Title: QUANTITATIVE ALARM LEVEL BASED ON INTRAOPERATIVE MONITORING OF BRAINSTEM AUDITORY EVOKED POTENTIALS

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Introduction. Our group has recorded brainstem auditory evoked potentials (BAEP) during posterior fossa surgery to provide information on the integrity of the auditory nerve and brainstem. Warnings to the surgeon or direct anesthesia interventions were made by the anesthesiologist (BLG) whenever changes thought to be clinically important were observed in the BAEP's. However, there were no definite criteria by which to determine an important change, and the decision as to when a change had become important was very subjective. The purpose of this study was to quantitatively model the criteria being used to identify clinically important intraoperative changes in BAEP.

Methods. BAEP's were acquired using standard digital averaging techniques.[1] Monaural clicks were used and evoked potentials were recorded between vertex and both left and right earlobes. The decision model was based on 21 monitored posterior fossa procedures. During each procedure, wave V latency was measured and overall waveshape was evaluated immediately after acquisition of each response. A decision to give a warning was made immediately, and the times of response acquisition and warnings/interventions (if any) were recorded. After the procedure, the amplitudes and latencies of the first five Jewett waves were measured and entered into a data base implemented on the PROPHET system. Trend plots for each parameter were then examined to identify the parameter changes that were correlated with the decision to issue a warning or intervention.

Results. The most consistent parameter change correlated with a warning or intervention was an abrupt change in wave V latency, and this feature was studied quantitatively. An "instantaneous" slope at the time of response acquisition was estimated by subtracting the wave V latency of the preceding response from the current wave V latency and dividing by the time elapsed between the two responses. A threshold slope level was selected, and the cases were divided into the following classes:

1. No supra-threshold slope, no warning
2. Supra-threshold slope, but no warning
3. Supra-threshold slope, warning
4. No supra-threshold slope, but warning

Classes 1 and 3 represented correct classifications. Class 2 represented potential false alarms (with respect to clinical judgement), and class 4 represented potential misses. The table below shows classification results obtained for three different threshold levels:

	Threshold (millisec/minute)		
Class	0.04	0.07	0.09
1 (correct)	5	5	8
2 (false alarm)	6	5	2
3 (correct)	10	7	4
4 (miss)	1	4	7

Discussion. Class 2 errors occurred early in the series while Class 4 errors occurred later, suggesting that, with experience, there was an increased tendency to intervene in the procedure. Hence, many of the Class 2 cases might have elicited warnings had they occurred later in the series. In addition, several of the Class 4 errors showed slopes between .04 and .065 millisec/min in associaton with some other parameter change; the latter change by itself would be insufficient to elicit a warning. Hence, many of these warnings were probably elicited by a combination of factors. We concluded that the wave V latency slope was the most important parameter in eliciting warnings and that the threshold level probably decreased during the series. We evaluated a threshold of .07 millisec/min as a screening test in an additional series of 10 posterior fossa procedures. In this series, warnings were given four times, but there were no warnings that were not associated with a supra-threshold slope change. There was one case of a prolonged wave V latency increase with just sub-threshold slope that almost elicited a warning to the surgeons, suggesting that an absolute latency change should also be included as a screening criterion. We realize that the introduction of a quantitative criterion has probably influenced the clinical decision process and hence our results in the second series, but our results suggest that a threshold of .07 millisec/min is a reasonably effective screening parameter.

References.

1. Grundy BL, Lina A, Procopio PT, Jannetta PJ: Reversible evoked potential changes with retraction of the eighth cranial nerve. Anesth Analg (Cleve) 60:835-838, 1981