Prediction Of Electroencephalographic Suppression Pattern In Patients Undergoing Total Intravenous Anesthesia For Ambulatory Surgery

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Intro: Electroencephalographic suppression (ES) is defined as the occurrence of isoelectric electroencephalogram during a period of time. ES pattern during general anesthesia is frequently associated with the use of intravenous or inhalation hypnotic drugs. Its presence has been defined as an indicator of too deep hypnotic effect and it has been associated with a poor outcome(1). The present study was designed to characterize factors that could increase the incidence of ES in patients undergoing total intravenous anesthesia.

Methods: Under IRB approval data was collected from patients undergoing general anesthesia for different ambulatory procedures. Patients were routinely monitored and had also EEG monitoring with BISpectral Index. Total intravenous anesthesia was performed via a TCI system administering propofol and remifentanil. Demographics, EEG, hemodynamics and TCI data as well as any relevant event during the procedure were collected online with the software Rugloop. ES was obtained from the BIS monitor data. For the purpose of the study ES was defined as amplitude of electrical activity below 5µV for periods longer than ten seconds. Matlab software was used to implement the logistic regression model of the probability of occurrence of Suppression as a function of different factors. The model validation process was performed using 30 fold cross validation in Matlab.

Results: Data from 600 patients were included. From all the factors studied predicted effect site concentration of propofol and remifentanil as well as mean arterial blood pressure were significantly included in the model. Age was not detected as a significant factor although it is a covariate factor in the PKPD models of the TCI system. The estimated logistic regression model is as follows:

$$BSPred = \frac{1}{1 + e^{B_1 + \text{CeProp} \cdot B_2 + CeRemi \cdot B_3 + MBP \cdot B_4}}$$

Where BSPred stands for the probability of ES, CeProp and CRemi are the effect-site concentrations of Propofol and Remifentanil (in µg/ml and ng/ml, respectively) and MBP is the Mean Blood Pressure (in mmHg). The estimated value of the coefficients were B_1: -0.9221; B_2: 0.   5497; B_3: 0.0102; B_4: -0.0371. The results of the cross validation procedure summarized into a McFadden's pseudo R^2= 0.7962. The following graph shows a typical individual ES observation and the predicted probability as well as predicted propofol (blue trace bottom graph) and remifentanil (green) time course.
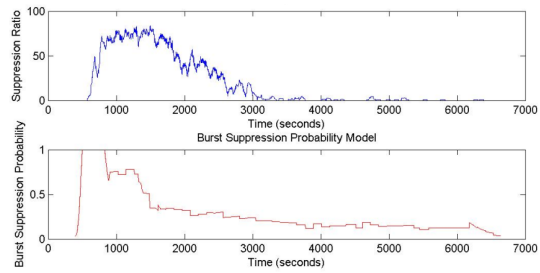
Conclusion: Based on real data it has been possible to generate a model to predict the probability of EEG suppression. The prediction ability of this model may be of help in optimal dosing of propofol to avoid overdosing associated with EEG suppression and its associated poor outcome.

(1) Besch G et al, 2011. (2) Willingham M et al, 2014