Data Driven Investigation of Bispectral Index Algorithm

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**Background/Introduction:** Bispectral index (BIS), a useful marker of anesthetic depth, is calculated by a statistical multivariate model using nonlinear electroencephalography (EEG)-based subparameters. However, only a part of proprietary algorithm has been identified. We investigated the BIS algorithm using clinical big data and machine learning techniques.

**Methods:** Retrospective data from 5,427 patients who underwent general anesthesia with BIS monitoring were used. Burst suppression ratio (BSR), 95% spectral edge frequency (SEF), and power of electromyogram (EMG) were received from the BIS Vista. SynchFastSlow (SFS) and relative beta ratio (RBR) were calculated from raw EEG waveform. Decision tree analysis (Figure 1) was performed to determine the criteria for EEG subparameters to classify five anesthetic states. For each anesthetic states, random sample consensus regression analysis was performed to derive a multiple linear BIS calculation model. The performance of decision tree and regression models were externally validated with predictive accuracy and mean absolute error, respectively.

**Results:** A total of 31,372,258 data points were used. A decision tree was built with subparameters. The accuracy of each binary branch of decision tree was 98%, 93%, 80%, and 88% for splitting BIS at 22, 61, 41, and 78 respectively. The median absolute errors of regression models was BIS value of 4.1.

**Conclusions:** A data driven algorithm of BIS calculation using multiple EEG subparameters of different criteria depending on anesthetic states has been proposed. The results will help the anesthesiologists interpret the BIS values observed during clinical practice.

**Figure 1. Decision tree analysis**