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ECT Seizure Duration: Database Information

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Abstract

Aim: In this naturalistic study the aim was to examine the impact on seizure duration of stimulus intensity, previous treatments (during the first course of ECT), age, gender, and electrode placement.
Method: The database of the ECT Service of the Royal Hobart Hospital was examined for the 15 years ending in 2010. First courses of ECT were identified in which the stimulus intensity was not altered and at least 5 treatments were provided. Seizure duration was determined by cessation of clonic movements.
Result: 383 patients (164 males) met selection criteria. A multiple regression analysis revealed that previous treatments, age, gender, and electrode placement had non-significant regression coefficient on the seizure length. The stimulus intensity, however, showed significant regression coefficient (-.267, p <.001), indicating that higher stimulus intensity induced shorter seizure duration.
Conclusion: It was suggested that electrode placement and the number of treatments had negligible influence on seizure duration, while high stimulus intensity reduced seizure duration. If fixed high dose ECT is being provided, and there is concern due to the brevity of seizures, rather than taking steps to increase the output of the machine, a modest reduction of dose (perhaps to ≤ 428.4 mC, or ≤ 85% of machine output) may increase seizure duration (German J Psychiatry 2011; 14: 35–39).

Keywords: Electroconvulsive therapy; depression; seizure duration

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Introduction

Early work (Ottosson, 1963) suggested that for a seizure to have antidepressant effects, it needed to last longer than 25-30 seconds. This became a universal standard and a recommendation of the American Psychiatric Association Taskforce on Electroconvulsive therapy (APA Taskforce on Electroconvulsive Therapy 1978). While other work (Weiner, 1980; Delva et al., 2001) appears to support this quantum, a positive correlation between seizure duration has not been demonstrated (Andrade et al., 1988; Lalla and Milroy, 1996; Shapira et al., 1996; Abrams, 2002).

Abrams (2002) states that the recommended minimum seizure duration of 25-30 seconds was arrived at “arbitrarily”, and “it might just as well have been 10 seconds or 60 seconds”.

While seizures of less than 25-30 seconds can be therapeutic, Krystal et al. (2000) have shown that patients experiencing seizures of < 25 seconds have a depression response rate of 32%, and those experiencing seizures of > 25 seconds have a response rate of 66%. In a field of many uncertainties, such findings have clinicians favouring longer seizures.

Stimulus dose and electrode position are complicating factors. Sackeim et al. (1987), for example, showed that seizures of greater than 25 seconds have little therapeutic effect in low dose, unilateral ECT.

Until recent decades, seizure duration was exclusively determined by the cessation of clonic movements. Some services use the "cuff method", which attempts to prevent depolarizing agent reaching the periphery of an upper limb, in the effort to better identify the end of the seizure. The Royal College of Psychiatrists' Special Committee on ECT, however, described the cuff method as unreliable (Scott, 2005).

EEG seizure description is beset by difficulties. "Seizure morphology" varies with ECT technique, for example, the "seizure intensity" of low dose unilateral ECT differs from that of high dose bilateral (Krystal et al., 1993) and EEG ictal features change over the course of treatment (Krystal et al., 1996). In short, physiological measurements (both EEG and ECG based) are yet to be universally approved and routinely applied in clinical practice. In fact, "The importance of seizure morphology in predicting clinical outcome is far from being understood" and "EEG seizures" are frequently less useful than the observation of clonic movements (McCall, 2009).

A progressive decrease in seizure duration over the course of ECT has been reported (Holmberg, 1954; Small et al., 1981; Kales et al., 1997). Such seizure duration decrease has been linked to progressive threshold increase (Shapira et al., 1996; Abrams 2002). The notion that seizure duration decreases over the course of ECT helped shape the recommendation that compensatory increases in stimulus intensity be made (Swartz 1993 & 2002, Abrams 2002). Consistent with seizure duration decrease over the course of ECT are the observations of Abrams (2002), that the first seizures are always longest, of Glenisson et al. (1998), that most prolonged seizures occur during the first treatment of a series, and of van Waarde et al. (2010), that for people receiving continuation ECT, increased time interval between treatment sessions correlates with increased seizure duration. However, di Michele et al. (1992) using a fixed dose stimulus, and Scott and Boddy (2000) using stimulus dosing strategy, did not show a significant change in seizure duration over a course of treatment.

Electrode placement has been found to influence seizure duration, significantly longer seizures being associated with bilateral compared to unilateral placement (Weiner, 1980). However, most reports (Weiner et al., 1986; Sackeim et al., 1987; Delva et al., 2000) have found no difference in seizure duration between electrode placements, in low dose ECT.

In general, stimulus intensity is positively associated with seizure duration (Azuma, 2009), and this has intuitive appeal. However, some evidence suggests that seizure duration is inversely related to stimulus intensity (Delva et al., 2000).

Age has been known to be positively correlated with seizure threshold for over half a century (Watterson, 1945, Delva et al., 2000). Rasimas et al. (2007) reported a strong inverse correlation between age and seizure duration. Gender is a strong predictor of seizure threshold, males having higher thresholds (Sackeim et al., 1987; 1991). Rasimas et al. (2007) found that females have longer first seizures than males, but there was no gender influence on the duration of subsequent seizures.

ECT practitioners may have concerns when seizures do not last 25–30 seconds, and when seizure duration does not reduce over the course of treatment. In this naturalistic study the aim was to examine the impact on seizure duration of stimulus intensity, previous treatments (during the first course of ECT), age, gender, and electrode placement.

Method

The Department of Psychological Medicine at the Royal Hobart Hospital is associated with the University of Tasmania, Australia. The ECT Service of this department has generated half a dozen papers and letters over 15 years, but is not directly attached to the university and is not conducting ongoing research. It has a dedicated ECT nurse and the medical staff are credentialed to provide ECT by the hospital. The machines most recently deployed were Thymatron® DG (1993-2007) and Thymatron® System IV (2007-2010).

The anaesthesia procedure for ECT at the RHH has not varied in the last 15 years and includes pre-oxygenation, and the anaesthetic agents, atropine 0.4-0.8 mg, propofol 1-2 mg/kg, and succinylcholine 0.5 mg/kg.

Two electrode placements are used: bilateral (bitemporal) and unilateral (using the d'Elia positions).

Three dosing methods have been used at different times and concurrently (different clinicians having different preferences): i) fixed-high-dose ($\geq$ 453.6 mC or $\geq$ 90% of machine output), applied either unilaterally or bilaterally, ii) age-based stimulation (the age of the individual determining the percentage of machine output, applied either unilaterally or bilaterally), and iii) stimulus titration (with treatment being applied at 2.5 X threshold stimulus, applied right unilaterally).

The duration of the seizure is determined by observation of cessation of clonic movements in all body regions. Additional information regarding the adequacy/quality of the seizure is drawn from the EEG including EEG endpoint, average seizure energy index, postictal suppression index, maximum sustained power, maximum sustained coherence and time to peak coherence. As the machines frequently fail to calculate one or more of these quanta, they are not relied upon, and will not be considered in this report.

The ECT Service (RHH) provides treatment comparable to that of many non-research ECT services of other major Australian hospitals.

Records were examined for the 15 year period ending in mid 2010, and 921 first courses of ECT were located. Courses were selected for inclusion when, 1) there had been no change in the stimulus dose during the course, and 2) at least 5 treatments had been provided. Seizure duration was examined for the first 5 or 6 seizures.

It was not possible to ascertain comprehensive details of medication. The great majority were taking an antidepressant, antipsychotic or mood stabilizer, or a combination of these. Benzodiazepines are used sparingly at the Royal Hobart Hospital, and these are reduced or ceased when ECT is to be provided, but a small proportion of patients selected for examination would have been receiving benzodiazepines and/or an anticonvulsant.

Statistical Analysis

A standard multiple linear regression was performed taking seizure duration as the criterion and the following variables as predictors: stimulus intensity, age, number of previous session (course), and unilateral/bilateral application. Prior to interpreting the results of the multiple regression, the assumptions of normality, linearity, and homoscedasticity of residuals were tested. In addition, multivariate outliers were assessed with Mahalanobis distance.

Results

Records were located of 383 patients who received an average of 5.3 ECT treatments, making a total of 2023 treatments. These were 164 males and 219 females, with a mean age of 48.03 (*SD*=15.87) years. 193 patients received unilateral treatment and 190 received bilateral. The mean seizure duration was 23.99 (*SD*=9.99) sec.

The multiple linear regression was used to investigate each of the predictors (stimulus intensity, age, number of previous session (course), and unilateral/bilateral application) contributions to the seizure length. Homoscedasticity was examined via several scatterplots and these indicated reasonable consistency of spread through the distributions. Mahalanobis distance did not exceed the critical χ^2 for df=4(at α=.001) of 18.47 for any case in the data, indicating that multivariate outliers were not of concern. Correlations between stimulus intensity, age, number of previous session were small (range between -.133 and .210), indicating multicollinearity is unlikely to be a problem.

Since no *a priori* hypotheses had been made to determine the order of entry of the predictor variables, a direct method was used for the multiple linear regression analyses. The four predictors produced an adjusted R^2 of .112 (F (4,378) = 11.84, p <.001) for the prediction of seizure length. However, the stimulus intensity was the only predictor which showed significant regression coefficient (see Table 1).

Table 1. Standard Regression Coefficients (β), and Squared Semi-Partial Correlations (sr^2) for Each Predictors in a Linear Regression Model Predicting Seizure Length

Variable	β	p	sr2
Age	-.060	.235	.003
Stimulus Intensity	-.267	.001	.042
Number of previous sessions	-.048	.333	.002
Uunilateral/ bilateral	.062	.322	.002

Discussion

This study is limited by 1) the retrospective design, and 2) involving patients taking psychotropic medication. This is a large (in terms of both time period and numbers treated) naturalistic study. Such studies carry the disadvantage of retrospection, but the advantage of being closer to the circumstances encountered in ordinary clinical practice. For example, in this study patients continued on at least some psychotropic medication, which is the routine practice in many service orientated units, but eschewed in research centres.

A further criticism of the study can be that we used propofol, which is known to reduce seizure duration (Fredman et al., 1994). Tan & Lee, (2009) found seizures associated with propofol to be half the length of those associated with etomidate. However, propofol was used for every ECT, and while the use of this agent may explain some overall seizure brevity, it would not explain the important findings of this study (that very high stimulus intensity shortens seizure duration and that during a course of ECT, seizure duration remains relatively constant).

We were inspired to conduct this study by years of providing ECT equipped with limited useful information on seizure duration. There is no universally agreed objective monitoring technique to determine seizure duration. Further, it is common for the device one is reliant upon to fail to provide one or many of those "Seizure Quality Measures" which are purported to possess some value in seizure monitoring. Thus, the clinician is often left largely reliant on the observation of the clonic movements to make the seizure duration determinations.

Clinical experience and some authorities (Abrams 2002; Scott, 2005) inform that seizures of less than 25-30 seconds can be therapeutic. However, there is a large body of information (Krystal et al., 2000) indicating that the chances of a therapeutic outcome are greater when the seizure length is at least this long. There is evidence to suggest that seizure duration decreases over the course (Holmberg, 1954; Small et al., 1981); Kales et al. (1997) reported a 37% duration reduction. Duration reduction is consistent with the anticonvulsant hypothesis of ECT, which is based on the observation that seizure threshold increases over the course of ECT (Sackeim et al., 1987). Thus, in ordinary ECT practice there may be concern when the seizure duration is less than 25 seconds and the duration of the seizure does not decrease.

The advantage of this study is that it is large, drawn from a period of 15 years and identified 383 first courses of ECT in which at least 5 treatments having been provided, and with the same anaesthetic applied in every case.

It is also important because 64% of patients (246) received fixed high dose stimulation. We had been influenced by Abrams (1992) who recommended "375 to 500 mC" (approximately 75-100% of machine output) applied right unilaterally.

The multiple linear regression analysis suggested that the effects of age, number of previous session, and electrode position (bilateral and unilateral) on the seizure length were rather negligible. Only the effect of stimulus intensity was significant, indicating that higher the stimulus intensity, shorter the seizure durations.

This is counter intuitive, one might expect that stronger stimulation would result in longer seizure, however, Delva et al. (2000) has reported seizure duration being inversely related to the applied charge. This observation may be related to the observations that higher doses (at least to some degree) are associated with better therapeutic outcomes (Sackeim et al., 1987), and the degree of post ictal suppression is related to clinical improvement of depression (Nobler et al., 1993). However, to our knowledge, any relationship between duration and post-ictal suppression is yet to be fully explored.

This study looks at seizure duration independent of therapeutic outcome. It confirms that seizure duration does not inevitably shorten with the progression of therapy. In addition, if fixed high dose ECT is being provided, and there is concern due to the brevity of seizures, rather than taking steps to increase the output of the machine, a modest reduction of dose (perhaps to $\leq$ 428.4 mC, or $\leq$ 85% of machine output) may increase seizure duration.

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