A (Semi) Hypothetical Case...
- 63 y.o., 5’2”, 88 kg female for hand assisted laparoscopic tranversecolectomy
- Co-morbidities include:
  - Hypertension controlled with lisinopril and atenolol.
  - Obesity
  - Remote smoking hx
- Plan for GETA:
  - Midazolam pre-med
  - Propofol, lidocaine, fentanyl, rocuronium for induction and intubation
  - Fentanyl, desflurane, rocuronium for maintenance
- Mild depression controlled with fluoxetine.

Post Operatively...
- Hypotension after induction, corrected with 20 mg ephedrine x 2.
- 1400 cc LR
- EBL 250cc
- Urine output:
  - Initial 25cc
  - Intraop 80cc
- Uneventful reversal of NMB, extubation, and transport to the PACU on O2 3 l/m via n.c.

Unintended Awareness Under General Anesthesia
- How do we define recall and what are the risk factors?
- When does does recall most commonly occur?
- What can we do to reduce the incidence of recall?
- What are the consequences of recall?
- How should patients experiencing recall be managed?

“Awake” The Movie
Joint PR effort from ASA & AANA
Print, and other media materials are prepared.
Public service messages and materials.
Private screening for Carol Weir.

Explicit recall [ER]: awake during surgery, aware of peri-operative events, and the memory of the experience after surgery.
Rate of about 0.18% of patients receiving general anesthesia with neuromuscular blockade (0.11% without NMB).
26,000 cases/yr or 100/day in U.S. *.


Consciousness: State in which information from the patient's surroundings can be processed.
Recall: Ability to retrieve stored memories
Explicit Memory: Recall of specific intra-operative clinical events.
Implicit Memory: Post-operative evidence of priming but without recall.

Cardiac surgery patients
Acute trauma with hypovolemia
C/S under general anesthesia
ASA status 3,4, and 5 patients
Impaired CV function
History of severe end stage lung disease

Expected intra-operative hypotension
Bronchoscopy, laryngoscopy
Anticipated difficult intubation
History of awareness
Heavy alcohol intake
Chronic use of bz’s, opioids or both

Incidence about 0.26%*
Rapid redistribution of induction agents prior to establishment of target (0.8 MAC) [ET gas] increase risk of recall.
Propofol redistributed more quickly than STP, but has greater amnesic effects.
Ketamine and midazolam reduce awareness, but not commonly used.

During pregnancy MAC is reduced 25-40%:
- Decreased FRC
- Increased minute ventilation
During C/S 0.5 MAC in 50% N₂O results in a BIS between 57 and 64.
BIS monitoring shown to reduce awareness by 82%*


### Awareness Descriptions...

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory perceptions</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Unable to move or breathe</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Anxiety/stress</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>Pain</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Sensation of ET tube</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Feeling surgery without pain</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>


### Consequences of Awareness

- PTSD sx are common after AUGA:
  - Pain
  - Anxiety
  - Delayed neurotic symptoms...
- Symptoms can persist for years post operatively & be psychologically debilitating
- Major source of dissatisfaction and anxiety
- Can result in litigation (2-12% of claims)

### Common Causes of Awareness

Administration of general anesthesia inadequate to maintain unconsciousness & prevent recall during surgical stimulation*.
- Exaggerated anesthetic requirements.
- Equipment misuse or failures.
- Smaller doses of anesthetic drugs.


### Strategies for Prevention...

- Periodic maintenance of anesthesia machines and vaporizers
- Pre-op check of pumps and equipment
- Use of amnestic agents
- Use of adequate dose of induction agents
- Measurement & documentation of end tidal concentrations of agents
- Recognize meds that place patients at risk
- Awareness of effects of neuromuscular blocking agents
**The Million Dollar Question.**

Can brain function monitors reduce the incidence of unintended awareness under general anesthesia?

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**Ekman, Lindholm et al.**

<table>
<thead>
<tr>
<th></th>
<th>No BIS</th>
<th>BIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>7826</td>
<td>4945</td>
</tr>
<tr>
<td>TIVA</td>
<td>3.7%</td>
<td>5.2%</td>
</tr>
<tr>
<td>GA+RA</td>
<td>752 (10%)</td>
<td>644 (13%)</td>
</tr>
<tr>
<td>NMB</td>
<td>7752 (99%)</td>
<td>4729 (96%)</td>
</tr>
<tr>
<td>Intubated</td>
<td>7796 (100%)</td>
<td>4926 (100%)</td>
</tr>
<tr>
<td>ET gas monitoring</td>
<td>6028 (80%)</td>
<td>4688 (99%)</td>
</tr>
</tbody>
</table>

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**Questions**

- What is the last thing you remember before going to sleep?
- What is the first thing you remember waking up?
- Do you remember anything between going to sleep and waking up?
- Did you dream during your procedure?
- What was the worst thing about your operation?

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**Results...**

- Awareness in the non-BIS group = 0.18%
- Awareness in the BIS group = 0.04%, a total of two patients (2/4945)
- Both patients remembered intubation, had BIS values greater than 60 at intubation. Both were young, healthy non-smokers, received STP, fentanyl, rocuronium, and sevoflurane anesthetic technique.

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**“Reduction in the incidence of awareness using BIS monitoring”**

Of Note...

- Average BIS was 38 (+/- 8).
- 8% of patients had BIS > 60 for four minutes or more (no ER).
- 1.7% of patients had BIS > 70 for four minutes or more (no ER).
- Specificity of high BIS < 100%.
- Sensitivity (upper limit of BIS = 60) is satisfactory.

What is BIS?

- The BIS system processes raw EEG signals and calculates a number between 0 and 100 that reflects the effects of anesthetics and sedatives on brain activity.
- BIS near 100 indicates the patient is fully awake.
- BIS value of zero indicates the absence of brain activity.
- Displays extensive clinical validation.

Typical BIS Changes

- Classic decrease during induction.
- Plateau during maintenance.
- Increase with discontinuation of anesthetic agents.

BIS Changes with Depth

Potential Benefits of BIS Monitoring

- Drug savings $$$
- Reduced frequency of awareness under general anesthesia.
- Reduced PONV.
- Faster wake ups.
- Shorter PACU stays.

Recent Results/Studies

- Reduced
  - Time to eye opening
  - Time to response
  - Time to extubation
  - Time to orientation
- Insignificant effect
  - Opioid & NMB use
  - Home readiness
- Incidence of recall in high risk groups reduced.
- Total drug costs are reduced.

Bispectral Index for Improving Anesthetic Delivery and Postoperative Recovery (Review) Punjasawadong et al. 2007
“Anesthesia Awareness and Bispectral Index”

- 2000 patients at high risk for recall
- BIS group target 40-61 (n=967)
- ETAG target 0.7-1.3 MAC (n=974)
- No difference in incidence of recall
  - 2 in each group
  - Rate = 2:1000 or 0.21%
- High risk rate assumed: 1:100 or 1%


“Mortality within 2 Yrs after Surgery...Low BIS”

- ASA status was the most reliable predictor of 2 yr mortality.
- Duration of deep anesthesia (BIS<45) was a significant risk factor (immuno-suppression?).
- Pre-existing malignancy and major surgery were associated with higher 2 year mortality.


“Awareness During Anesthesia: Risk Factors, Causes & Sequelae: A Review”

- Light anesthesia a major risk factor (for all of the aforementioned considerations).
- Prior history of awareness is a major risk factor.
- Patient subjective experiences were consistent with previous reports.
- Untoward sequelae may occur in as many as 33% of cases.


Latest Sensor Evolution

- Captures bi-hemispheric data
- Four channels of continuous real time data
- Intended to improved management of cases with risk of acute changes in cerebral blood flow, or with known cerebral vascular dz.

Joint Commission Sentinel Event Alert on Awareness

Requires that institutions:

- Develop a policy that:
  - Educates clinical staff
  - Identifies patients at risk
  - Addresses equipment maintenance
  - Provides for follow up post op for all patients
  - Identification of patients experiencing AUGA
  - Assures access to counseling, or other support for patients experiencing PTSS

Questions & Discussion...