

# BIS™ Brain Monitoring for Critical Care



The Bispectral Index™ (BIS™) is a processed EEG parameter that provides a direct measure of the effects of sedatives on the brain. The BIS™ monitoring value is represented as a number from 0 to 100 that is calculated from the raw EEG obtained by a sensor that is placed on a patient's forehead. The BIS™ value is used in a variety of settings, including anesthesia, critical care and procedural sedation, to provide objective information about an individual patient's response to sedative drugs.

## Definition of Key Terms:

**Sedation:** The reduction of anxiety or stress by the administration of a sedative drug; pain and motion may be present.

**Analgesia:** The absence of a normal sense of pain by the administration of an analgesic drug; anxiety and motion may be present.

**Neuromuscular paralysis:** Loss of voluntary muscular function by the administration of a drug (neuromuscular blocking agent) that obstructs nerve impulse transmission; pain and anxiety may be present.

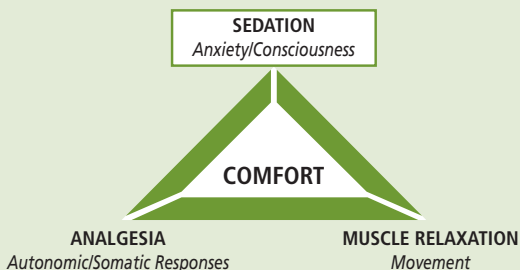


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# Patient Sedation in the ICU

## ASSESSING COMFORT



## Addressing the Challenges of the ICU Environment

As you know, both over- and under-sedation in critically ill patients pose significant risk of adverse clinical outcomes.

### Over-sedation

- Patient unable to participate in care
- Delayed weaning
- Ventilator-associated pneumonia
- ↑ Unnecessary testing
- ↑ ICU and hospital length of stay
- ↑ Costs

### Under-sedation

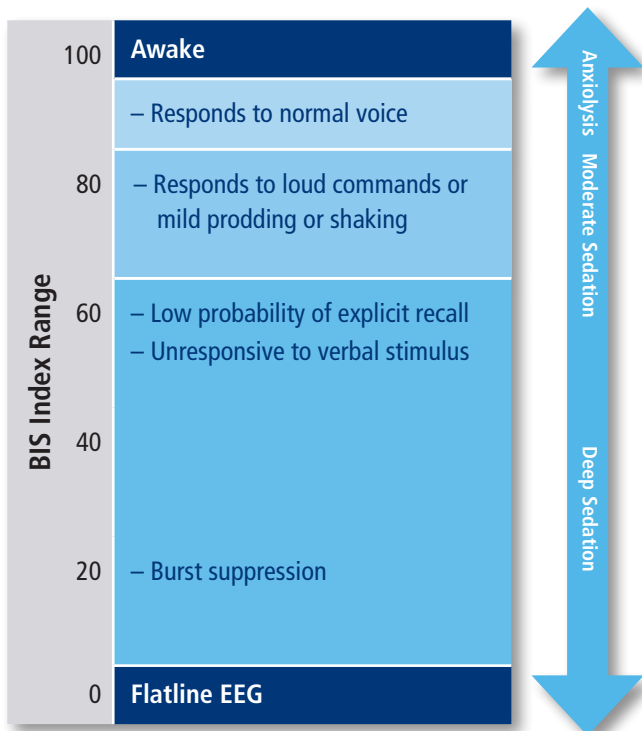
- Anxiety, agitation
- ↑ Costs, nursing time
- ↑ Use of neuromuscular blocking agents
- ↑ Risk of recall/awareness of unpleasant events
- ↑ Unintended medical device removal



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# BIS™ Monitoring Range Guidelines



Titration of sedatives to BIS monitoring ranges should be dependent upon the individual goals for sedation that have been established for each patient. These goals and associated BIS ranges may vary over time and in the context of patient status and treatment plan.



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## The BIS™ monitor provides a direct measure of the effects of sedatives on the brain.

In the critical care setting, the BIS monitor is commonly used to allow objective assessment of sedation during:

- Mechanical ventilation
- Barbiturate coma
- Bedside procedures
- Neuromuscular blockade

BIS™ monitoring is most useful for patients who are chemically paralyzed and/or moderately to deeply sedated. Muscle activity may interfere with reliable BIS monitoring performance.

## Important information for using BIS™ monitoring in the ICU

- Reliance on the BIS™ value alone for sedative management is not recommended.
- Clinical judgment should always be used when interpreting the BIS value in conjunction with other available clinical signs.
- BIS monitoring readings should be interpreted over time and in response to stimulation, and in the context of patient status and treatment plan.
- Movement may occur with low BIS values.
- Movement (EMG) may indicate inadequate analgesic level.
- Artifacts and poor signal quality may lead to unreliable BIS values. Potential artifacts may be caused by poor skin contact, muscle activity or rigidity, head and body motion, sustained eye movements, improper sensor placement or skin preparation, and unusual or excessive interference.
- BIS values should be interpreted cautiously in patients with known neurological disorders, in those taking psychoactive medications and in children less than 4 years old.
- Natural sleep cycles may affect the hypnotic level.

## SCCM Guidelines

The Society of Critical Care Medicine (SCCM) suggests using objective measures of brain function (e.g., AEP's, BIS, NI, PSI or SE) as an adjunct to standard methods on adult ICU patients to<sup>1</sup>:

- Assess depth of sedation in patients receiving neuromuscular blocking agents
- Tailor titration to achieve desired level of burst suppression therapy in patients with elevated intracranial pressure

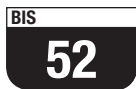
1. Barr J, et al. Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit. *Crit Care Med.* 2013 Jan;41(1):263-306.



# BIS™ Monitoring Display Information

## BIS™ Value

Displays the current BIS value (0-100).



## BIS™ Trend

Displays the BIS values over time.



## EEG Waveform

Shows real-time raw EEG.



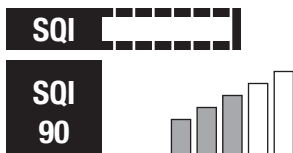
## EMG (electromyogram)

Depicts presence of muscle activity or high-frequency artifacts. When present, interpret BIS value with caution; assess source of artifact. May be shown as a bar graph or numerically depending on the monitor interface being used.



## SQI (signal quality index)

Indicates quality of EEG signal over the last 63 seconds. May be shown as a bar graph or numerically depending on the monitor interface being used.



## SR (suppression ratio)

Indicates percentage of last minute that EEG signal was suppressed. Burst suppression refers to bursts of EEG activity alternating with isoelectric EEG.



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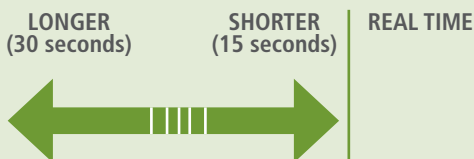
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# Smoothing Rate

Although raw EEG data is acquired and displayed in real-time, the BIS™ value, a processed EEG parameter, is calculated as a rolling average using a moving window of time. This “smoothing” is necessary to prevent excessive fluctuations.

**Smoothing rate (or averaging time) is the time period (e.g., 15 or 30 seconds) over which artifact-free data is analyzed to calculate the BIS value.**

## Smoothing Rate Effects on BIS™ Monitoring



### Longer Smoothing Rate

- Decreased variability
- Easier to discern general case trends
- Decreased sensitivity to artifacts

### Shorter Smoothing Rate

- Decreased delay
- Increased responsiveness to state changes and bolus administrations

BIS™ monitors from Covidien offer different smoothing rate options. To change your monitor's setting, please refer to your operator's manual.



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# Interpreting BIS™ Monitoring Values in the ICU

## BIS™ Value Increases Suddenly or is Higher than Expected

### Clinical situations that may indicate the need to increase sedative agents

**Is the sedative dose sufficient?** Due to inter-patient variability, some patients may require higher doses than others. If metabolic demands or stimulation have increased, or if patient is becoming tolerant to their therapy, additional sedation may be necessary.

**Has the sedation been decreased?** BIS value can be expected to increase as patients are weaned from sedation. If patient is not ready to wean from sedation, additional sedation may be appropriate.

**Is there an increase in stimulation?** An increase in stimulation may result in patient arousal. Additional sedatives may be appropriate.

**When was an analgesic last given?** Pain may result in patient arousal. Administration of analgesic and/or additional sedation may be appropriate.

**Are sedative delivery systems operating properly?** Check patency/integrity of IV lines and pumps used to administer sedation.

### EMG and high-frequency activity that may falsely elevate the BIS value

**Is there any muscle shivering, tightening or patient motion?** The BIS value may be higher than the actual hypnotic state due to the presence of EMG. Check EMG bar for presence of EMG.

**Did the patient receive any neuromuscular blocking agents that may be wearing off?** Check nerve stimulator for current state of muscle relaxation. Note: Facial muscles will recover sooner than skeletal muscles.

**Does the patient have a pacemaker?** Check EEG waveform for presence of pacemaker or EKG spikes.

**Has the use of any mechanical device that could generate high frequency activity (e.g., warming blanket, oscillator ventilator) been initiated, or is any such device (or power cords) in close proximity to the BIS™ sensor (or BIS power cord) or monitor?** Artifacts in the higher frequency ranges can artificially increase the BIS value. Check EMG bar for presence of high-frequency artifacts. If possible, move offending device away from BIS sensor, and plug power cords into separate outlets.

**Could the patient be in REM sleep?** In the REM sleep pattern, the low amplitude/high frequency EEG patterns may be similar to those in the awake state, but with coexisting hypotonia and eyeball movement artifacts.

**Is the patient seizing?** Seizure-related EEG is typically composed of higher frequency activity that can increase the BIS value.

*Note: During these situations, the BIS value should be interpreted cautiously, and within the context of clinical events.*



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# Interpreting BIS™ Monitoring Values in the ICU



## BIS™ Value Decreases Suddenly or is Lower Than Expected

### Clinical situations that may indicate the need to decrease sedative agents

**Has there been a decrease in stimulation?** A decrease in stimulation may lower dosing requirements for sedation.

**Has there been an increase in sedation or has BIS value decreased with no change in sedation dosing?** Excessive sedation or accumulation of sedative drugs over time may decrease BIS values. Patients with kidney and/or liver impairment and/or those receiving longer-acting sedative agents may be at greater risk.

**Has the patient recently received neuromuscular blocking agents?** The BIS value may drop after giving a neuromuscular blocking agent if excessive EMG was present prior.

**Has the patient recently received analgesia?** The BIS value may drop after giving (additional) analgesia if pain resulted in EMG.

**Is the patient significantly hypothermic?** Hypothermia decreases brain activity, and hypnotic state may be deepened.

### Unique clinical situations where decrease in BIS value may not necessarily indicate a decrease in sedative needs

**Is the BIS value decreasing when you think it should be increasing? (e.g., sedatives have been discontinued)** This could be due to an EEG pattern called paradoxical delta (characterized by a pronounced slowing of the EEG), which occurs over a short period of time (two to three minutes).

**Is the temporal electrode of the BIS™ sensor placed properly?** If the sensor is placed over the temporal artery, pulse artifacts can cause the BIS value to be inappropriately low. Check EEG waveform for presence of pulse artifacts and move sensor if necessary.

**Is the patient blinking or rolling his or her head?** These movements may cause artifacts that mimic slow-frequency EEG patterns.

**Is the patient sleeping?** Deep sleep may cause the BIS value to decrease to levels equivalent to a very deep sedation state.

**Has there been a sudden, significant drop in blood pressure, or other signs of ischemic event?** A reduction in cerebral blood flow or cerebral oxygen supply may result in a reduced BIS value. Patients with unilateral brain injuries may manifest asymmetric BIS values. Preliminary research suggests that BIS values may be lower on the injured side.

*Note: During these situations, the BIS value should be interpreted cautiously, and within the context of clinical events.*



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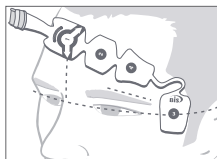
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# BIS™ Extended Sensor

## Extended Performance in Consciousness Monitoring

- Provides an objective measure of level of sedation



## Sensor Application

- 1) Using a ballpoint pen, record date and time of application of sensor.
- 2) Wipe skin with alcohol, and dry.
- 3) Apply sensor on forehead as follows (see above):

Circle #1: Center of forehead, approximately 2 inches (5 cm) above nose

Circle #4: Directly above and parallel to eyebrow

Circle #3: On the temple area between corner of eye and hairline

- 4) Press edges of sensor to ensure adhesion.

- Circle all four elements/circles to seal in gel



- 5) Press each circle for five seconds to ensure proper contact.

- Use fingertip
- Press circles one at a time
- Press firmly



- 6) Insert sensor tab into patient interface cable until fully engaged.
- 7) Replace the sensor within 24 hours. When disconnecting sensor, press release button on patient interface cable.



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# BIS™ Extended Sensor

## Impedance Checking

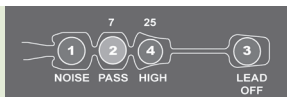
Impedance refers to the electrical resistance of the skin surface to each of the electrodes in the BIS™ sensor. Combined impedance values must be below a certain threshold for the BIS™ monitor to provide a reading.

→ Impedances (sensor connection to skin) are tested automatically upon start-up

→ Impedances can also be manually tested

Depending on your monitor, [Sensor Check] will be on the main screen or press [Menu] and go to [Sensor Check]

**In both cases, the screen will provide the status:**



**PASS:** Impedance is good

**HIGH:** High impedance – Re-prep (see below)

**NOISE:** May appear if pressing sensor during check or in the presence of large external stimulus

**LDOFF:** (Lead off) Element has lifted off – Re-prep

**BIS™ Monitoring will not begin until all impedances are acceptable**

**Re-prep Sensor.** For problem element(s), repeat circling and pressing (steps 4 and 5). If unsuccessful, lift sensor and repeat steps 2 to 5.

**During BIS Monitoring.** If Re-prep Sensor error message appears, a connection problem has been detected. Run the manual impedance check (see above), identify suspect element(s) and correct.

**BIS™ Extended Software Settings.** When the BIS Extended Sensor is connected to the BIS monitoring system, the Extend mode is turned on in the System Configuration menu. The following settings are activated:

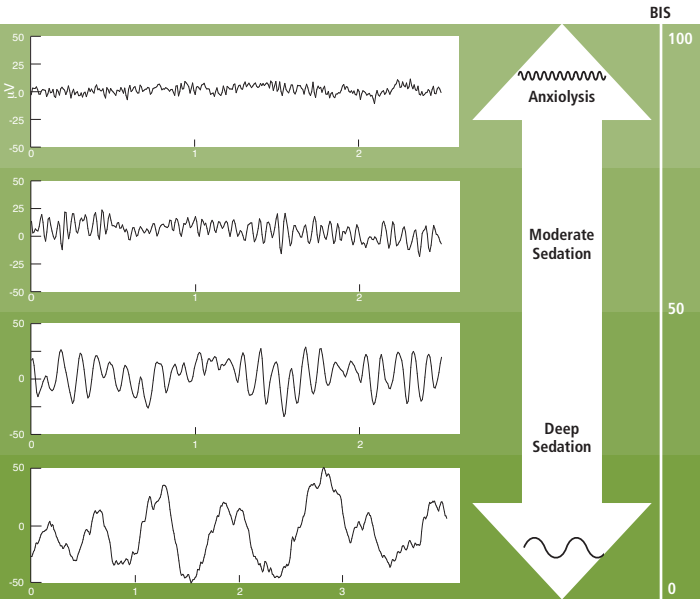
- 30-second smoothing rate
- Alarm suspend is on (alarm will only silence for two minutes)
- 60-minute BIS™ Log interval



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# EEG Sample Waveforms



Shown at smaller scale

NOTE: The above EEG waves, while real, represent idealized examples selected for educational purposes. Many commonly seen EEG waves may deviate from these ideals by superimposing the above waves with each other or with artifact.

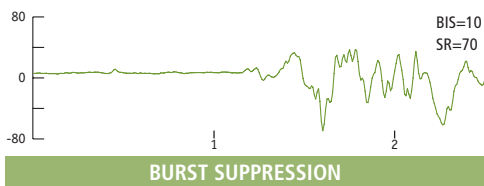
## Real-time assessment using the EEG

While BIS™ monitoring values require calculation and “smoothing,” raw EEG provides a real-time display of the patient’s brain status.



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## Uncommon EEG States

Burst suppression refers to bursts of EEG activity alternating with isoelectric (flat or “suppressed”) EEG, indicating very deep sedation, hypothermia or ischemia. Level of burst suppression is indicated by suppression ratio (SR on display). In the ICU, barbiturates may be administered in high doses to induce suppression of electrical brain activity.

**Suppression ratio (SR) is the percent of time in the last minute the EEG signal is considered suppressed**

### CASE STUDY

## BIS™ Monitoring Response to Stimulation in Sedated Patient

17-year-old, 97 kg female receiving sedation for mechanical ventilation. On continuous infusion of lorazepam 2 mg/hour and morphine 4 mg/hour for past several days. Baseline BIS™ value in 40s.

