BIS Monitoring

or how to avoid awareness in one easy lesson

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ASSESSMENT OF DEPTH OF ANAESTHESIA

MONITORING ANAESTHETIC DEPTH

- Why measure depth of anaesthesia?
- How do the various EEG monitors work?
- What can be achieved when using them?

Why measure depth of anaesthesia?

Anaesthesia Monitoring

- Is the patient unconscious?
- Are they forming memories?
- Will they respond to stimulation?
**Anesthetic Management and One-Year Mortality After Non-cardiac Surgery**

TG Monk, Y Saini, BC Weldon, JC Sigl. Anesth Analg 2005;100:4-10

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**BIS & MORTALITY**

- little known about effect of anaesthetic management on long-term outcomes
- prospective observational study of adult patients undergoing major non-cardiac surgery with general anaesthesia
- to determine if mortality in the first year after surgery was associated with demographic, preoperative clinical, surgical, or intraoperative variables.

**BIS & MORTALITY**

- 1-year mortality was 5.5% in all patients \( n = 1064 \) and 10.3% in patients \( > 65 \) yr \( n = 243 \)
- 3 variables as significant independent predictors of mortality:
  - patient co-morbidity \( (P < 0.0001) \)
  - intra-operative systolic hypotension \( (P = 0.013) \)
  - time at deep hypnotic levels (BIS &lt;45) \( (P = 0.012) \)

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How do the various EEG monitors work?

PRINCIPLES OF ANALYSIS

Descriptive Approach
- EEG measurements directly processed by a mathematical algorithm
  - e.g. Entropy, AEPex

Probabilistic Approach
- EEG measurements compared with historical events or knowledge-based systems
  - e.g. BIS, Narcotrend

Surface EEG Monitors

Evoked Response Monitors

COMPRESSED SPECTRAL ARRAY (CSA)

DERIVATION OF THE BIS

Power Spectrum Analysis

Bispectral Index

Burst Suppression
**Entropy**

- Mathematical analysis which quantifies disorder in a system
- Characterises the complexity of a signal
- Analysis techniques are being assessed to distinguish between different levels of sedation and hypnosis

**Entropy**

- Entropy measures the **Irregularity** of the signal
- Independent of absolute amplitude/frequency scale

**State Entropy and Response Entropy**

- Facial EMG
- Cortical EEG

- State Entropy and Response Entropy

**Auditory Evoked Potentials**

- Latency increased
- Amplitude decreased

**Middle latency auditory evoked potentials**

- Deeper anaesthesia

- Sound stimulus

**Br. J. Anaesth. 2001 87:505-7**
MLAEP detects subconscious awareness

MLAEP detects subconscious awareness

subconscious awareness

NO subconscious awareness


EEG and artifacts

- Muscle activity / EMG
- HF electrosurgery
- Doppler probes (e.g. TOE)
- Anaesthetic drugs
  - Ketamine
  - Nitrous oxide
  - Xenon

EEG and artifacts

Low BIS in awake volunteers

Low BIS in awake volunteers

- Propofol TCI 0.6 µg/ml plus Midazolam 0.05 mg/kg in 1 min, and 0.05 mg/kg/min

Low BIS in awake volunteers

- Propofol TCI 1.0 µg/ml plus Midazolam 0.035 mg/kg in 1 min, and 0.035 mg/kg/min

The bispectral index declines during neuromuscular block in fully awake persons


BIS & PARALYSIS

- BIS monitored in 3 volunteers by using an Aspect A-1000 monitor
- Experiment repeated in 1 volunteer
- EMG activity recorded
- Alcuronium and succinylcholine were administered
- No other drugs were used
**BIS & PARALYSIS**

- BIS decreased in response to muscle relaxation to a minimum value of 33
- In the repeated measurement when total NMB was achieved, BIS decreased to 9
- In two volunteers, no total block was achieved
- BIS decreased to a minimal value of 64 and 57

**BIS & PARALYSIS**

- BIS recovery coincided with reappearance of spontaneous EMG activity
- Volunteers were fully consciousness during the entire experiment

**BIS and EMG**


**BIS & PARALYSIS**

**Conclusions**

- BIS is an EEG variable intended to measure depth of anaesthesia
- EMG activity influences calculation of BIS
- Administration of a muscle relaxant to awake volunteers decreased BIS
- Awareness in totally paralyzed patients cannot be excluded

**Entropy of EEG during anaesthetic induction: a comparative study with propofol or nitrous oxide as sole agent**

*RE Anderson and JG Jakobsson. British Journal of Anaesthesia 2004; 92 (2): 167-70*

**PROPOFOL GROUP** increased [propofol] until loss of consciousness
**Nitrous Oxide (N₂O) Group**

Increased end-tidal N₂O until loss of consciousness.

**Increasing Anaesthesia**

**Prediction of Movement at Laryngeal Mask Airway Insertion**

Doi, M., Gajraj, R.J., Mantzaridis, H., Kenny, G.N.

*British Journal of Anaesthesia,* 1999; 82: 203-207

**Auditory Evoked Potential (AEPex) Monitoring**

- Propofol
- Midazolam
- Ketamine

**BIS Monitoring**

**Response to LMA Insertion**

- Non-Movers
- Movers

*P < 0.05*

**Auditory Evoked Potential Index predicts the depth of sedation and movement in response to skin incision during sevoflurane anesthesia**


*Anaesthesia,* 2001; 95: 364-370
**PREDICTION PROBABILITY VALUES**

**60 SECONDS BEFORE SKIN INCISION**

<table>
<thead>
<tr>
<th></th>
<th>Probability</th>
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</thead>
<tbody>
<tr>
<td>[Sevo]</td>
<td>0.857 *</td>
</tr>
<tr>
<td>AEPex</td>
<td>0.910 *</td>
</tr>
<tr>
<td>BIS</td>
<td>0.537</td>
</tr>
</tbody>
</table>

* p<0.05 = Pk value significantly > 0.5

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**Impact of BIS monitoring on fast tracking in day-case patients**

"With a standardized anesthetic regimen and a strict discharge scoring system, BIS monitoring does not have a significant effect on the ability to fast track outpatients"

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**Anaesthesia Monitoring**

- What aspects of cerebral function are essential to allow consciousness?
- Is there some invariant property of the EEG that reliably indicates the transition between consciousness and unconsciousness?
- Is this independent of the class of drug used for anaesthesia?

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**SURFACE EEG MONITORS**

- entropy & BIS are blind or react wrongly to some anaesthetic agents
- when nitrous oxide, xenon, or ketamine is used, the level of cortical activity is maintained, even when the patient is anaesthetised
- with these drugs, the high frequency EEG power is relatively unaffected and SEMs are inaccurate

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**SURFACE EEG MONITORS**

- are indicators of cortical activity, rather than level of consciousness
- It is unclear whether any of these indices differ greatly in performance
- await further critical examination with interest
DEPTH OF ANAESTHESIA MONITORS

- clinical relevance of differences between monitors remain to be demonstrated
- EEG-derived parameters will always quantify the degree of cortical activity, regardless of the underlying level of consciousness
- the potential to detect and subsequently avoid memory formation and recall is likely but still more evidence is required

MONITORING ANAESTHETIC DEPTH - New Standard of Care?

- ASA Practice Advisory for Brain Function Monitoring: draft 8/7/2005
- “not routinely indicated either to reduce the frequency of intraoperative awareness or to monitor depth of anaesthesia”
- “the decision to use brain function monitor should be made on a case-by-case basis”