A) Specific Aims

Anaesthesia is the medically induced numbness by treatment of intravenous or inhalational medications to a patient before a surgical operation. This prevents the patient from experiencing pain during the procedure. While local anaesthesia induces absence of sensation in a particular region of body, general anaesthesia is meant to induce a temporary coma. Anaesthetics are usually combined with pain-relievers and neuro-muscular blockers.

Anaesthesia is marked by a suppression in cardiorespiratory and thermoregulatory activity and the patient requires external support for maintaining vital functions, particularly breathing1. This is accompanied by discernible changes in the brain behaviour, with a progressive decrease in the dominant frequency in the electroencephalogram (EEG) of the patient. In the deeper stages of anaesthesia, the EEG witnesses nearly flat waves interspersed with sudden alpha and beta activity, a phenomenon called burst suppression1.

Depth of Anaesthesia (DoA) is a measure of the degree of depression (or ‘numbness’) in the central nervous system and other body functions during treatment with anaesthetics. Till a century ago, determination of the effect of anaesthesia in patients was done by mere physical examination, often resulting in anaesthetic overdose2. While underdosage can put the patient in pain and the reflex responses of the body can interfere with the medical procedure, overdosage can ‘shut the body down’ which can be fatal. Today, keeping a check on DoA while administering anaesthetics is of utmost importance and anaesthetists are trained well to prevent both underdosage and overdosage.

Quantifying anaesthetic effect into DoA is an active area of research and several metrics have come up to make the monitoring more accurate. Bispectral index (BIS) is one of the several technologies used for the purpose. While the company that developed BIS and manufactures BIS monitors has not revealed the exact details of the algorithm, it uses raw EEG data from the patient’s scalp and processes it to provide a number between 0 to 100 (0 signifying EEG silence). A BIS value in the range of 40 to 60 is optimum for surgical procedures (as recommended by the manufacturer). The BIS value is used to supplement the anaesthetist’s physiology and response-to-stimulus based assessment.

In the proposed study, we aim to develop a novel method of quantifying DoA by using body vitals along with the raw EEG signal. We use the heart rate, breathing rate and SpO­2 along with entropy and power parameters from the processed EEG signal to construct a simple neural network. While some older studies have used both body vitals and EEG signal to compute DoA3, to the best of our knowledge, not much has been done using the newer methods of spectral entropies and machine learning.   
  
Our algorithm gives a score between 0 to 1 with a low score indicating a high depth of anaesthesia. <write about test data, putting it against the BIS scores, results we got>

B) Background and Significance

The earliest work in the lines of what we are trying to achieve was done by Rob J Sharma and Ashuthosh Sharma (1994) who used autoregressive parameters from EEG along with heamodynamic parameters – blood pressure and heart rate. While the claimed accuracy was 85%, the study was performed on dogs with halothane as the anaesthetic. Halothane has long been abandoned because it has adverse side-effects. Moreover, a study on dogs is largely different from a human under anaesthesia undergoing a surgical procedure.

D)

After pre-processing the correlation various parameters have with the BIS score are observed. Below are the most notable parameters among them:

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These graphs were plotted only for patient 31. It is to be noted that for other patients the trends were sometimes very different

For sec E – Burst Supression?

1) Brown EN, Lydic R, Schiff ND. General anesthesia, sleep, and coma. *N Engl J Med*. 2010;363(27):2638-2650. doi:10.1056/NEJMra0808281

2) Siddiqui BA, Kim PY. Anesthesia Stages. [Updated 2021 Mar 7]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557596/