AAGBI Core Topics 2013
Depth of Anaesthesia Monitoring

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Objectives

- Why do I need to know about Depth of Anaesthesia monitors and should I be using them?
  - Not enough anaesthetic (NAP5)
  - Too much anaesthetic
  - Practical tips for using BIS
National Audit Project 5: 
Accidental Awareness under General Anaesthesia in the UK

Previous reports have suggested a surprisingly high incidence of awareness of about one in 500 general anaesthetics. The current report found it to be much less common in the UK, with one episode known to anaesthetists in every 15,000 general anaesthetics. The report also reports very low use of brain monitoring technology with only 2% of anaesthetists routinely using it.

### Table: Incidence of Awareness

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Country</th>
<th>Number</th>
<th>Incidence of Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sebel</td>
<td>2004</td>
<td>US</td>
<td>19,575</td>
<td>0.13% 1 in 769</td>
</tr>
<tr>
<td>Sandin</td>
<td>2000</td>
<td>Sweden</td>
<td>11,785</td>
<td>0.18% 1 in 555</td>
</tr>
<tr>
<td>Errando</td>
<td>2008</td>
<td>Spain</td>
<td>4,001</td>
<td>0.60% 1 in 167</td>
</tr>
<tr>
<td>Mashour</td>
<td>2012</td>
<td>US</td>
<td>18,836</td>
<td>0.10% 1 in 1000</td>
</tr>
<tr>
<td>Myles</td>
<td>2004</td>
<td>US</td>
<td>2,463</td>
<td>0.52% 1 in 192</td>
</tr>
<tr>
<td>Avidan</td>
<td>2008</td>
<td>US</td>
<td>1,941</td>
<td>0.10% 1 in 1000</td>
</tr>
<tr>
<td>Pollard</td>
<td>2007</td>
<td>US</td>
<td>87,361</td>
<td>0.07% 1 in 14,560</td>
</tr>
</tbody>
</table>
Brice Questionnaire

- What was the last thing you remember before going to sleep?
- What is the first thing you remember on waking up?
- Can you remember anything in between?
- Did you dream during the procedure?
- What was the worst thing about your operation?
Why is the UK different?

- Use of supraglottic airways & less NMB
- More doctor (consultant) delivered care
- Genetically pharmacologically different
- Methodological flaws
  - Trainees excluded
  - Reliance on self-reporting
  - No formal Brice questionnaire

Where do DOA monitors fit in?

<table>
<thead>
<tr>
<th>Centre with DOA</th>
<th>Anaesthetists using DOA in selected cases only</th>
<th>Anaesthetists using DOA routinely</th>
<th>Type of DOA used (as % of those using DOA) (n = 1040)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>BIS</td>
</tr>
<tr>
<td>163/263</td>
<td>1772</td>
<td>132</td>
<td>1442 (76%)</td>
</tr>
<tr>
<td>(62%)</td>
<td>(25%)</td>
<td>(1.8%)</td>
<td>(73%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Entropy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>332</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nanotrend</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.3%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IFT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1%)</td>
</tr>
</tbody>
</table>

BIS: bispectral index; EP, evoked potential monitoring; IFT, isolated forearm technique; ‘Other’ included mention of the Vigileo Biofeedback as a haemodynamic monitor of awareness, the cerebral function analysing monitor, a targeted end-tidal volatile agent algorithm, or was not specified.
1 Recommendations

1.1 The use of electroencephalography (EEG)-based depth of anaesthesia monitors is recommended as an option during any type of general anaesthesia in patients considered at higher risk of adverse outcomes. This includes patients at higher risk of unintended awareness and patients at higher risk of excessively deep anaesthesia. The Bispectral Index (BIS) depth of anaesthesia monitor is therefore recommended as an option in these patients.
BIS Technology
Rampil. Anesthesiology 1998; 89:980-1002

- **Beta ratio**
  log ratio of power in two empirical frequency bands

- **Bispectrum**
  Relationship between two sinusoidal components of EEG at two primary frequencies
- BIS
- EMG
- EEG
- SQI
- SR
BIS and the **Probability** of Memory

![Graph showing the relationship between BIS and probability of response, with curves for Responsiveness and Explicit Recall.]

**BIS will not predict movement**


![Graph showing the probability of no movement for opioids, isoflurane, and propofol.]

Increasing dose
**B-Aware**

- 2463 patients at high-risk of awareness
  - 45% cardiac surgery
  - 43% TIVA
- Brice at 6 h, 36 h & 30 days
- Awareness
  - Routine care 11 (0.92%) vs BIS 2 cases (0.17%)
  - BIS awareness with values of 79-82 & 55-59
- NNT=138

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**Swedish Awareness Follow-up Trial**

- 4945 standard patients
  - 23% benzodiazepines
  - 5% TIVA
- Brice at 1-3 & 7-14 days
- Awareness
  - Routine care 14 (0.18%) vs BIS 2 cases (0.04%)
  - BIS awareness with values of > 60 for 4-10 min
  - ET Agent 80% vs 99%
BAG-RECALL
Avidan et al. NEJM 2011; 365:591-600

- 6041 at high-risk of awareness
  - 48% cardiac
  - BIS target 40-60 vs ET-Agent 0.7-1.3 MAC (age/N₂O adjusted)
- Brice at 3 & 30 days
- Awareness
  - BIS 7 (0.24%) vs ET-Agent 2 (0.07%)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BIS Group (N = 2661) %</th>
<th>ETAC Group (N = 2532) %</th>
<th>P Value</th>
<th>Difference, BIS-ETAC percentage points (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite awareness: primary outcome</td>
<td>7 (0.24)</td>
<td>2 (0.07)</td>
<td>0.98</td>
<td>0.17 (−0.01 to 0.38)</td>
</tr>
<tr>
<td>Definite or possible awareness: pre-specified secondary outcome</td>
<td>19 (0.66)</td>
<td>8 (0.28)</td>
<td>0.99</td>
<td>0.38 (0.03 to 0.74)</td>
</tr>
<tr>
<td>Distressing experience of awareness: post hoc secondary outcome</td>
<td>8 (0.28)</td>
<td>1 (0.04)</td>
<td>0.99</td>
<td>0.24 (0.04 to 0.45)</td>
</tr>
</tbody>
</table>

Not awake but too asleep?
Monk et al. Anesthesia & Analgesia 2005; 100:4-10

Independent predictors of mortality
1. Patient comorbidity
2. Cumulative deep hypnotic time (BIS <45)
3. Intraoperative hypotension

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Relative risk (odds ratio) (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comorbidity (3+ versus 0-2)</td>
<td>13.401 (7.722-25.007)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age (55+ versus 18-54 yr)</td>
<td>4.859 (2.852-8.176)</td>
<td>0.0002</td>
</tr>
<tr>
<td>History of hepatic disease</td>
<td>3.316 (1.763-6.213)</td>
<td>0.0004</td>
</tr>
<tr>
<td>History of previous myocardial infarction</td>
<td>3.339 (1.723-6.405)</td>
<td>0.0003</td>
</tr>
<tr>
<td>History of heart disease</td>
<td>2.174 (1.264-3.726)</td>
<td>0.0214</td>
</tr>
<tr>
<td>Cumulative deep hypnotic time (per h)</td>
<td>1.331 (1.32-1.53)</td>
<td>0.0069</td>
</tr>
<tr>
<td>Intraoperative systolic blood pressure &lt;80 mm Hg (per mm)</td>
<td>0.946 (0.866-1.032)</td>
<td>0.4817</td>
</tr>
<tr>
<td>Body mass index</td>
<td>0.966 (0.937-1.000)</td>
<td>0.0494</td>
</tr>
<tr>
<td>Preoperative diastolic blood pressure</td>
<td>0.962 (0.942-0.982)</td>
<td>0.0052</td>
</tr>
<tr>
<td>Preoperative systolic blood pressure</td>
<td>0.974 (0.959-0.990)</td>
<td>0.0132</td>
</tr>
<tr>
<td>Intraoperative Mean Arterial Pressure (per unit)</td>
<td>0.820 (0.700-0.962)</td>
<td>0.0248</td>
</tr>
<tr>
<td>Type of surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimal invasive or superficial versus intracavity</td>
<td>0.308 (0.123-0.774)</td>
<td>0.0123</td>
</tr>
<tr>
<td>Orthopaedic versus intracavity</td>
<td>0.217 (0.080-0.610)</td>
<td>0.0011</td>
</tr>
</tbody>
</table>
Not awake but too asleep?
Kertai et al. Anesthesiology 2011; 114:545-56

Triple Low
Sessler et al. Anesthesiology 2012; 116:1195-203

MAP < 75 mmHg; BIS < 45; ET_{Volatile} < 0.8 MAC
BIS & POCD
Radtke et al. BJA 2013; 110:98-105

- 1277 patients aged > 60 years
- BIS guided vs BIS Blinded
- Postoperative delirium assessed
  - BIS 16.7% vs Control 21.4%
  - Related to % time with BIS <20 (p=0.04)
  - No correlation with POCD

BIS accounts for “outliers”
Gan et al. Anesthesiology 1997; 87:808-15

![Graph showing Probability of Not Responding over Elapsed Time After Propofol Off (minutes)](image.png)

18% vs 5%
**Patient Recovery with BIS**
Gan et al. Anesthesiology 1997; 87:808-15

BIS-titrated patients (n=302)
- Extubate sooner (4 min)
- Shorter PACU stay (6 min)
- Are more oriented upon arrival to the PACU

![Bar chart](chart1.png)

**BIS & Recovery Time**

- Sevo: 6 studies (n=585)
- Propofol: 7 studies (n=584)
- Iso: 3 studies (n=106)
- Des: 2 studies (n=110)

- Control recovery time 10-12 min
- Actual OR time saving 2-3 min
**Anaesthetic drug consumption & BIS**


- 2582 pts in 14 studies
- Mean BIS in the standard practice group was 43.6
- Mean BIS in the BIS-titrated group was 49.9
- 1 point of BIS difference reduces hypnotic drug use by 2%.

**Just a random number generator?**

- **Awareness**
  - Possibly in high-risk patients
  - Unclear if using volatile & ET
- **Excess depth of anaesthesia**
  - Studies in progress
- **Recovery times**
  - Not clinically significant
- **Drug cost savings**
  - Not financially significant
**TOF & PORC**


![Graph showing TOF & PORC](image)

**CVP & Fluid Management**

Marik et al. Chest 2008; 134:172-78

- 24 study meta-analysis (n=803)
- Correlation between CVP and:
  - Blood volume 0.16
  - Responsiveness to fluid challenge 0.18
- AUC ROC curve 0.56 (95% CI 0.51-0.61)
ECG for Perioperative Ischaemia
Martinez et al. Crit Care Med 2003; 31:2302-08

CM$^{5}$ sensitivity for ischaemia 12% (95% CI 7-17%)

Why have I become a BIS user?

• Lets me give a better neuroanaesthetic
  – Faster awakening
  – More orientation in PACU
  – More cardiostability with TIVA
  – Early warning device for problems
    • Anaesthetic
    • Surgical
    • Patient
  – NICE have suggested I should...
Practical Tips for BIS in Theatres

You got an idea... You don't have a clue... You don't know the room, go to the dark side!
Yes! That's it!

Vader used to practice in front of the mirror for hours.

Practice make Perfect

[Image of medical equipment readings]
Remember the Connector!

BIS & Muscle Relaxants
BIS & Artefact

Sudden Increases in BIS
Sudden Increases in BIS

![Image of BIS monitor with sudden increases](image1)

Sudden Increases in BIS

![Image of BIS monitor with sudden increases](image2)
Sudden Falls in BIS

Sudden Falls in BIS
Sudden Falls in BIS
In Summary

• Depth of anaesthesia monitors generally help you give a “Goldilocks” anaesthetic for little extra cost
• The available evidence may make it hard to convince your CD that they are necessary
• They are difficult to use effectively if reserved for special occasions and/or patients

References

References