Entropy: Monitoring Anesthesia Depth.. A Recent Trend

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I. Introduction

In recent times, intraoperative awareness during anesthesia has gained lot of discussion due to rise in medico legal problems and a cause of embarrassment for anaesthesiologists. Various monitoring are in use for assessing anesthesia depth and with the passage of time significant advancement has been made. Now a days, electroencephalogram (EEG) based monitoring has been under use and lot of discussion has been underway for them (e.g BISpectral index and EEG response to auditory, visual, somatosensory response). But both have inherent disadvantages of having wide inter individual variations, lack of linearity in dose response and different behaviors for different anaesthetic agents.

Recently, concept of entropy has been applied to EEG signals for measuring anaesthesia depth. Entropy as physical concept was defined for first time by Shannon in 1948 and it signifies the amount of disorder in the system. With awake patients, EEG is highly irregular and thus entropy is high whereas with medico legal problems and a cause of embarrassment for anaesthesiologists. Various monitoring are in use for assessing anesthesia depth and with the passage of time significant advancement has been made. Now a days, electroencephalogram (EEG) based monitoring has been under use and lot of discussion has been underway for them (e.g BISpectral index and EEG response to auditory, visual, somatosensory response). But both have inherent disadvantages of having wide inter individual variations, lack of linearity in dose response and different behaviors for different anaesthetic agents.

Recently, concept of entropy has been applied to EEG signals for measuring anaesthesia depth. Entropy as physical concept was defined for first time by Shannon in 1948 and it signifies the amount of disorder in the system. With awake patients, EEG is highly irregular and thus entropy is high whereas with patients under deeper anesthesia, EEG becomes regular and hence entropy lowers down³. Therefore, a close relation exists between entropy and the depth of anesthesia and this will reduce drug doses and enhance speed of emergence from anesthesia.³⁴

Entropy module monitors the change in irregularity of EEG and frontal electromyography (FEMG) signals, which changes from irregular to more regular pattern as anesthesia deepens⁵. During lighter plane of anesthesia, facial muscles activity is present which is not abolished by neuromuscular blocking agents used at clinical doses. An abrupt increase in FEMG values denotes lighter plane and together with analysis of EEG helps in generation of entropy values and development of entropy algorithms¹ based on volunteer clinical studies. Individual patients show variations and values are effected by different clinical states such as frequent eye movement, seizures, neurological disorders, trauma, psychomotor activity, electrocautery, pacemakers etc. The two entropy parameters are fast-reacting Response Entropy (RE) calculated up to 47 Hz and more steady and robust State Entropy (SE) calculated up to 32 Hz.

Response entropy (range from 0–100) signifies activation of facial muscles (FEMG). Facial muscles give an early indication of emergence or awake stage which causes rapid rise in RE. State entropy (range 0-91) is always less than or equal to RE and estimates the hypnotic effect of anesthetic drugs on the brain based on EEG. The entropy range guidelines³ based on entropy validation studies shows correlation with patient’s clinical status. It measures activity of brain which is the site of action of various anesthetic drugs and thus it helps in titrating drug doses³ and helps in smooth and rapid patient turnover. However, these monitors are still in evolving phase and more studies based on different anesthetic agents with variety of surgical stimuli are needed to establish its conclusivity and authenticity.

II. Conclusion

Amnesia, Analgesia, Unconsciousness and muscle relaxation together with autonomic stability are mainstay of safe anesthesia for the patients. Thus, entropy used together with other parameters monitoring such as haemodynamic parameters, NMT monitoring etc. can give you a complete picture of intraoperative patient’s status.

References


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