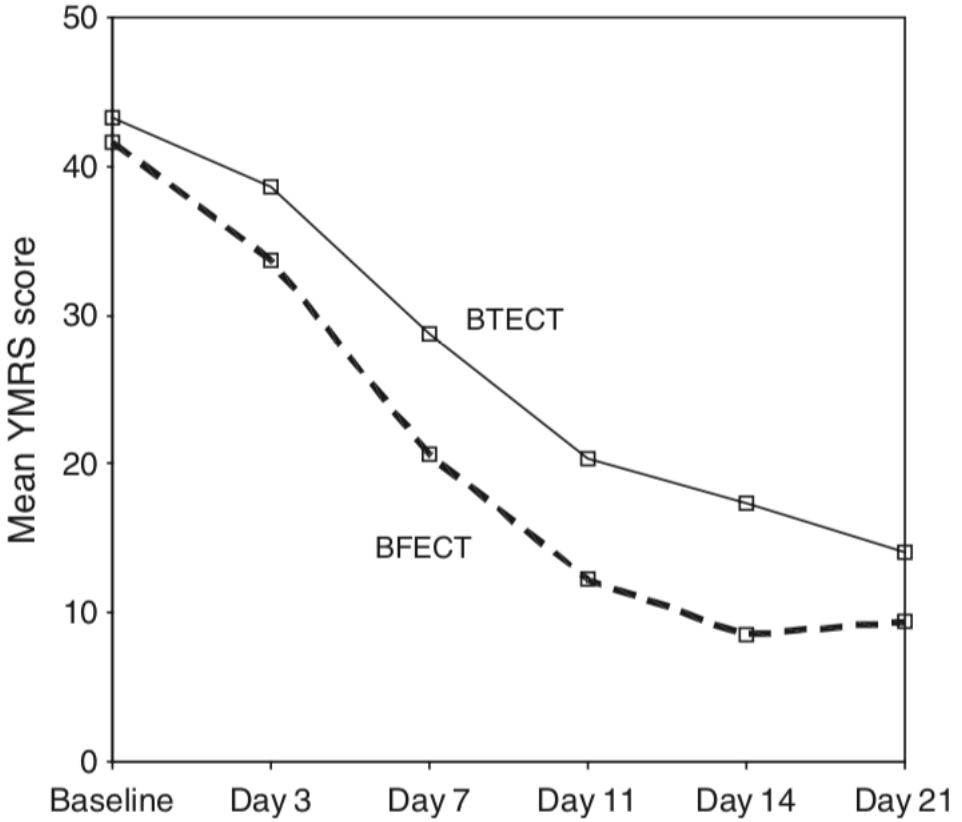

Fig. 1. Young Mania Rating Scale (YMRS) scores across assessment sessions. Group × Occasion effect (quadratic contrast) $F = 5.13$; df = 1,33; $p = 0.03$. BFECT = bifrontal electrode placement; BTECT = bitemporal electrode placement.

Cardiac Risk During Stimulus

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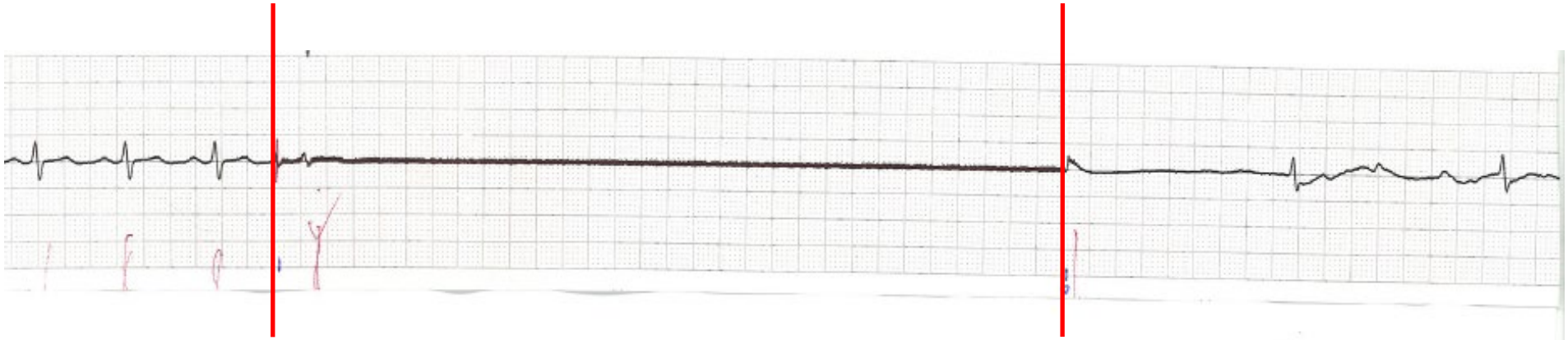
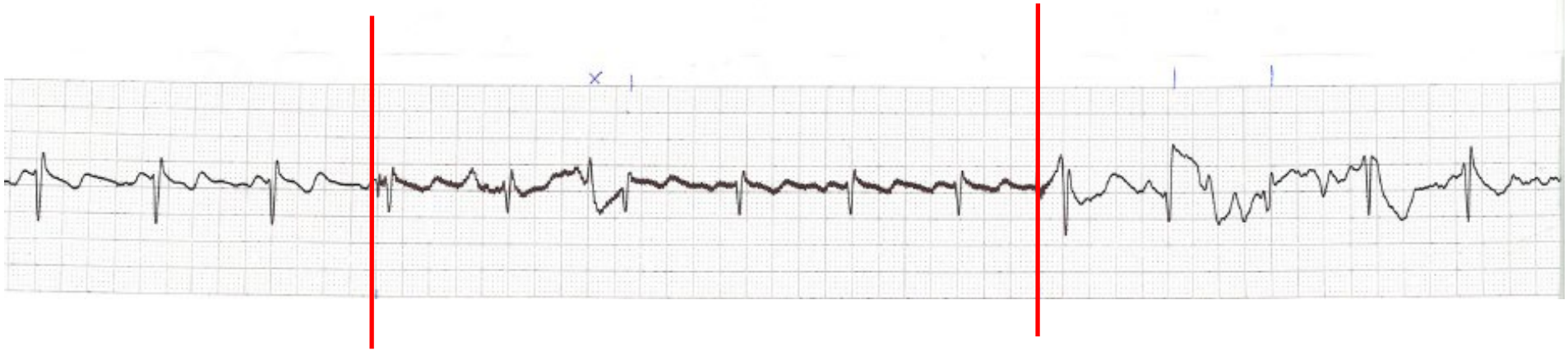
- ECT has a biphasic effect on the cardiovascular system.
- Initial vagal stimulation & pronounced parasympathetic surge during stimulus➞ sinus bradycardia, asystole, & hypotension.
- Usually benign but can be prolonged in:
    - Pre-existing cardiac disease
    - Age >65
    - Beta blockers
    - Sub-convulsive stimuli
    - Hypoxia
    - Acetylcholinesterase inhibitors
    - Increased or second dose of suxamethonium

Hermida et al. (2022) *Journal of ECT.*38: 2–9

Cardiac Effects of ECT Stimulus



RUL ECT, 504 mC



Post-Ictal Asystole

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- Post seizure, there is a second parasympathetic surge that can lead to asystole.
- Occurs more commonly in adult well conditioned males with a low resting HR.
- Postulated to be due to more responsive and healthier heart conduction system of younger patients.
- Avoid beta blockers and use prophylactic anticholinergics (Glycopyrrolate 0.2-0.4mg IV or Atropine 0.3-0.6mg IV).
- Anticholinergics cause tachycardia, so routine use not recommended (Hermida et al, 2022).

Hermida et al. (2022) *Journal of ECT.*38:2-9.

Cardiac Effects of ECT Stimulus

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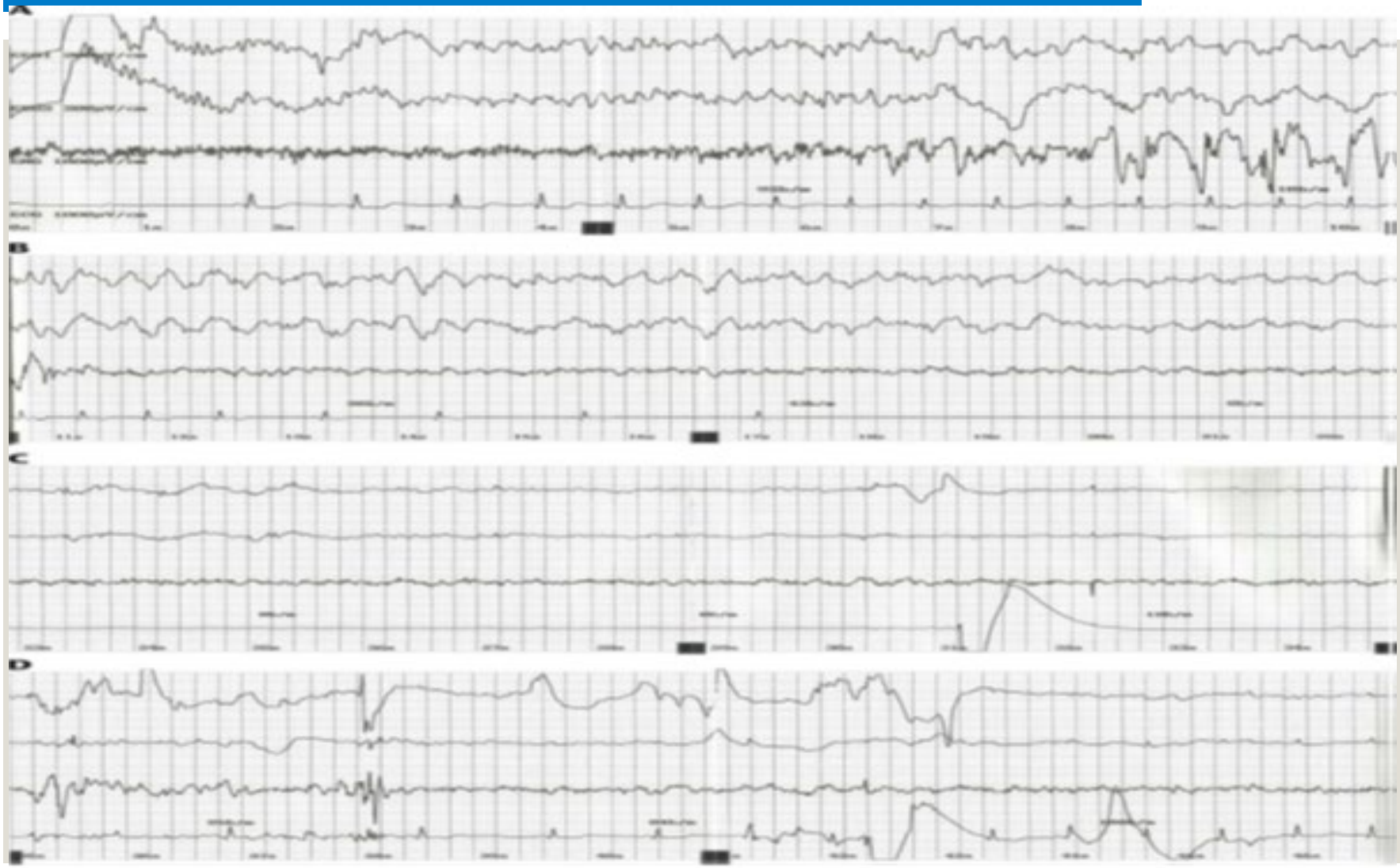


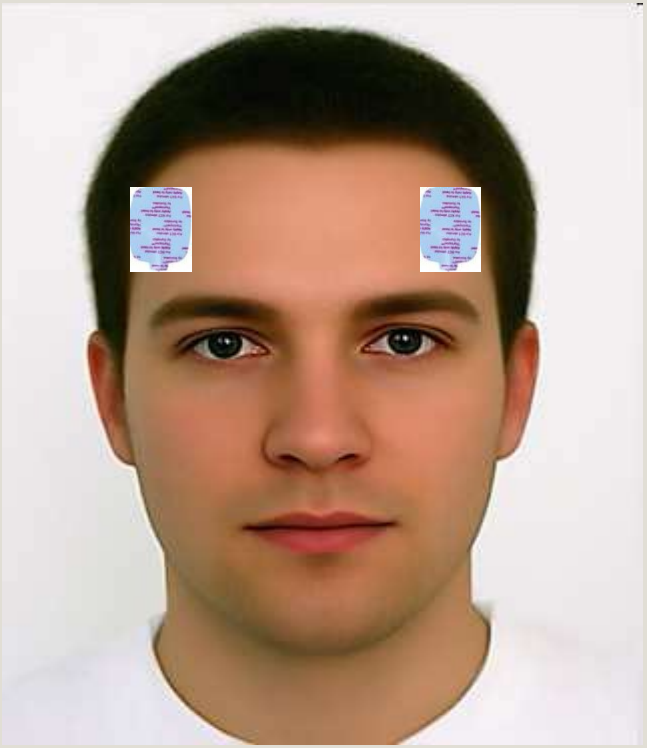
Bryson et al (2018) *Journal of ECT* 34: 3-4.

Electrode Placement & Asystole

The Royal Australian & New Zealand College of Psychiatrists

Bifrontal (BF) placement is associated with less asystole than bitemporal (BT) and right unilateral (RUL) placements.

Electrode Placement	Incidence Asystole >5 secs
RUL-UB	24% (43/180)
RUL 1.0 ms	49% (39/80)
BF 1.0 ms	**2.5% (2/79)**
BT 1.0 ms	11.6% (14/121)



Stewart et al. (2011) *International Journal of Neuropsychopharmacology.*14: 585-594.

Cardiac Risk During Seizure

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- Sympathetic surge during seizure.
- Increases in cardiac output, systemic vascular resistance, blood pressure, and heart rate, with tachyarrhythmia and increasing myocardial oxygen demand.
- In a study of 450 ECT treatments BP increased from 136/74 to 179/97. HR increased from 75 to 126 bpm (Bryson et al, 2013)
- Although transient, it may lead to left ventricular systolic dysfunction, acute coronary syndrome, or cardiac failure and in vulnerable populations myocardial infarction or intracerebral hemorrhage (Bansal et al, 2021)

Bryson et al. (2013) *Journal of ECT.*29:76–77
Bansal et al. (2021) *J Neuroanaesthesiol Crit Care.*8:173–179

Stimulus Dose Titration

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- ST= minimum electrical charge (millicoulombs) capable of producing a generalized seizure
- Wide range of inter-individual variability in ST (increased by older age, male sex, bilat electrode placement, medications, higher PW)
- Substantial evidence to support basing dosing on individual ST (not basing on age or absolute dose) is a better predictor of side effects, efficacy and speed of response (Sackeim et al, 1987, 1991, 1993)
- Recent criticism about the evidence of stimulus dosing (Rosenman, 2018) triggered vigorous debate (Loo et al, 2018).

Rosenman (2018) *Australian & New Zealand Journal of Psychiatry.* 52: 410–414.
Loo et al (2018) *Australian & New Zealand Journal of Psychiatry. 52: 711-712.*

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RANZCP Guidelines

ANZJP

Royal Australian and New Zealand College of Psychiatrists professional practice guidelines for the administration of electroconvulsive therapy

Alan Weiss[1], Salam Hussain[2,3], Bradley Ng[4], Shanthi Sarma[5], John Tiller[6,7], Susan Waite[8,9] and Colleen Loo[10,11]

Australian & New Zealand Journal of Psychiatry
2019, Vol. 53(7) 609–623
DOI: 10.1177/0004867419839139

SAGE

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ECT Electrode Placements, Pulse Width and Threshold

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Electrode placement	Recommended parameters for pulse width and threshold	
For right unilateral (RUL) ECT	Ultrabrief pulse width (0.3 ms) at 6× threshold	1.0-ms pulse width at 5–6× threshold[a]
	0.5-ms pulse width at 5–6× threshold is recommended, noting lower level of evidence	
For bifrontal (BF) ECT	1.0-ms pulse width at 1.5× threshold	0.5-ms pulse width at 1.5–2.5× threshold
For bitemporal (BT) ECT	1.0-ms pulse width at 1.5× threshold	0.5-ms pulse width at 1.5–2.5× threshold

Weiss et al. (2019) *ANZJP.*53(7): 609– 623.

ECT Titration and Stimulus Dosing Chart

Dr Shane Gill
TQEH, SA, 2018

Level	Dose	BITEMPORAL 1ms (DGX) 1 level above (1.33x – 1.5x ST)	BIFRONTAL 1 ms (DGX) 1 level above (1.33x – 1.5x ST)	RUL 1 ms (DGx) 5 levels above (5x – 6x ST) (except L1 = 4 levels)
1 BP	5%	Only use for all RUL women & RUL men < 50 y.o. Treatment dose is 4 levels higher, not 5 levels		→ L5 = 30%
2 BP	10%	L3 = 15%	L3 = 15%	L7 = 55%
3 BP	15%	L4 = 20%	L4 = 20%	L8 = 75%
4 BP	20%	L5 = 30%	L5 = 30%	L9 = 100%
5 BP	30%	L6 = 40%	L6 = 40%	L10 = 150%
6 BP	40%	L7 = 55%	L7 = 55%	L11 = 200%
7 BP	55%	L8 = 75%	L8 = 75%	200%
8 BP	75%	L9 = 100%	L9 = 100%	200%
9 BP	100%	L10 = 150%	L10 = 150%	200%
10 BP	150% (2XDGX)	L11 = 200%	L11 = 200%	200%
11 BP	200% (2XDGX)	200%	200%	200%

RUL UB (0.3ms)

Level & Dose	Treatment dose
1 UB 3%	→ 20%
2 UB 5%	→ 35%
3 UB 7%	→ 50%
4 UB 10%	→ 70%
5 UB 15%	→ 100%
6 UB 20%	→ 140% (2XLP)
7 UB 30%	→ 200% (2XLP)

TITRATION GUIDELINES

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- Commence titration at appropriate level on chart.
- Use isolated cuff R lower limb- should see motor activity and/or ictal EEG slow wave activity to call it threshold.
- Observe EEG and motor response (10-12 secs). If no seizure activity restimulate at next level.
- Repeat re-stimulation by levels until threshold reached.
- Administer **Supra-threshold** stimulus 60 – 90 sec after the threshold stimulus. Avoid a second bolus of Propofol if feasible.
- Option to stop after reaching threshold seizure to improve tolerability and reduce risk of confusion and anaesthetic complications.
- There should be a maximum of **FOUR** stimulations per titration session

TITRATION GUIDELINES

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- If the first **THREE** titrations are sub-threshold, deliver the **FOURTH** stimulus at what the appropriate dose would be if the next level was the threshold e.g. for RUL UB, if 3, 5 and 7 % were subthreshold, deliver the 4th stimulus at 70%, the therapeutic dose for the next level in the schedule (10%).
- At the next session continue titration at that next level (in this example, 10%).
- At TQEH, option to select 100% in Bilateral ECT for the fourth dose in high risk cases where urgent response is needed.

STIMULUS DOSING GUIDELINES DURING COURSE

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- When **EEG quality deteriorates** compared to the best EEG for that patient, (or 'reference seizure' which is usually the EEG post-titration at session two) either:
  - **Increase to the next level on the chart**, according to the placement and PW used, or;
  - **Consider retitration of threshold**, especially if in doubt about EEG quality e.g. in UB, and set dose to previously titrated threshold.
- Consider **retitrating threshold**, (or increasing stimulus dose by 1 level if titration unsuitable), **if clinical response has plateaued**, regardless of EEG quality.

STIMULUS DOSING GUIDELINES DURING COURSE

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- When re-titrating, commence at previous threshold. Option to start lower if there has been a significant medication change (e.g. cessation of anticonvulsants).

- In **RUL UB**, **re-titrate threshold at session #7**, unless:
  - -EEG quality remains very good, and;
  - -Clinical response has also been good, or;
  - -There has been a recent retitration and/or increase in stimulus dose, or;
  - -Titration is unsuitable (e.g. for anaesthetic reasons)

Stopping at Threshold Seizure Versus Suprathreshold Seizure Session 1

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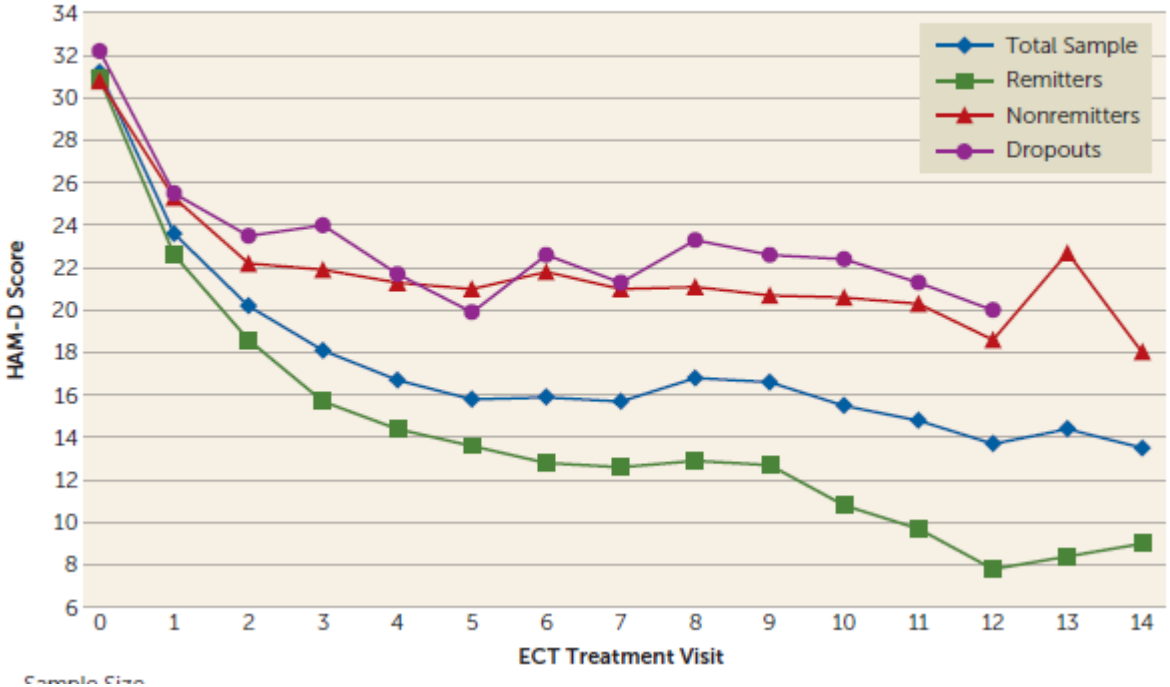
- Evidence supporting efficacy of session 1 threshold seizure includes a 10 point reduction in HRSD scores after only one ECT (Kellner et al, 2010 & 2016).
- ?ECT naïve brain may be more sensitive to first threshold dose.

Kellner et al. (2016) *Am J Psychiatry.*173:1101–1109.

Kellner et al. (2010) *British J Psych.*196 (3): 226-234.

FIGURE 2. Trajectory of Observed Mean Scores on the 24-Item Hamilton Depression Rating Scale (HAM-D), by Outcome Group, in a Study of ECT and Venlafaxine in Geriatric Depression[a]



Risks of Progressing to Suprathreshold Seizure Session 1

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- Higher chance of confusion, myalgia and anaesthetic complications with titration to suprathreshold stimulus, especially in the elderly.
- If the delay is too long and a 'top up' dose of anaesthetic agent is required, resultant stimulation and seizure could be poor, negating the potential benefit of restimulation while potentially worsening cognitive outcome (Weiss et al, 2019).
- So, weigh up pros and cons for individual patient.
- More research needed (Gill, 2019)

Weiss et al. (2019) *ANZJP*.53(7): 609– 623.
Gill S. (2019) *ANZJP.*53(9): 920– 922.

Factors to Consider in Assessing EEG quality During Course

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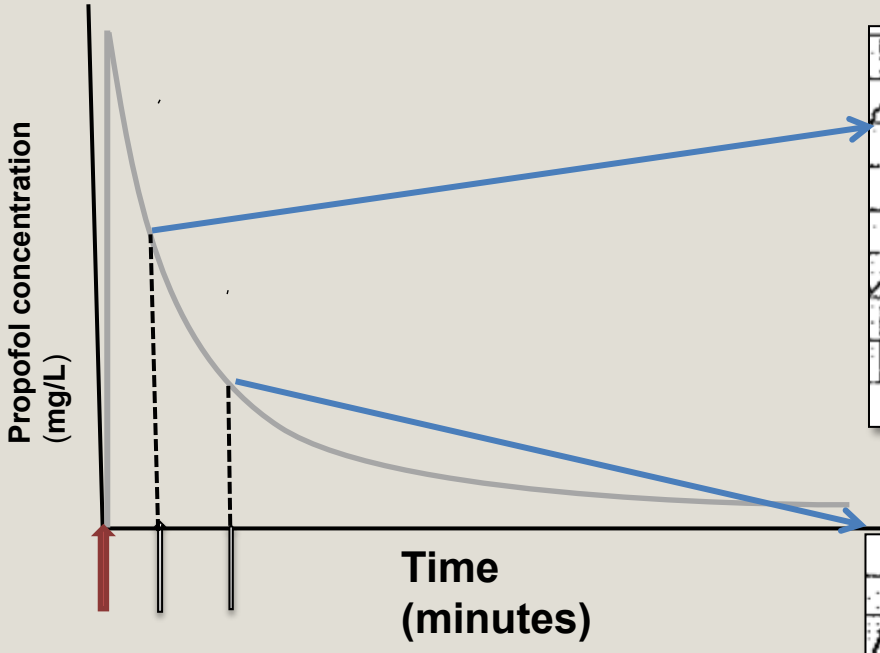
- Type and dose of induction agent (Propofol vs Thiopentone, combine with remifentanil or alfentanil)
- Anaesthetic time (time between induction and stimulus)
- pO2/pCO2-ratio (hyperventilation)
- # ECT treatments (GABA effect)
- Other medications
- ‘MIGHT’ (Cian Tuohy)

- ECT modality and dose
- Spacing between sessions

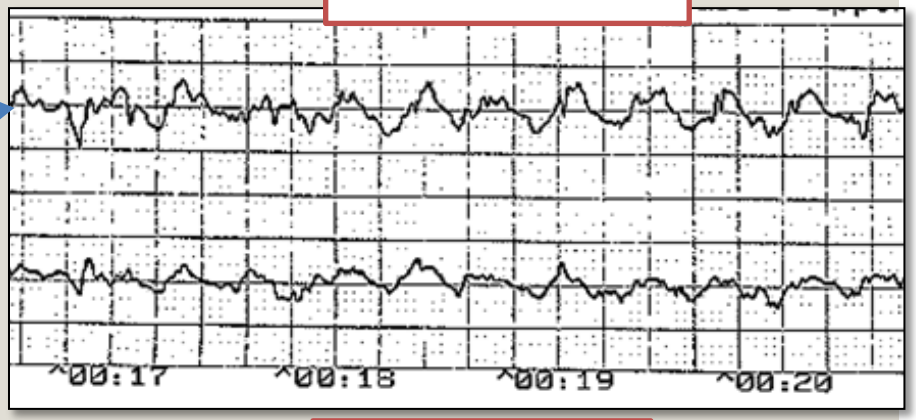
Galvez et al. (2017) *Journal of ECT*. 33:4-6.

Timing of Anaesthesia in ECT

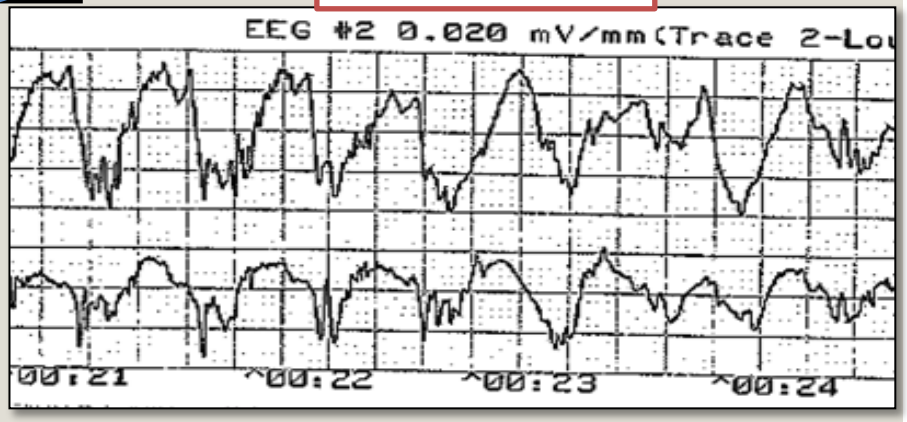
The Royal Australian & New Zealand College of Psychiatrists



1 min 35 s

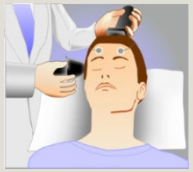


3 min 8 s



Anaesthetic injection

ECT stimulus



Galvez et al. (2016) *Brain Stimulation*.9:72–77.

Maximising Efficacy

The Royal Australian & New Zealand College of Psychiatrists

- Switch to bilateral after 6 sessions of RUL 1.0msec PW if no response as some depressed patients experience significant improvement after switching.
- Switch after 6-8 sessions of RUL-UB if no improvement as response to UB is slower.
- Ensure adequate dose above ST.
- As ECT is anticonvulsant (GABA effect), change anaesthetic parameters, increase stimulus dose during course or retitrate if poor response and/or EEG deteriorates.
- Continue acute course until recovery maintained for about 2 treatments and then consider stepdown.

Medications and ECT

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- Give oral medications at their usual time up to one hour prior to each treatment, especially medications that will make ECT safer (antihypertensives, steroids, anti-reflux agents, anti-anginals & antiarrhythmics).
- If possible avoid medications that will increase the risks of ECT or make it less therapeutic.
- Consider stopping or holding theophylline, diuretics, hypoglycaemics, anticonvulsants, benzodiazepines and lithium.

Antidepressants- adverse effects

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- Reports of adverse cardiac effects (prolonged QTc, postural hypotension), confusion (anticholinergic side effects) and excessive sedation in patients taking TCAs during ECT.
- Early reports of prolonged asystole and hypotension in patients taking venlafaxine during ECT (Kranaster et al, 2012).
- MAOIS with ECT have been associated with BP changes, hyper-reflexia and seizures.
- SSRIs generally considered safe during ECT.
- Bupropion has been associated with a dose dependent increased risk of seizures. But case control study showed seizure duration actually significantly shorter with ECT + concomitant bupropion, and probability of a prolonged seizure was not significantly different (Takala et al, 2017).

Kranaster et al. (2012) *Pharmacopsychiatry*.45: 122–124
Takala et al. (2017) *Journal of ECT*.33: 185–189

Antipsychotics

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- Generally safe with ECT.
- Clozapine may increase risk of prolonged seizures and confusion as it lowers the seizure threshold.
- Typical antipsychotics may induce ECG abnormalities such as prolonged QTc interval and cause postural hypotension.
- ECT may augment pharmacotherapy for treatment resistant patients. Use of ECT- risperidone or ECT-clozapine most effective.

Sanghania et al. (2018) *Curr Opin Psychiatry.* 31:213–222

Lithium carbonate

The Royal Australian & New Zealand College of Psychiatrists

- Case reports of severe confusion and prolonged seizures resulting from ECT in patients taking Lithium (Huber & Burke, 2015)
- Treatment with Lithium predicted slightly lower initial seizure threshold (Galvez et al, 2015)
- Where possible, suspend lithium prior to a course of ECT.
- In a patient with bipolar disorder, with risk of a manic swing if lithium is withdrawn, omit evening dose prior to each ECT treatment and delay morning dose until after recovery from the treatment. Alternatively, use dose at lower end of the therapeutic range during ECT.

Huber & Burke. (2015) *Australasian Psychiatry.* 23(5):500-502.
Galvez et al. (2015) *Brain Stimulation*. 8(3):486-92.

Emerging Evidence Re Antiepileptic Drugs (AEDs)

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- Despite intuitive evidence that anti-seizure medications should be avoided, evidence is inconclusive.
- Possible to induce seizures with minimal effect on ST and seizure duration in patients on multiple different AEDs (Chiao et al 2020)
- Anticonvulsants can increase, decrease or have no effect on ST and seizure duration (Tang et al, 2017).
- In prospective studies, anticonvulsants did not reduce ECT effectiveness and there was a faster response to BT ECT in manic patients who remained on full dose (vs half dose) anticonvulsants (Rakesh, 2017).
- Valproate had strongest evidence supporting continued use in recent review (Cinderella et al, 2022)

Chiao et al. (2020) *JECT.*36: 115-122.
Rakesh et al (2017) *JECT.* 33:16-21.
Tang et al (2017) *JECT.* 33:237-242.
Cinderella et al. (2022) *JECT.* 38: 133-137

Benzodiazepines

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- Review showed benzos decrease seizure duration but rarely increase ST (Tang et al, 2017).
- Benzodiazepines may reduce response in RUL ECT but not BL ECT.
- Mixed results re effects on treatment response. Response actually better with in BT + BZD group in recent study (Delamarre et al, 2019)
- Some case reports and case series of patients on polypharmacy (benzos and AEDs) had poor seizures which improved when medication was reduced.
- Option to use Flumazenil (0.5-1mg IV pre-ECT) in cases where patients are on benzodiazepines (e.g. catatonia) and there are poor seizures or treatment response (Cinderella et al, 2022).
- Non-benzodiazepine hypnotics have similar detrimental effects on ECT.

Tang et al (2017) *JECT.*33:237-242. Delamarre et al (2019*) JECT*.35:184-188.
Cinderella et al. (2022) *JECT.*38: 133-137.

Good ECT Resources

The Royal Australian & New Zealand College of Psychiatrists

- Kellner C. (2019). *Handbook of ECT A Guide to Electroconvulsive Therapy for Practitioners.* Cambridge; UK: Cambridge University Press.
- Kellner C. et al. (2020) When to consider ECT. *Acta Psychiatr Scand*. 141: 304-315
- Richardson M. (2022). ECT: What's Love Got To Do With It? *JECT.* 38: 72-73.
- Tiller JWG, Lyndon RW. (2013). *Electroconvulsive Therapy A Guide.* Melbourne: Health Education Australia Limited.
- Weiss AJ. (2018). *The electroconvulsive therapy workbook : clinical applications*. Abingdon, Oxon ; New York, NY: Routledge.
- Weiss A, Hussain S, Ng B, Sarma S, Tiller J, Waite S and Loo C. RANZCP professional practice guidelines for the administration of electroconvulsive therapy. (2019) *ANZJP*;53(7): 609– 623.

Patient Resources

The Royal Australian & New Zealand College of Psychiatrists

Gold Coast ECT journey (6 mins)
https://www.youtube.com/watch?v=HEot7ow3yfk

ECT -The Whole Story (10 mins)

https://www.youtube.com/watch?v=IjoS31JC0As

ECT-Let's Talk About It (16 mins)

https:youtube/ZYCjz-6iEW4

Radio National Podcast, Conversations, 'An Extreme Treatment for Depression" featuring Helen Elliot 8/3/18

http://www.abc.net.au/radio/programs/conversations/conversations-helen-elliott/9500946

Handout re ECT from RANZCP

https://www.yourhealthinmind.org/treatments-medication/ect