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Short Communication

Epilepsy surgery: How accurate are multidisciplinary teams in predicting outcome?

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ABSTRACT

Background: Since epilepsy surgery is an elective procedure, patients need to weigh the risks of the procedure against the likely outcome if they are to make an informed decision to proceed. The aim of this study was to examine the accuracy of multidisciplinary team predictions of postoperative outcome in epilepsy surgery candidates.
Methods: An experienced multidisciplinary team provided preoperative predictions of postoperative outcome in 94 temporal lobe epilepsy patients who subsequently proceeded to surgery and were followed up one year later.
Results: Team predictions of postoperative outcome were generally accurate for groups of patients judged to have a 30%, 40%, 50% or 60% chance of becoming seizure free. Team estimates of odds tended to regress towards the mean. Logistic regression analyses were more accurate than the team estimates in identifying patients with a very good (>70%) or very poor (<20%) chance of complete seizure freedom. Non localising scalp EEG, necessitating the need for an invasive EEG study prior to surgery was a significant predictor of poor postoperative outcome in this series.
Conclusions: Probabilities based on logistic regression models may augment and improve the accuracy of clinical estimates of postoperative outcome in patients with a very good or very poor chance of being rendered seizure free by surgery, by counteracting the tendency of regression towards the mean in team decision making.

1. Introduction

The advantages of an early, definitive surgical intervention to stop seizures are many.[1,2] Living with uncontrolled seizures for many years has a negative impact on quality of life, particularly in social, economic and cognitive domains and increases the risk of Sudden Unexpected Death in Epilepsy (SUDEP).[3] However, surgery carries small risks of a catastrophic complication such as stroke, postoperative infection and death.[4] A significant visual field defect may develop in 1 in 20 cases following a temporal lobe resection.[5] Cognitive functions may also be adversely affected.[6] Although odds vary according to individual clinical factors, many patients contemplate surgery knowing that it entails an appreciable risk of a postoperative decline in memory or language function.[7]

Since epilepsy surgery is an elective procedure, patients need to weigh these risks against the chances of surgical success if they are to make an informed decision to proceed. Most patients consider the surgical option as a curative rather than a palliative procedure and hope to become seizure free as a result, since even infrequent postoperative seizures can continue to have a significant impact on quality of life, particularly when it comes to driving. It is therefore imperative that clinicians are able to give every patient accurate odds on their chances of becoming seizure free if they proceed to surgery. This estimate of the likelihood of success is the foundation of the decision making process, since these are the odds against which the patient and clinician will evaluate all the other risks of the procedure before they proceed.

Numerous clinical and demographic factors have been associated with poor postoperative outcome in univariate studies. Generally the factors that have been associated with a poor postoperative outcome tend to be markers of a neurological abnormality that is more widespread than the proposed margins of the resection, be they neurophysiological, neuropsychological, neuroradiological or clinical signs. However, combining these factors in multivariate statistical models to predict postoperative

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seizure control, has yielded disappointing results,[8] partly because candidates with a poor prognosis tend not to proceed to surgery, thus surgical cohorts become more homogenous over time. Nevertheless, between 15% and 40% of surgical candidates will not be seizure free, one year postoperatively.[9]

In clinical practice, outcome studies published in the literature inform clinical decision making, alerting clinicians to relevant prognostic indicators. In the majority of cases, the odds of becoming seizure free will be determined by an expert team reviewing the case, rather than statistical manipulation of individual patient data. However the accuracy of team decision making in this context has not been established.

The aim of this study was to examine the accuracy of multidisciplinary team expert review in the prediction of postoperative outcome in epilepsy surgery candidates.

2. Methods

2.1. Subjects

In our centre, potential epilepsy surgery candidates are discussed in a weekly multidisciplinary team meeting. To be eligible for inclusion, patients who were assessed had to have been given quantified odds of becoming seizure free based on the team discussion of their presurgical test results *prior* to surgery. A consecutive series of 100 patients who fulfilled this criteria and who had subsequently proceeded to surgery and been followed up one year later was identified from the patient records (2000–2007). 94 patients underwent a standardised temporal lobe resection: 44 RTL, 50 LTL. Six patients underwent extratemporal resections. These patients were excluded from the analyses since decision making in the two groups is not comparable. In extra temporal cases, predictions are likely to be more conservative, experience will be inevitably less, and variability between cases will be more. The mean age of the 94 patients who underwent a temporal lobe resection was 34.8 years (s.d. = 8.6) at the time of surgery, with a mean age of seizure onset of 11.7 years (s.d. = 9.1).

This sample does not represent a consecutive series of patients who underwent surgery at our hospital, rather it is a series where there was clear clinical documentation in the patients medical records that the chance of becoming seizure free following surgery had been determined at the presurgical multidisciplinary meeting, rather than by the individual treating neurologist or surgeon who subsequently transmitted the odds to the patient at the presurgical consultation. Whilst this means that we can be sure that this study is evaluating the accuracy of team decision making, it is also the case that this sample will form a biased subset of the patients on the surgical programme at the hospital. Whether team determined odds are documented in a patients records will depend on administrative factors such as the individuals chairing and documenting the meeting, in additional to clinical considerations where team discussions may have resulted in no clear consensus. The cohort selected for this study did not differ in age, gender or surgical outcome from the surgical series as a whole over the same time period.

2.2. Multidisciplinary team expert review

The core multidisciplinary team consists of experienced, UK National Health Service Consultant grade specialists in neurology, neurophysiology, neuroradiology, neuropsychology, neuropsychiatry and neurosurgery. The discussion of each case follows a fixed pattern: the presentation of the clinical history, neuroradiological presentations (MRI, PET), the viewing of video EEG footage with analysis of ictal semiology and ictal and interictal EEG changes, and presentation of the neuropsychological data and neuropsychiatric status. Following the presentation of all presurgical investigations, the team discuss whether surgery is a viable option for the patient and if it is, the likelihood that the surgery offered will result in complete seizure control.

2.3. Postoperative outcome

Postoperative outcome was assessed at one year via clinical follow-up and classified using the International League Against Epilepsy classification with respect to epileptic seizures following epilepsy surgery.[9] Patients in Class 1 and Class 2 were deemed to be seizure free, the remainder were classified as not seizure free.

2.4. Statistics

A logistic regression model was used to examine the value of demographic and binary clinical indices in the prediction of postoperative outcome (Class 1 and 2 vs. all other outcomes).

The following variables were entered as dependent variables:

1. Age (years)
2. Febrile convulsion (yes/no)
3. Age at habitual seizure onset (years)
4. Discrete unitary lesion on MRI (yes/no)
5. Concordant semiology (yes/no)
6. Non localising scalp EEG with invasive EEG studies required (yes/no)
7. Verbal *and* non verbal memory deficits (yes/no)

The logistic regression model in this study served as a test bed to contrast a statistical approach with human decision making. Scalp EEG is established as a critical variable in predicting seizure outcome in epilepsy surgery patients. It is difficult to classify individual ictal and post ictal characteristics for the purposes of a logistic regression, bearing in the mind the case:variable ratio required for sufficient statistical power with $n = 94$. We therefore chose the requirement for intracranial recording as a proxy for non lateralising scalp EEG in this analyses.

3. Results

3.1. Seizure outcome

At the one year postoperative follow-up 49% of the patients were completely seizure free (Class 1) and a further 20% had only experienced simple partial seizures since the surgery (Class 2). The postoperative outcomes in this sample were consistent with those reported by Wieser et al.[9] (see Table 1). 69% of the sample were therefore classified as seizure free (Class 1 + Class 2). The remaining 31% were not deemed to be seizure free one year following the surgery.

3.2. Team predictions

The team predictions of postoperative seizure control verses actual outcome are presented in Fig. 1A. The team predictions were accurate within a 7% margin of error for patients given a 30%, 40%, 50%, and 60% chance of being seizure free, preoperatively. Team predictions were less accurate at both extremes of the prediction scale (<20%; >70%), although the number of patients who fell in these categories was small (see Fig. 1A). Only one patient proceeded to surgery on the basis of 20% chance of seizure freedom following the surgery. Patients deemed to have such low odds do not generally proceed. However, they may sometimes be offered surgery on a palliative basis. Whilst the chances of complete seizure freedom are deemed to be low, the chances of a

Table 1
Postoperative outcome: seizure frequencies one year following surgery.

ILAE classification	Study sample ($n = 100$)	ILAE series (9) at 1 year ($n = 369$)
Class 1: completely seizure free; no auras	50%	56%
Class 2: only auras; no other seizures	19%	13%
Total seizure free	69%	69%
Class 3: 1–3 seizure days per year; ±auras	7%	7%
Class 4: 4 seizure days per year – 50% reduction	15%	14%
Class 5: <50% reduction to 100% increase in seizures	9%	10%
Class 6: >100% increase in seizure days	0%	0%
Total not seizure free	31%	31%

helpful reduction in a specified seizure type may have been judged to be sufficient to offer surgery as a possible treatment. This was the case with this patient.

3.3. Statistical predictions

In the logistic regression model, only the need for an invasive EEG study prior to surgery was a significant predictor of poor postoperative seizure control ($p < 0.05$) (see Table 2). The group membership probabilities from the logistic regression model, versus actual outcome are presented in Fig. 1B. Unlike the team predictions, the statistical model achieved greater accuracy at the extreme ends of the prediction scale (<20%; >70%) correctly identifying those most and least likely to be seizure free. However the model had less accuracy than the team predictions in the 25–65% ranges.

4. Discussion

Although the prediction of postoperative seizure control forms the crux around which the decision to proceed to surgery is based, there has been little research to date on the accuracy of these team based predictions.[10] The results of this study suggest that predictions based on the clinical experience of a multidisciplinary team are accurate in distinguishing probabilities of seizure freedom in patients where estimates range between 30% and 60%. Unsurprisingly, team predictions demonstrate regression towards the mean in their distribution and no patients in our sample were given odds greater than 70%. The numbers given very good or very poor odds of seizure freedom by the multidisciplinary team were too small to judge the accuracy of these judgements.

The need for an intracranial EEG study was associated with a poorer outcome in this series, consistent with previous studies that have highlighted the significance of preoperative EEG characteristics in predicting postoperative seizure outcome.[11] The results from the logistic regression analyses are consistent with previous studies that have failed to find other consistent clinical predictors of surgical outcome.[8] This may be in part because the clinical characteristics of the surgical population have changed over the past two decades with surgical series becoming more homogenous as patients with known factors associated with a poor prognosis do not proceed to surgery.

It is perhaps unsurprising that our logistic model performed poorly in the intermediate range, whilst performing well at the extremes. We employed a very reductionist approach to the data, with most variables reduced to binary scales. It is highly likely that the accurate determination of whether someone has a 50% or 60% chance of becoming seizure free lies in the fine detail of their presurgical examinations. Scores on specific neuropsychological tests may raise red flags for some clinicians, whilst the richness of both ictal and interictal scalp EEG data in each individual cannot be reduced to a single variable. Our aim in this study was not to present a comprehensive predictive model of surgical outcome, but rather to provide a rough benchmark against which to measure human decision making, to look for any systematic bias. Statistical predictions are not subject to regression towards the mean. Human

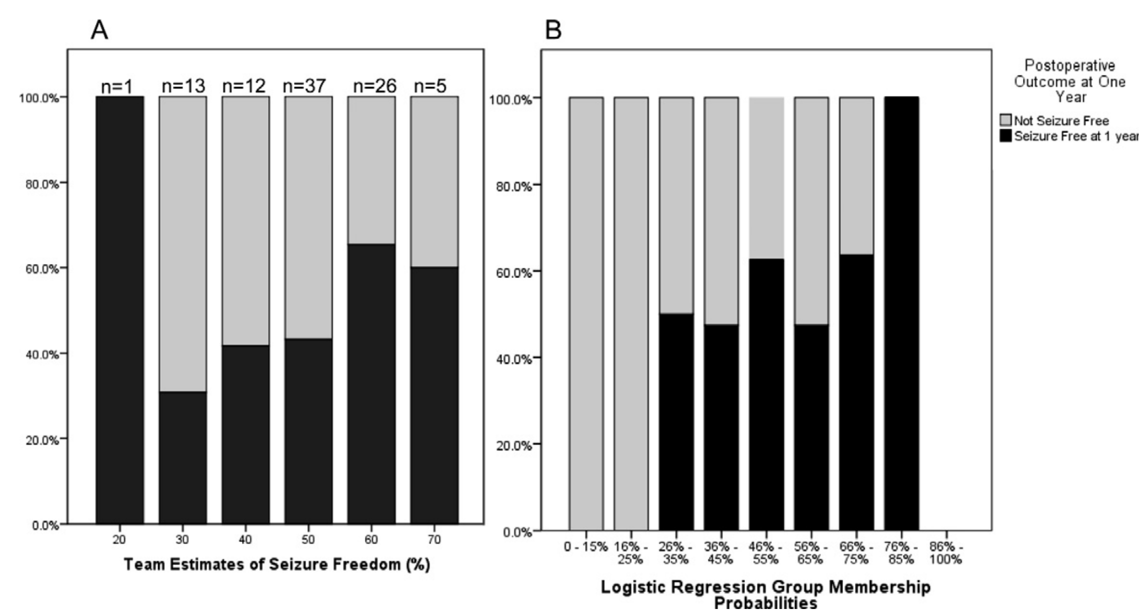

Fig. 1. Postoperative outcome at one year: (A) multidisciplinary team estimates of the chances of being seizure free and (B) logistic regression probabilities of the chances of being seizure free.

Table 2
Logistic regression analyses: significance of factors predicting postoperative outcome in ILAE Class 1 and 2.

	B	S.E.	Sig.	Exp(*B*)	95% CI for Exp(*B*)	
					Lower	Upper
Age (years)	.001	.026	.957	1.001	.951	1.055
Age of onset (years)	−.024	.027	.377	.977	.927	1.029
Atypical semiology (1)	−.647	.681	.342	.524	.138	1.991
Intracranial EEG study (1)	2.121	.973	.029	8.335	1.238	56.110
Widespread neuropsychological dysfunction (1)	.067	.456	.883	1.070	.438	2.612
Single MRI lesion (0)	−.297	.597	.619	.743	.231	2.394
Febrile convulsion (1)	−.358	.456	.433	.699	.286	1.709
Constant	−.786	1.229	.522	.456		

$R^2 = 0.08$ (Cox & Snell), 0.11 (Nagelkerke). Model: χ^2 (7) 7.9, $p > 0.05$. Hosmer & Lemeshow Goodness of Fit: χ^2 (8) 9.5, $p > 0.05$.

decision making is. Our study suggests that this bias is present in the prediction of postoperative outcome for epilepsy surgery.

It is noteworthy that our simplified statistical model was able to reliably identify patients who had a very high or very low chance of becoming seizure free postoperatively. These findings suggest that a combination of the judgements of the clinical team and statistical predictions may be helpful in improving the accuracy of predictions for patients at either end of the odds continuum, counteracting the inevitable effects of regression towards the mean in human decision making.

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