

# Awareness Under General Anesthesia: Where Are We Now?

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## 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
  - Mild depression controlled with fluoxetine.
- Plan for GETA:
  - Midazolam pre-med
  - Propofol, lidocaine, fentanyl, rocuronium for induction and intubation
  - Fentanyl, desflurane, rocuronium for maintenance

- 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 O<sub>2</sub> 3 l/m via n.c.

## Post Operatively...

- Tearful in the recovery room.
- Denies significant pain
- Denies shortness of breath
- Seems confused, when asked, "what's wrong?" simply responds, "I don't know..."
- On post operative visit on POB#1 states simply, "I remember my surgery, all of it..."

## Unintended Awareness Under General Anesthesia

- How do we define recall and what are the risk factors?
- When 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



## The Response of the Professions

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

## Defining the Issue...

- 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.\*.

\*The Incidence of Awareness During Anesthesia: A Multicenter United States Study. Sebel et al. Anesthesia and Analgesia 2004;99:833-9

## Defining the Definitions

- 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.

*Priming: Presentation of material to an anesthetized patient.*

## Patients at Increased Risk



- 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

## Patients at Increased Risk

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



## Example: C/S Under GA

- 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.

\*Paech et al. Int J Obstet Anesth 2008;17:298-303

## Example: C/S Under GA

- During pregnancy MAC is reduced 25-40%
  - Decreased FRC
  - Increased minute ventilation
- During C/S 0.5 MAC in 50% N<sub>2</sub>O results in a BIS between 57 and 64
- BIS monitoring shown to reduce awareness by 82%\*

Myles et al. Lancet 2004;363:1757-63.

## Timing of Awareness

- During endotracheal intubation
- At skin incision
- Other times of intense or changing stimulation

## Awareness Descriptions...

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

The Incidence of Awareness During Anesthesia: A Multicenter United States Study. Sebel et al. Anesthesia and Analgesia 2004;99:833-9

## 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.**



\*The Incidence of Awareness During Anesthesia: A Multicenter United States Study. Sebel et al. Anesthesia and Analgesia 2004;99:833-9

## 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?



## "Reduction in the incidence of awareness using BIS monitoring"



Ekman, Lindholm, et al. Acta Anaesthesiol Scand  
2004;48:20-26

## Ekman, Lindholm et al.

	No BIS	BIS
Number	7826	4945
TIVA	3.7%	5.2%
GA+RA	752 (10%)	644 (13%)
NMB	7752 (99%)	4729 (96%)
Intubated	7796 (100%)	4926 (100%)
ET gas monitoring	6028 (80%)	4688 (99%)

## Ekman, Lindholm et al.

- Used BIS A-2000 monitors
- All providers trained to use BIS
- Target: BIS < 60 during induction and maintenance (40-60)
- Data analyzed during induction and maintenance
- Patients questioned for recall in PACU, POD 1-3, & POD 7-14 (3 times)

## 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?

## 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.

## Of Note...

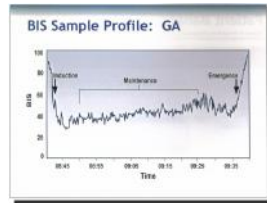
- Average BIS was 38 (+/- 8).
- 8% of patients had BIS > 60 for four minutes or more (no ER).
- 1.7% of patients had BIS > 70 for four minutes or more (no ER).
- Specificity of high BIS < 100%.
- Sensitivity (upper limit of BIS = 60) is satisfactory.

## What is BIS?

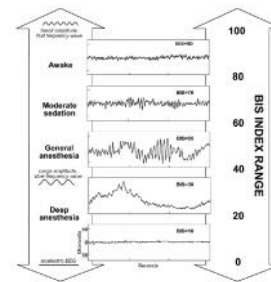
- The BIS system processes raw EEG signals and calculates a number between 0 and 100 that reflects the effects of anesthetics and sedatives on brain activity
- BIS near 100 indicates the patient is fully awake
- BIS value of zero indicates the absence of brain activity.
- Displays extensive clinical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

## Typical BIS Changes

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

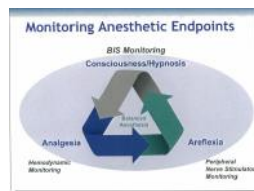


## BIS Changes with Depth



## 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 Anaesthetic 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%

Avidan et al. N Engl J Med 2008;358:1097-1108

## "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 (immunosuppression?).
- Pre-existing malignancy and major surgery were associated with higher 2 year mortality.

Lindholm et al. AnesthAnalg 2009;108: 508-12

## "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 sequela may occur in as many as 33% of cases.

Ghoneim et al. AnesthAnalg 2009;108:527-35

## 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...

