AWARENESS IN PEDIATRIC ANESTHESIA

Dr Noël Emmanuel
CHU TIVOLI
What Anesthesia Can Teach Us About Consciousness

Eureka
By MAGGIE KOERTH-BAKER DEC. 10, 2013

BOOK REVIEW | NONFICTION
What Happens When You Go Under
By HENRY MARSH JAN. 3, 2018
Waking up under the surgeon's knife
ONE IN 700 PEOPLE WAKE UP DURING SURGERY

AWAKE

IMAGINE IF YOU WOKE UP DURING YOUR MURDER

“CUTTING EDGE SUSPENSE” - DAILY STAR
Anesthesia

- Amnesia
- Unconsciousness
- Muscle relaxation
- Analgesia
- Loss of reflexes
Memory

- **Explicit memory**: conscious recollection of events and facts
  - Age of 3

- **Implicit memory**: memory which cannot be consciously recalled but will result in changed behaviour or performance
  - Implicit memory << explicit memory
Awareness

- Explicit recall of an event occurring during anesthesia
  - Auditory or tactile experiences, pain, ...
  - Distressing
- Post-traumatic stress disorder
- Awareness <3 yr ??
Consciousness

- Cortex/thalamus

- Age of consciousness: early

"A conscience is that still small voice that people won't listen to."
(J. Cricket)
Incidence

• Spontaneous reporting
  • 5th National Audit Project

• Direct questioning
  • Modified Brice questionnaire
  • *Children are more suggestible*

• Isolated Forearm Technique
Spontaneous reporting

Approximate year of AAGA:

- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010

Age group (year):

- 1-5
- 6-10
- 11-15
- 16-20

NAP5. BJA 2014
Modified Brice Questionnaire

1. What is the last thing you remember before going to sleep (please tick one box)?
- Being in the pre-op area
- Being with family
- Feeling mask on face
- Burning or stinging in the IV line
- Seeing the operating room
- Hearing voices
- Smell of gas
- Other [Please write below]:

2. What is the first thing you remember after waking up (please tick one box)?
- Hearing voices
- Feeling mask on face
- Seeing the operating room
- Being with family
- Nothing
- Feeling breathing tube
- Feeling pain
- Being in the recovery room
- Being in ICU
- Other [Please write below]:
3. Do you remember anything between going to sleep and waking up (please tick box)?
   - No ☐
   - Yes: -Hearing voices ☐ -Hearing events of the surgery ☐
   - Unable to move or breathe ☐ -Anxiety/stress ☐
   - Feeling pain ☐ -Sensation of breathing tube ☐
   - Feeling surgery without pain ☐ -Other [Please write below]

4. Did you dream during your procedure (please tick box)?
   - No ☐ - Yes ☐
   - What about [Please write below]:

5. Were your dreams disturbing to you (please tick box)?
   - No ☐ - Yes ☐

6. What was the worst thing about your operation (please tick box)?
   - Anxiety ☐ - Pain ☐
   - Recovery process ☐ - Unable to carry out usual activities ☐
   - Awareness ☐ - Other [Please write below]:
## Direct questioning

<table>
<thead>
<tr>
<th>Individual cohorts</th>
<th>Incidence of AAGA (%)</th>
<th>Number of AAGA and size of cohort</th>
<th>Age range (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davidson et al. (16)</td>
<td>0.2</td>
<td>1 of 500</td>
<td>5–12</td>
</tr>
<tr>
<td>Blusse Van Oud-Alblas et al. (17)</td>
<td>0.6</td>
<td>6 of 928</td>
<td>3–16</td>
</tr>
<tr>
<td>Davidson et al. (18)</td>
<td>0.8</td>
<td>7 of 864</td>
<td>5–12</td>
</tr>
<tr>
<td>Malviya et al. (19)</td>
<td>0.8</td>
<td>14 of 1784</td>
<td>3–15</td>
</tr>
<tr>
<td>Lopez and Habre (20)</td>
<td>1.2</td>
<td>5 of 410</td>
<td>6–16</td>
</tr>
<tr>
<td>Cohorts combined</td>
<td><strong>0.74</strong></td>
<td><strong>33 of 4486</strong></td>
<td></td>
</tr>
<tr>
<td>Davidson et al. (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Isolated Forearm Technique

1. Induction agent

2. Inflate to 50 mmHg above SBP

3. Muscle relaxant

4. Verbal command
   “[NAME], squeeze my hand.”
   “[NAME], squeeze my hand twice if you have pain.”

Sanders et al. Anesthesiology 2017; 126: 214-22
Isolated Forearm Technique

• Gold standard?

• Dysanesthesia hypothesis?
  • Binary interpretation

Pandit. BJA 2015; 115: 32-45
Incidence

• Adults: 0.1-0.2%

• Children: 0.74%
  • UK: ± 3430/Yr (NHS: 463400/Yr)
Characteristics

• Tactile experiences: 79%

• Auditory experiences: 55%

• Scared: 24%

• Pain: 24%
Dreaming

- 11%: No association with premedication, agents, type of surgery


- 19%: Liverpool technique

  Hobbs et al. Anaesthesia 1988; 43:560-562
Dreaming during anaesthesia in children: incidence, nature and associations

G. H. Huang,¹ A. J. Davidson² and R. Stargatt³

- Prospective cohort study
  - 864
  - Aged 5-12 Yr

- 10.4%
Risk factors in adults

- **Inadvertent light anesthesia**: mishap or misjudgement

- **Unintentional light anesthesia**: where signs of light anesthesia are masked (NMBA)

- **Intentional light anesthesia**: trauma, c-section
Risk factors in children

- Use of tracheal tube
- N2O
- Multiple airway manipulations
- No associations with NMBA

Davidson et al. Anaesthesia 2011;66:446-454


- Endoscopic procedures

Risk factors in children

• Pharmacodynamics of anesthesia?
Target of anesthesia
Monitoring

- ECG
- Saturation
- NIBP
- Temperature
- Diuresis

- Do we monitor the brain?
Monitoring the depth of anesthesia

- Raw EEG
- BIS
- Spectral entropy
- Narcotrend Index
- A-Line arx Index
- Cerebral State Monitor
Raw EEG

- Frequencies
- Amplitude
- Coherence
- Order

- *Frontal monitoring*: waves that we classically see during GA is well represented in the frontal cortex
Conventional waveform nomenclature

- Gamma: 30-100 Hz
- Beta: 12-30 Hz
  - High beta: >20
  - Low beta: 12-20
- Alpha: 8-12 Hz
- Theta: 4-8 Hz
- Delta: 0-4 Hz
  - Slow delta: <1Hz
Patterns of EEG during GA

- Coherant alpha, delta
- High amplitude, slow oscillations (0.1-1Hz)
- Propofol ≈ sevoflurane
A Anteriorization of Alpha Oscillations

Awake Baseline  LOC  Unconscious  ROC  Awake Emergence

B Thalamocortical Circuits Underlying Propofol-Induced Alpha Oscillations

Conscious

Unconscious

C Asynchronous Slow Oscillations and Neuronal Activity

Neuronal firing and local slow oscillations
Distant asynchronous slow oscillations
Nearby synchronous slow oscillations

Characteristics of EEG in children

- Total EEG power increase
  - Increase from infancy
  - Peak at 5-8 yr
- No alpha waves and slow waves <1yr
- No alpha oscillation coherence < 1yr
- Epileptiform EEG patterns and sevoflurane
Raw EEG and awareness

• Children: No study

• Adults:
  • Prospective cohort study: IFT
  • Multicenter
  • Frontal alpha-delta EEG
  • Connected consciousness can occur

Gaskell BJA 2017; 119: 664-673
Processed EEG

• Limitations of the processed EEG
  • High power
  • Epileptiform pattern
  • Alpha coherence
  • Age-related EEG patterns (adults patterns)
  • Drug-dependant
  • Delay up to 1 min.
Processed EEG

- BIS
- Spectral entropy
- Narcotrend Index
- A-Line ARX Index
- Cerebral State Monitor
- PSI
BIS

• Gold standard

• Mathematical algorithm: score 0-100
  • Adults EEG signal
  • Frequency of EEG signal
  • Synchronization of waveforms
  • Burst suppression %

• Range: 40-60

• Validated for propofol and volatile agents
BIS

- **Awareness**: No study

- **Low to fair correlation**: >1yr
  - Low accuracy
  - Limitations

- **Performance**: as age

  McDermott A&A 2003; 97: 30-41

  Sciusco et al. Pediatric anesthesia 2017; 27: 399-408
Spectral entropy

• Degree of disorder EEG
• Independant of absolute frequency or amplitude
• 100-0
  – Response entropy: high frequency range (EMG)
    • \( RE \geq SE \)
  – State entropy: low frequency range
    • More stable
Spectral entropy

- **Awareness:** No study

- **Correlation:** > 1yr
  - Age dependency

Klockars. Anesthesiology 2012; 116: 340-351

Narcotrend index

- Pattern recognition EEG
  - Spectral, entropy
- Stage A (awake) to F (burst suppression, silent)
  - E: anesthesia
  - 14 stages
- Score: 100-0
- Correlation

• A-line ARX:
  • Derived AEP/2
  • Mid-latency AEP and passive EEG

• Cerebral State Monitor:
  • Alpha and beta power
  • Burst suppression
• BIS >> AAI-1.6
  • Poor predictor of sevo. Concentration

Ironfield PA 2007; 17: 452-459

• CSI and A-Line-arx in children
  • 20 P.
  • Diagnostic procedures
  • Good correlation CSI, AAI and UMSS scores

Disma PA 2007; 17: 445-451
Which one is the best?
Consequences Adults

• Bored indifference $\Rightarrow$ PTSD

• 1/3: significant psychological symptoms

• Delayed

Osterman et al., General Hospital Psychiatry, 1998

Lennmarken et al., A A Scandinavica, 2002
Consequences in children

• Awareness and dreaming during anaesthesia
  • No child disturbances
  • 2 disturbing dreams

Mckie et al  Anaesth Intensive care, 1973

• Intraoperative awareness in children: myth or reality?
  • < 50% (5) realized “aware”
  • 1 negative thoughts
  • Later follow up: little evidence

Iselin-chaves et al  Current Opinion Anesthesiology, 2006
Awareness during anesthesia in children

- Prospective cohort study: 864
- Interview: Day 1, 3, 30
- True awareness: 7 (0.8%)
- No child upset by the memories
- 1 child: phobia unrelated to awareness

Davidson et al. A&A 2005; 100: 653-661
Consequences in children

• Few psychological problems

• No PTSD
Prevention

• Aware!!
• Detection high risk population?
• Check of anesthesia equipement and drugs
• Age adapted doses of hypnotic agents
• Monitoring
  – Old children: ok
  – Young children ?
Meeting
- Face-to-face meeting with patient
- Listen carefully to patient's story to detail and understand their experience
- Accept the patient's story as their genuine experience
- Express regret that the event has happened (this does not constitute an admission of liability)
- Consult with local clinical psychologist

Analysis
- Seek cause of awareness using NAP5 process
- Check details of patient's story with monitoring details and with staff
- Seek independent opinion of analysis

Support
- To detect impact early, in first 24 hours check for 4 cardinal signs of impact: (1) flashbacks; (2) nightmares; (3) new anxiety state; (4) depression
- Active follow up at 2 weeks
- If impact persists, formal referral to psychiatric/psychological services
Conclusion

- Awareness can occur in children
- Not same population as adults
- No substantial degree of distress (limited)
- Monitoring adapted to age
- Causes: unclear (genetics?)