Clinical observation provides vital information regarding the patient. Observations gained from the use of the various monitors should augment that information; skin perfusion, capillary refill, cyanosis, pallor, skin temperature and turgor, chest movement and heart auscultation are just a few examples.

The equipment used to monitor the patient is becoming more sophisticated. It is vital that the clinician using these monitors is aware of their limitations and the potential causes of error. Errors can be due to patient, equipment and/or sampling factors. Monitoring equipment can be invasive or non-invasive.

Bispectral index (BIS) analysis

The BIS monitor is a device to monitor the electrical activity and the level of sedation in the brain and to assess the risk of awareness while under sedation/anaesthesia. In addition, it allows titration of hypnotics based on individual requirements to reduce under- and overdosing. BIS has been shown to correlate with measures of sedation/ hypnosis, awareness and recall end points likely to be reflected in the cortical EEG. It can provide a continuous and consistent measure of sedation/hypnosis induced by most of the widely used sedative hypnotic agents. Although BIS can measure the hypnotic components, it is less sensitive to the analgesic/ opiate components of an anaesthetic.



Components

1. *Display*:

a) BIS (as a single value or trend).
b) facial electromyogram, EMG.
c) EEG suppression measured.
d) signal quality index (SQI)

2. A *forehead sensor* with four numbered electrodes (elements) and a smart chip. The sensor uses small tines, which part the outer layers of the skin, and a hydrogel to make electrical contact. It is designed to lower the impedance and to optimize the quality of the signal.

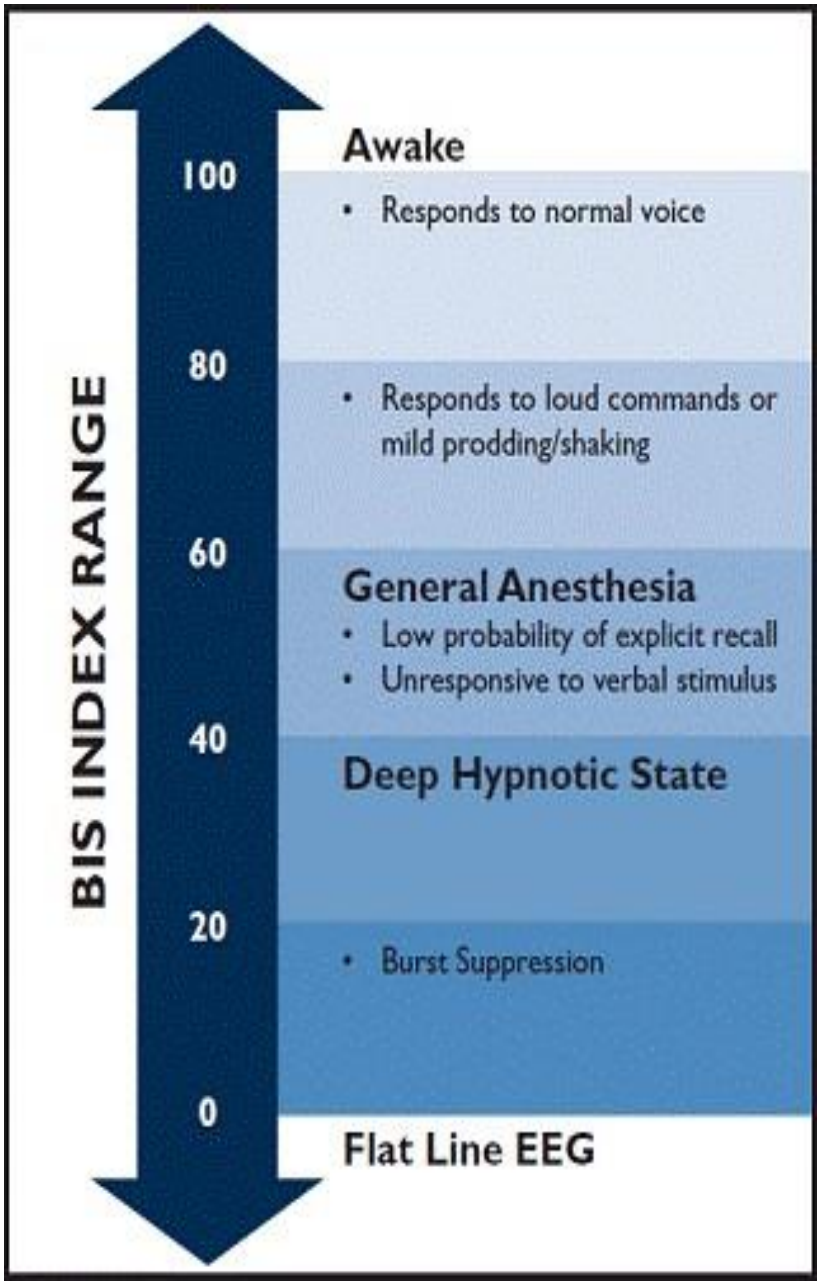
Mechanism of action

1.BIS is a value derived mathematically using information from EEG power and frequency as well as bispectral information.

2.BIS is an empirical, statistically derived measurement. It uses a linear, dimensionless scale from (**0 *to* *100***). The lower the value, the greater the hypnotic effect. A value of ***100*** represents an ***awake*** EEG while ***zero*** represents complete ***electrical silence*** (cortical suppression). BIS values

of **65–85** are recommended for **sedation**, whereas values of **40–60** are recommended for **general anaesthesia**.

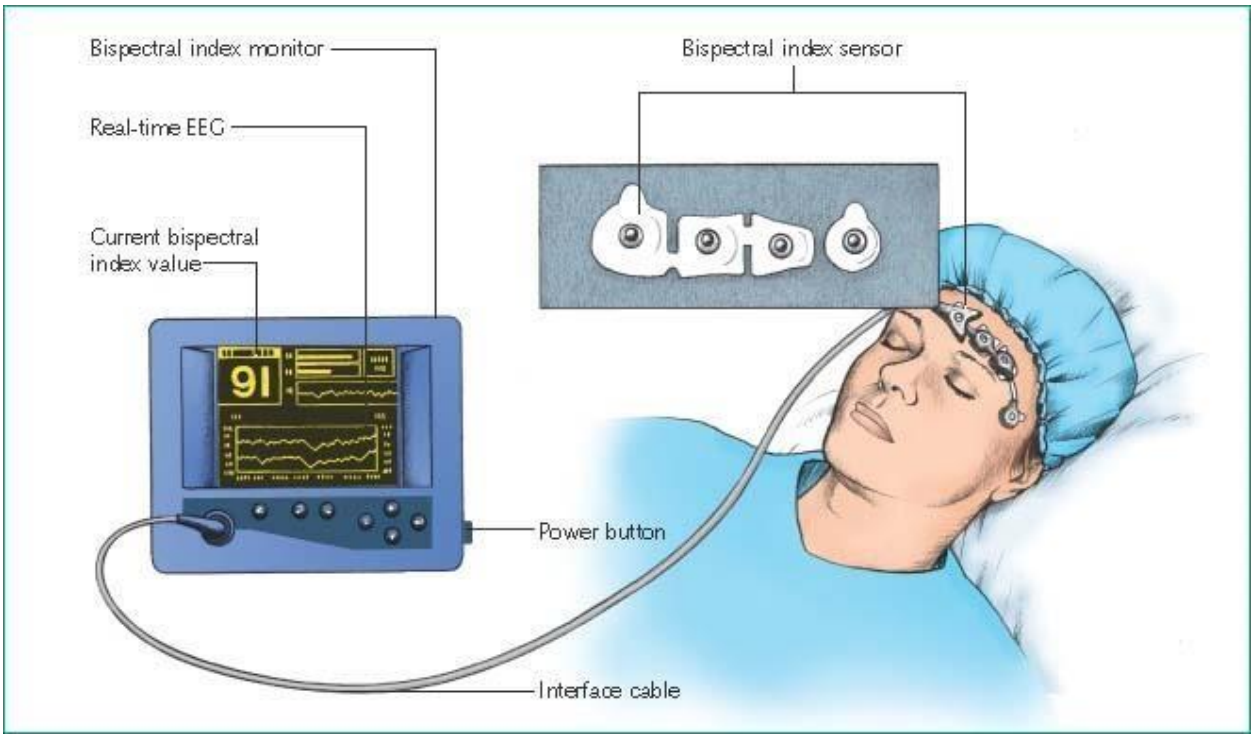
3.BIS measures the state of the brain, not the concentration of a particular drug. So, a low value for BIS indicates hypnosis irrespective of how it was produced. It has been shown that return of consciousness occurs consistently when the BIS is above 60 and, interestingly, at the same time, changes in blood pressure and heart rate are poor predictors for response.



4.The sensor is applied on the forehead at an angle. It can be placed on either the right or left side of the head. Element *number 1* is placed at the center of the forehead, 5 cm above the nose. Element *number 4* is positioned just above and adjacent to the eyebrow. Element *number 2* is positioned between *number 1* and *number 4*. Element *number 3* is

positioned on either temple between the corner of the eye and the hairline. The sensor will not function beyond the hairline. *Each element should be pressed for 5 seconds with the fingertip.*

5.Cerebral ischaemia from any cause can result in a decrease in the BIS value if severe enough to cause a global EEG slowing or outright suppression.



Problems and safety features

1.Hypothermia of less than 33°C results in a decrease in BIS levels as the brain processes slow.
2.Interference can be from diathermy or EMG.
3.BIS cannot be used to monitor hypnosis during ketamine anaesthesia. This is due to ketamine being a dissociative anaesthetic with excitatory effects on the EEG.
4.Sedative concentrations of nitrous oxide (up to 70%) do not appear to affect BIS.
5.As with any other monitor, the use of BIS does not obviate the need for critical clinical judgement.

Entropy of the EEG

This is a more recent technique used to measure the depth of sedation/ anaesthesia by measuring the 'regularity' or the amount of disorder of the EEG signal. High levels of entropy during anaesthesia show that the patient is awake, and low levels correlate with deep unconsciousness. The EEG signal is recorded using electrodes applied to the forehead and side of the head, as with the BIS.