Emergence agitation
Case Scenario:

- A 3 yr-old child weighing 15 kg was planned for bilateral myringotomy and tubes.

- born at term, no peri or post natal cx

- Hx of previous surgical procedure (pyloric stenosis) – no cx

- no premedication was given to the patient.

- On the day of surgery, the child was very anxious, agitated and cried because of being separated from his mother.
- Sevoflurane 6%
- O₂/N₂O: 50%/50%
- Peripheral line inserted
- 1 µg of sufentanil and 200 mg of IV paracetamol
- Spontaneous breathing with a 3% sevoflurane
- Duration of surgery was 10 min
- Child transferred sedated (no reaction to verbal or tactile stimulation) to the PACU under spontaneous ventilation.
IN PACU

- agitated
- inconsolable
- made no contact with caregivers

needed some physical restraint in order to avoid self-injury.

- IV bolus of 1 µg of sufentanil followed by rapid cessation of the agitation.

- A Pediatric Anesthesia Emergence Delirium (PAED) scale performed retrospectively was found to be 19 and decreased to 4, 30 min after sufentanil administration.
Complete recovery after 1 h

Ability to eat and drink without any nausea or vomiting.

No new episode of agitation

No additional analgesics or postoperative nausea and vomiting treatment given

Left the PACU 75 min after admission with a good recovery profile

2 weeks later and with a phone call 3 months later, no evidence of any postoperative adverse behaviors (no mood or temperament changes and no bed-wetting)
What was the anesthesiologist diagnosis?
Postanesthetic or postoperative delirium, agitation, or excitement in children
Any other investigations should be done?
Why?
Rapid satisfactory recovery of the episode

Characteristics

Absence of hemodynamic or respiratory failure

Absence of pain

It was considered an emergence agitation

no complementary laboratory (glycemia or natremia dosage) or imaging were considered necessary.
IS Emergence Agitation Frequent in Children?
The exact incidence difficult to establish.

Ranges from 2 to 80%

increased by the use of the new volatile agents (sevoflurane and desflurane)

no consensus upon the diagnostic criteria for EA until recently

Self-made, nonvalidated tools previously used to define and score EA

Cases of agitation caused by other etiologies such as pain could be classified as EA.

its frequency depends on the preventive strategies used to decrease its occurrence during the perioperative period.
What Is the Clinical Presentation of Emergence Agitation?
The association of agitation together with a confusion state without recognition of the surrounding environment.

Soon after emergence from anesthesia (mean 14 ± 11 min), reported (up to 45 min)

Malarbi et al.

Table 1. Specific Signs Associated with Emergence Agitation in Children

<table>
<thead>
<tr>
<th>Predictor</th>
<th>OR (95% CI)</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kick</td>
<td>19.3 (1–373.9)</td>
<td>54%*</td>
<td>98%*</td>
</tr>
<tr>
<td>Purposefulness movement</td>
<td>0.03 (0–0.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consolability</td>
<td>0.06 (0–0.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predictor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes reverted</td>
<td>73.7 (0.62–97.5)</td>
<td>81%*</td>
<td>90%*</td>
</tr>
<tr>
<td>No language</td>
<td>0.05 (0–316)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purposefulness movement</td>
<td>93.3 (2.75–1,585)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 95% confidence intervals were not displayed in the original article.

Some specific symptoms of EA in relation with delirium criteria as defined in DMS-IV
Results:

- Eyes stared or averted and nonpurposeful movement as independent signs associated with probable cases of emergence agitation in children aged 18 months–6 yr.

- Kicking, nonpurposeful movements, and inconsolability as independent predictors of EA
Limitations

- Clinical agreement between observers
- No correlation between the presence of EA and other epidemiologic characteristics of this complication
In 2004, Sikich and Lerman developed a specific PAED scale with a sensitivity of 64% and a specificity of 86%.

The diagnostic criterion of EA was also relying on the clinical judgment of clinicians.

Table 2. Pediatric Anesthesia Emergence Delirium (PAED) Scale

<table>
<thead>
<tr>
<th>Items</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>The child makes eye contact with caregiver</td>
<td>1</td>
</tr>
<tr>
<td>The child action is purposeful</td>
<td>2</td>
</tr>
<tr>
<td>The child is aware of his surroundings</td>
<td>3</td>
</tr>
<tr>
<td>The child is restless</td>
<td>4</td>
</tr>
<tr>
<td>The child is in consolable</td>
<td>5</td>
</tr>
</tbody>
</table>

Items 1, 2, and 3 are scored: 4 = not at all, 3 = just a little, 2 = quite a bit, 1 = very much, 0 = extremely. Items 4 and 5 are scored: 0 = not at all, 1 = just a little, 2 = quite a bit, 3 = very much, 4 = extremely.
- Less impact of possible bias (correlations between the PAED scale and other epidemiologic characteristics of EA, such as age).

- Major advance for comparing the preventive efficacy of strategies
EA based on the mentioned publications is:

1. Purposeless agitation with kicking

2. Absence of eye contact with caregivers with eyes stared or averted

3. Inconsolability

4. Absence of awareness of the surroundings.

5. The case we described was consistent with EA.
Are There Risk Factors of Emergence Agitation?
Many factors have been identified as possible predictors of EA.

Their role in the genesis of this complication is still undetermined.
Aono et al.: EA occur more frequently in preschool children

(40% in the preschool sevoflurane group vs. 11.5% in the school-age sevoflurane group).

One of the most important predictors of this complication

Used as a criterion for validating diagnostic scores
Type of Surgery

- Post ophthalmologic and ENT

- Radiologic imaging.

- Voepel-Lewis et al. in their investigation of factors associated with EA, have found both ENT procedures and a rapid emergence from anesthesia as independent predictors of this complication.
The rapidity of these procedures and the resulting rapid emergence from anesthesia

Rapid emergence as a potential risk factor of EA independently from the type of surgery.

However, no satisfactory explanation concerning the association between ENT surgery and EA was found
Anesthesia-related Factors

- The increasing use of the new volatile agents (sevoflurane and desflurane)
- Kuritani and Oi: greater incidence of EA following sevoflurane and desflurane anesthesia in comparison with halothane (odds ratio = 2.21, 95% CI [1.77–2.77]).
Perioperative pain

- EA ------- not due to pain during recovery
- Imaging

- Intraoperative analgesia role in preventing and treating EA
- Cannot exclude intraoperative pain from the genesis of this complication
When and How to Treat Emergence Agitation?
Clinical diagnosis
Specific signs summarized in the PAED scale
Presence of risk factors
Elimination of other potential causes of agitation
Pain, respiratory failure (airway obstruction: foreign body in the upper airway, bronchospasm, or laryngospasm)
Hemodynamic instability (hypotension).
no clear recommendations

- Treat if intense agitation with high risk of self-injury

- less intense agitation without self-injury risk, first try to reassure patients

- treatment become indicated when agitation continues or increases.
Treatment of EA

- Administration of IV sedative agents
  - Midazolam 0.1 mg/kg
  - Propofol 0.5 or 1 mg/kg
  - Opioid agents (IV fentanyl 1 or 2 mcg/kg)
- These treatments are empirical and were extrapolated from pharmacologic preventive studies performed at the end of surgery or from personal experience.
Voepel-Lewis et al
EA require pharmacologic intervention in 52% of children

- Increased the duration of PACU stay
- Midazolam at the end of surgery has shown to prevent EA but delay PACU discharge

- Optimal postoperative doses remain to be determined.
EA ETIOLOGY

1. Difference of clearance of volatile agents from the central nervous system

2. late emergence of cognitive function in comparison with other brain functions ------confusion

3. the introduction of less soluble (and thus more rapidly eliminated) volatile agents
Prevention

- Ideal treatment
- Potential negative issues (confusion state, traumatic injuries), parents, and caregivers
- Pharmacologic
- Non pharmacologic
Many sedative and analgesic agents given either systemically or by regional route were found efficient in the prevention of EA

- Propofol at the end of surgery
- Intraoperative fentanyl
- Ketamine
- Clonidine
- Dexmedetomidine
- Hydroxyzine-midazolam association
- Propofol induction bolus ??
- Premedication with midazolam ??
- Premedication with clonidine and melatonin ?
Pharmacologic methods

- No great impact on the duration emergence from anesthesia

- By contrast, the postoperative treatment increase the duration of PACU stay
Non Pharmacologic

- Kain et al

ADVANCE strategy: Family based preparation information to parents

- Decrease both preoperative anxiety and postoperative emergence agitation.

- More effective on EA prevention than premedication with midazolam
ADVANCE: time- and cost-consuming effect

Fortier et al:
Practicing mask induction at home and parental use of distraction in the preoperative holding area were most efficient in relieving preoperative anxiety in children.
Is There a Relationship between EA and Other Postoperative Behavioral Complications?
Postoperative maladaptive behavioral

- Late postop complication
- Sleep disturbances
- Bedwetting
- Temper tantrums
- Attention seeking
- Fear of being alone
Risk factors:

- Younger age
- A lower birth order
- Preoperative anxiety (in parents and children), sevoflurane-based anesthesia
- Postoperative pain and emergence agitation
- Prevention: midazolam and family-centered preparation
<table>
<thead>
<tr>
<th>Agent</th>
<th>Route and Timing of Administration</th>
<th>Efficacy</th>
<th>Doses</th>
<th>Onset Time</th>
<th>Adverse Effects</th>
<th>Postoperative Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midazolam</td>
<td>Preoperative</td>
<td>No</td>
<td>OR: 0.5 mg/kg</td>
<td>OR: 20–45 min</td>
<td>No adverse effects</td>
<td>Possible delayed recovery and PACU discharge</td>
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<tr>
<td>Midazolam</td>
<td>IV, end of surgery</td>
<td>Yes</td>
<td>IV: 0.1 mg/kg</td>
<td>IV: 15 min</td>
<td>No</td>
<td>Delayed recovery and PACU discharge</td>
</tr>
<tr>
<td>Hydroxyzine combined to OR, preoperative midazolam</td>
<td></td>
<td>Yes</td>
<td>1 mg/kg</td>
<td>60 min</td>
<td>No adverse effects</td>
<td>No delayed recovery or discharge from PACU</td>
</tr>
<tr>
<td>Propofol</td>
<td>Continuous intraoperative</td>
<td>Yes</td>
<td>Induction 2–3 mg/kg</td>
<td>—</td>
<td>No</td>
<td>No prolonged PACU stay</td>
</tr>
<tr>
<td>Propofol</td>
<td>End of surgery</td>
<td>Yes</td>
<td>1 mg/kg</td>
<td>—</td>
<td>No</td>
<td>No prolonged duration of PACU stay</td>
</tr>
<tr>
<td>Ketamine</td>
<td>IV, preoperative</td>
<td>Yes</td>
<td>0.25 mg/kg</td>
<td>10 min</td>
<td>No</td>
<td>No prolonged duration of PACU stay</td>
</tr>
<tr>
<td>α2 Adrenoceptors</td>
<td>IV, end of surgery</td>
<td>Yes</td>
<td>0.25 mg/kg</td>
<td>30 min</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>No prolonged duration of PACU stay; prolonged postoperative sedation</td>
</tr>
<tr>
<td>Clonidine</td>
<td>OR or IR, preoperative</td>
<td>Yes</td>
<td>6 mg/kg or 4 μg/kg</td>
<td>45 min</td>
<td>Decrease of arterial pressure and heart rate (intraoperative and PACU)</td>
<td>Delayed recovery and PACU discharge; prolonged postoperative sedation</td>
</tr>
<tr>
<td>Clonidine</td>
<td>IV after induction</td>
<td>Yes</td>
<td>2, 3, or 4 μg/kg</td>
<td>—</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>No prolonged PACU stay</td>
</tr>
<tr>
<td>Clonidine</td>
<td>CAU</td>
<td>Yes</td>
<td>3 μg/kg</td>
<td>Intraoperative</td>
<td>Decrease of arterial pressure, no effect on heart rate(intraoperative and PACU)</td>
<td>No delayed recovery or discharge from PACU</td>
</tr>
<tr>
<td>α2 Adrenoceptors:</td>
<td>IV, preoperative</td>
<td>Yes</td>
<td>0.2 μg/kg</td>
<td>10 min</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>No delayed recovery. No delayed discharge from PACU</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>IV, intraoperative</td>
<td>Yes</td>
<td>0.3 μg/kg</td>
<td>After induction</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>No delayed recovery. No delayed discharge from PACU</td>
</tr>
<tr>
<td>α2 Adrenoceptors:</td>
<td>IV, intraoperative</td>
<td>Yes</td>
<td>1 μg/kg</td>
<td>After induction</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>Delayed recovery. No delayed discharge from PACU</td>
</tr>
<tr>
<td>Dexmedetomidine</td>
<td>IV, intraoperative</td>
<td>Yes</td>
<td>0.5 μg/kg</td>
<td>5 min before the end of surgery</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>Delayed recovery</td>
</tr>
<tr>
<td>α2 Adrenoceptors:</td>
<td>CAU</td>
<td>Yes</td>
<td>1 μg/kg</td>
<td>Intraoperative</td>
<td>Decrease of arterial pressure and heart rate</td>
<td>Sedation in PACU</td>
</tr>
</tbody>
</table>

CAU = caudal; IR = intrarectal; OR = oral; PACU = postanesthesia care unit; PONV = postoperative nausea and vomiting.
Thank You!