

# Emergence delirium in children

R2 Thidarat Lertwacha

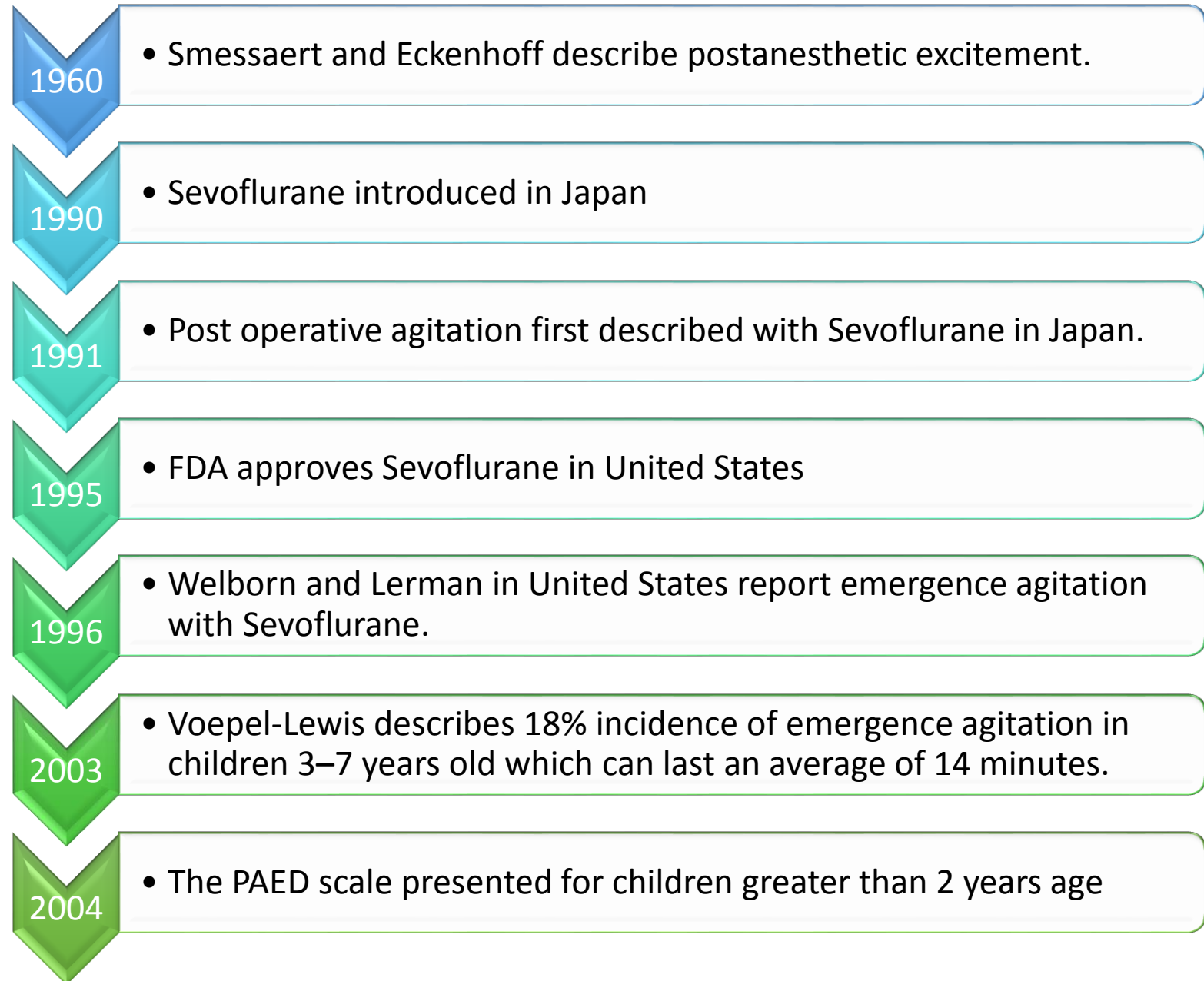
R2 Saowaluk Sotananan

Advisor Taniga Kiatchai

# Definition

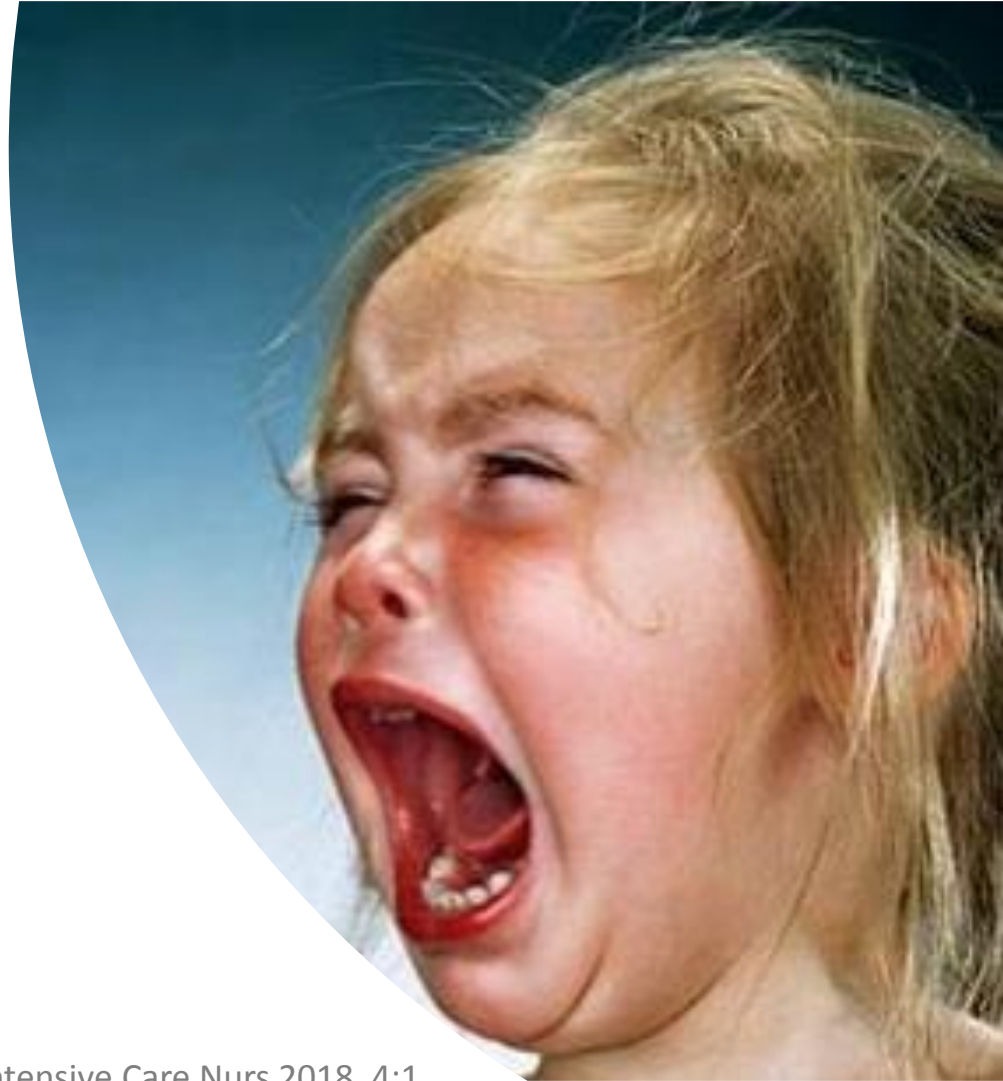
“A disturbance in a child’s awareness or attention to his/her environment with disorientation and perceptual alterations including hypersensitivity to stimuli and hyperactive motor behavior in the immediate post anesthesia period”

- Eckenhoff and colleagues in 1960s



# Incidence

20-30% incidence of ED  
in children 3–7 years old



# Does it matter?

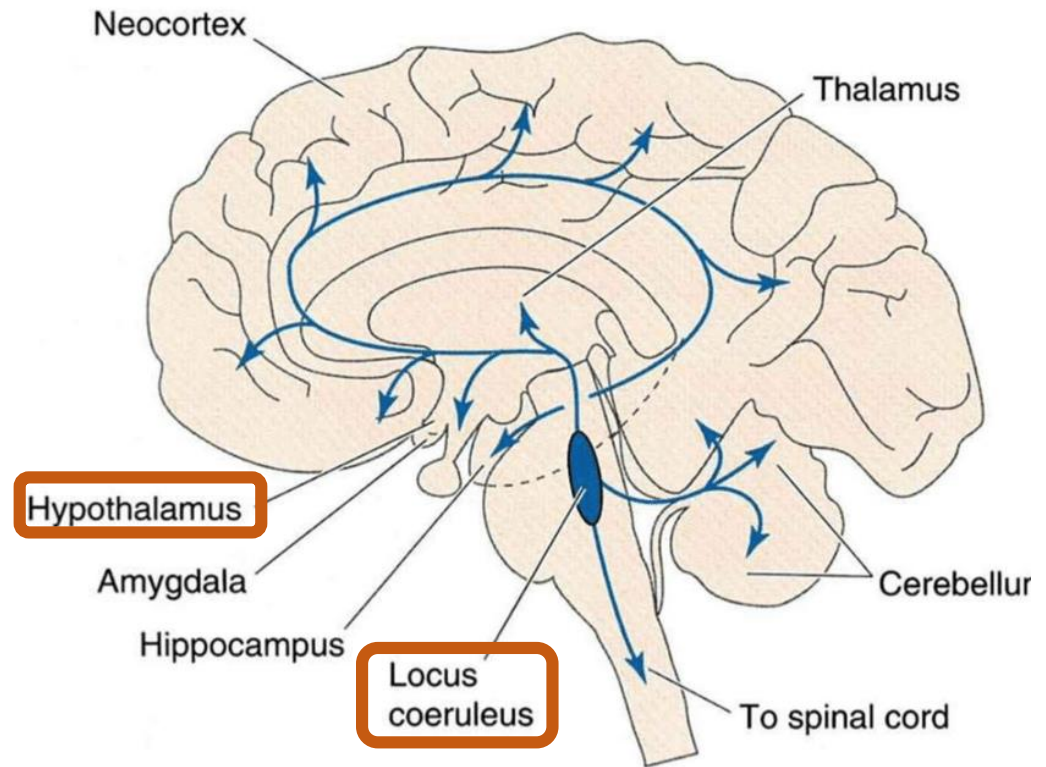
- Risk of harming self and surgical wound dehiscence
- Risk of harming caregivers
- 1.43 times greater risk of having maladaptive behavioral change





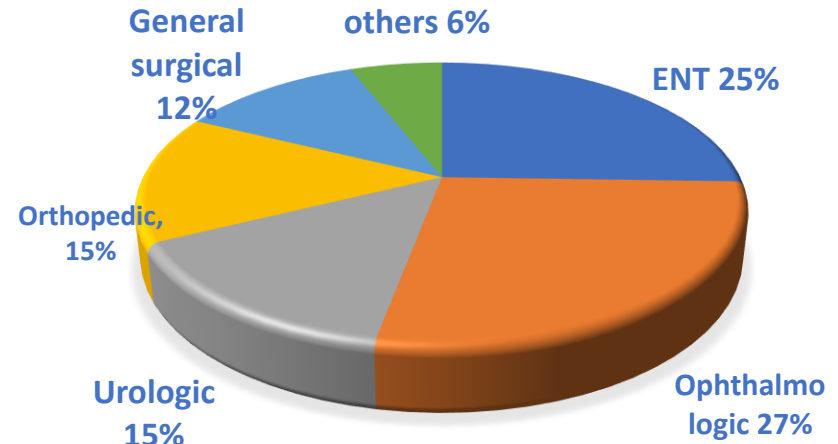
# Causes

- Remains unknown
- Various theories suggest that from the immature nervous system



# Risk factors

- Volatile anesthesia
- Preschool children
- Male
- Otorhinolaryngology and ophthalmology procedure
- Preoperative anxiety
- Child temperament
- Parental anxiety



(Terri Voepel-Lewis Anesth Analg 2003;96:1625–30)

# **Preoperative Anxiety and Emergence Delirium and Postoperative Maladaptive Behaviors**

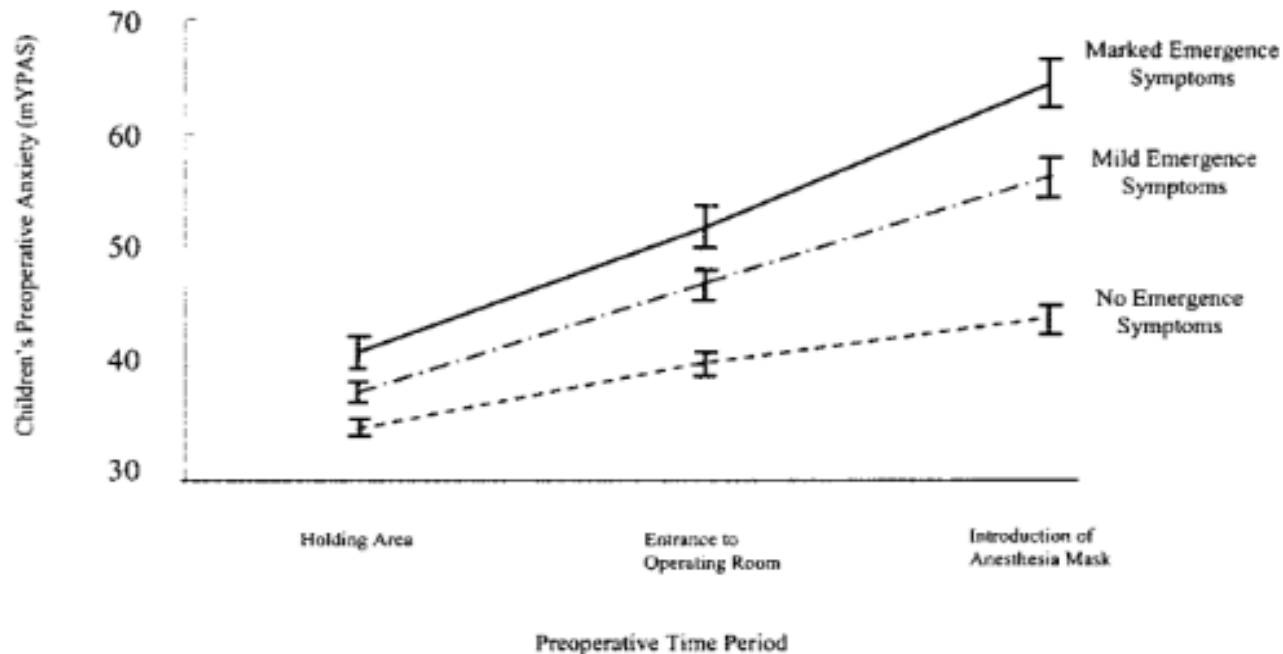
Zeev N. Kain, MD, MBA, Alison A. Caldwell-Andrews, PhD, Inna Maranets, MD, Brenda McClain, MD, Dorothy Gaal, MD, Linda C. Mayes, MD, Rui Feng, MS, and Heping Zhang, PhD

The Center for the Advancement of Perioperative Health, and the Departments of Anesthesiology, Pediatrics, and Child and Adolescent Psychiatry, Yale University School of Medicine, Department of Epidemiology, School of Public Health, Yale University, New Haven, Connecticut

- Included 8 Prospective studies related to
  - Preoperative anxiety
  - Emergence status
  - Postoperative behavioral changes over the past 6 years
- Children with a physical class of ASA I–II, undergoing surgery with general anesthesia



# Results



**Figure 2.** Relationship between preoperative anxiety and emergence delirium symptoms. mYPAS = modified Yale Preoperative Anxiety Scale

ED were increased by approximately 10% as a result of an increment of 10 points in the mYPAS (95% CI 1.0017– 1.0171,  $P=0.0168$ )

# Clinical presentations

Non-purposeful movement

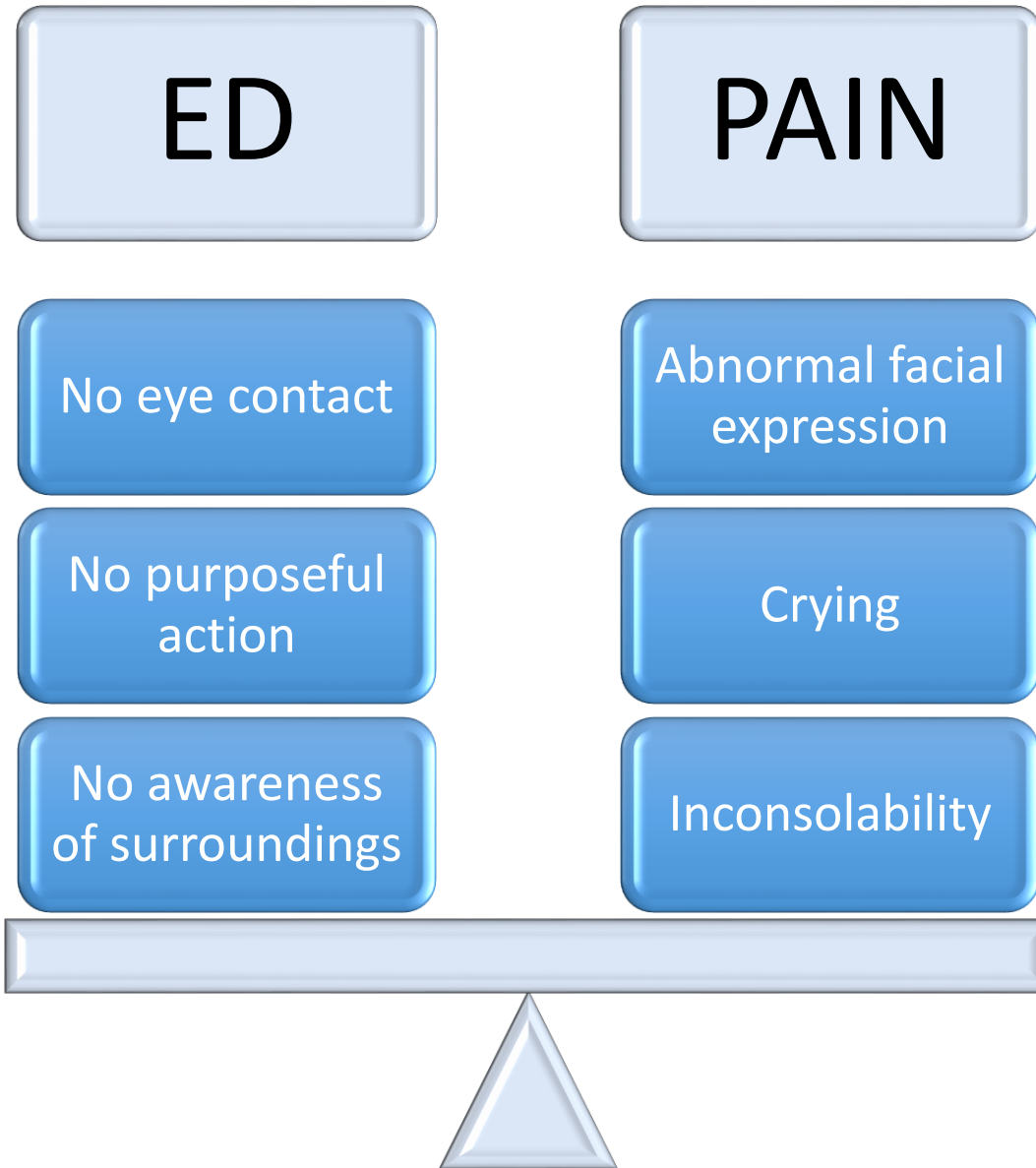
Failing to make eye contact

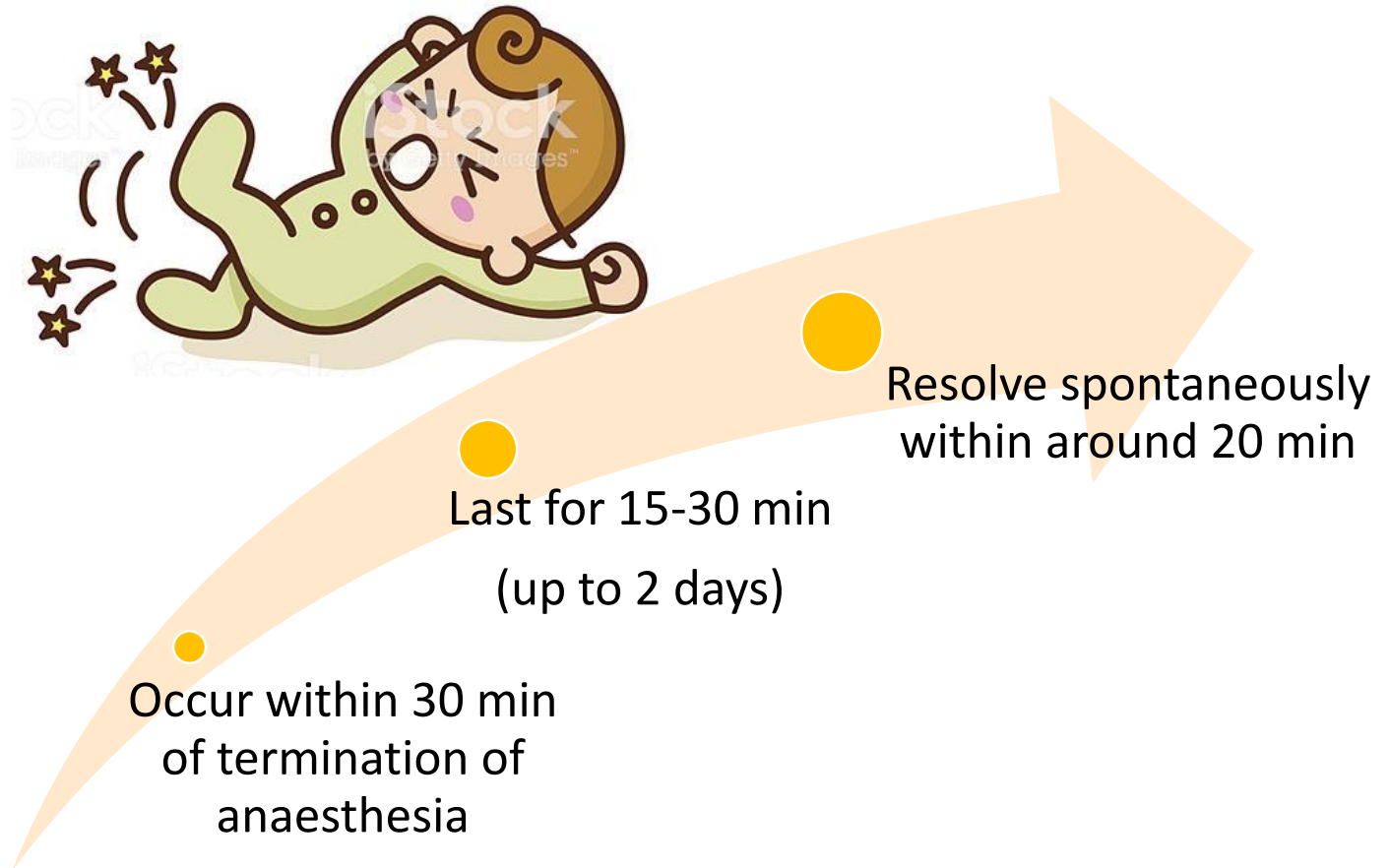


Kicking

Inconsolable demeanor

Thrusting their head backward

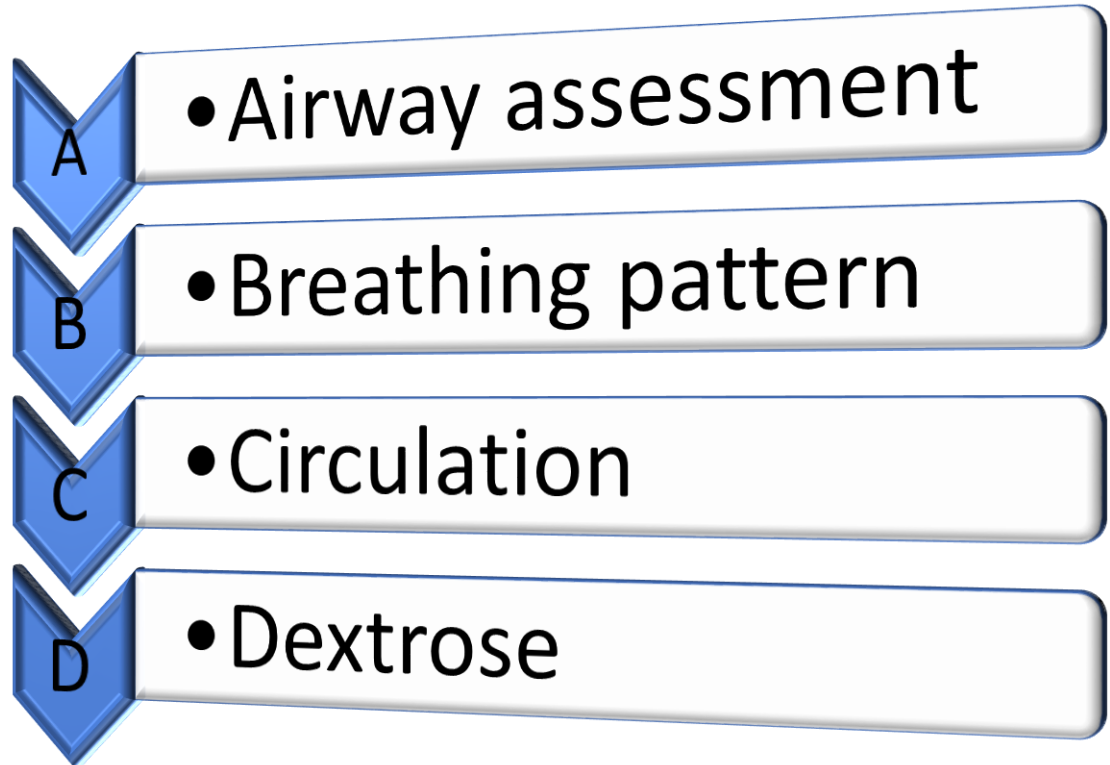




# Clinical approach

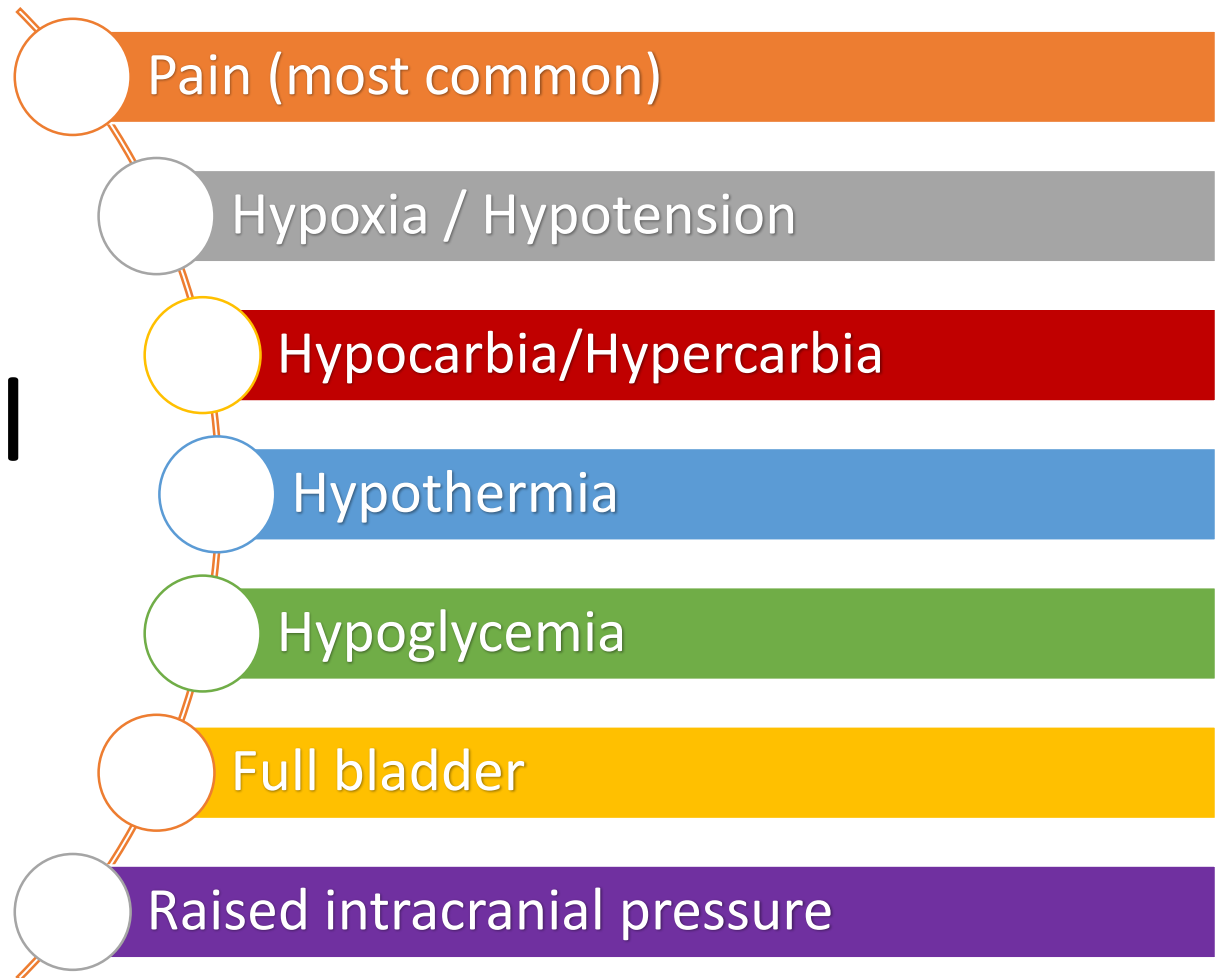
## Ensure their safety

- Placing pillows
- Padded boards around the patient
- Securing IV lines and dressings
- Excluding life threatening conditions





# Differential diagnosis



## The Paediatric Anaesthesia Emergence Delirium (PAED) scale

**Table 2** PAED scale (from Bajwa and colleagues,<sup>4</sup> with permission. ©2010 Blackwell Publishing Ltd). Score is sum of all values

Behaviour	Not at all	Just a little	Quite a bit	Very much	Extremely
Makes eye contact with caregiver	4	3	2	1	0
Actions are purposeful	4	3	2	1	0
Aware of surroundings	4	3	2	1	0
Restless	0	1	2	3	4
Inconsolable	0	1	2	3	4

- A score of  $\geq 10$  displays 64% sensitivity and 86% specificity.
- A score of  $>12$  yields 100% sensitivity and 94.5% specificity for the diagnosis of ED.

$\geq 10$

**Table 3** Watcha scale. Score is observed values

Behaviour	Score
Asleep	0
Calm	1
Crying, but can be consoled	2
Crying, but cannot be consoled	3
Agitated and thrashing around	4

## The Watcha scale

- A child with a score of  $>2$  on the Watcha score can be considered to have emergence delirium.

# The Cravero scale

**Table 1** Cravero scale

Behaviour	Score
Obtunded with no response to stimulation	1
Asleep but responsive to movement or stimulation	2
Awake and responsive	3
Crying (for >3 min)	4
Thrashing behaviour that requires restraint	5

- A score of  $\geq 4$  (from crying and difficult to console to wild thrashing) for a 5 or more minute duration despite active calming efforts is regarded as indicative of ED

# Preventative strategies

- **Non-pharmacological**

- **ADVANCE**

- **Anxiety reduction**
    - **Distraction on the day of surgery**
    - **Video modelling and education**
    - **Adding parents**
    - **No excessive reassurance**
    - **Coaching of parents by staff**
    - **Exposure/shaping of the child via mask practice**

- **Avoid volatile agents**





[Intervention Review]

# Non-pharmacological interventions for assisting the induction of anaesthesia in children

Anne Manyande<sup>1</sup>, Allan M Cyna<sup>2</sup>, Peggy Yip<sup>3</sup>, Cheryl Chooi<sup>2,4</sup>, Philippa Middleton<sup>5</sup>

<sup>1</sup>School of Psychology, Social Work and Human Sciences, University of West London, London, UK. <sup>2</sup>Department of Women's Anaesthesia, Women's and Children's Hospital, Adelaide, Australia. <sup>3</sup>Department of Paediatric Anaesthesia, Starship Children's Hospital, Auckland, New Zealand. <sup>4</sup>Department of Acute Care Medicine, The University of Adelaide, Adelaide, Australia. <sup>5</sup>Women's and Children's Research Institute, The University of Adelaide, Adelaide, Australia

Contact address: Allan M Cyna, Department of Women's Anaesthesia, Women's and Children's Hospital, 72 King William Road, Adelaide, South Australia, 5006, Australia. [allan.cyna@health.sa.gov.au](mailto:allan.cyna@health.sa.gov.au).

**Editorial group:** Cochrane Anaesthesia, Critical and Emergency Care Group.

**Publication status and date:** New search for studies and content updated (no change to conclusions), published in Issue 7, 2015.

**Citation:** Manyande A, Cyna AM, Yip P, Chooi C, Middleton P. Non-pharmacological interventions for assisting the induction of anaesthesia in children. *Cochrane Database of Systematic Reviews* 2015, Issue 7. Art. No.: CD006447. DOI: 10.1002/14651858.CD006447.pub3.

Copyright © 2015 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

# Results

Intervention	Results	Difference (95%CI)
Parental presence	<b>No significant differences</b> in child anxiety compared with not having a parent present	Standardized mean difference (SMD) 0.03, 95% CI -0.14 to 0.20
Mask introduction	<b>No significant differences</b> in child anxiety	RR 0.59, 95% CI 0.31 to 1.11
Video of the child's choice was played during induction	<b>Significantly less</b> anxious than controls	mYPAS 31.2, 95% CI 27.1 to 33.3
A video fairytale or Music therapy	<b>No significant differences</b> in co-operation at induction	
Video games before induction	<b>Significantly less</b> anxious at induction	mYPAS mean difference (MD) -9.80, 95% CI -19.42 to -0.18
Clowns/clown doctors and sedative premedication	<b>No significant differences</b> in child anxiety in the operating room between clown VS medication.	mYPAS MD -9.67, 95% CI -21.14 to 1.80

# Effect of preoperative visiting operation room on emergence agitation in preschool children under sevoflurane anesthesia

Qiaosheng Zhong<sup>a</sup>, Xianfeng Qu<sup>b</sup>, Chuanhua Xu<sup>b,\*</sup>

<sup>a</sup> Department of Anesthesiology, Xiamen Changgong Hospital, Xiamen, Fujian 361028, PR China

<sup>b</sup> Department of Anesthesiology, Taizhou Municipal Hospital, Taizhou, Zhejiang 318000, PR China



**69 children**  
(3 to 6 years)  
tonsillectomy under  
sevoflurane

```
graph TD; A["69 children  
(3 to 6 years)  
tonsillectomy under  
sevoflurane"] --> B["Preop Visit OR  
(Group PV)"]; A --> C["Routine  
preoperative  
visit (Group RV)"]; A --> D["Routine  
preoperative visit  
plus propofol  
(Group RP)"];
```

Preop Visit OR  
(Group PV)

Routine  
preoperative  
visit (Group RV)

Routine  
preoperative visit  
plus propofol  
(Group RP)

# Results

Significantly lower  
than routine preop  
visit group

Significantly shorter  
than routine preop  
visit plus propofol  
group

Group	n	PAED score	Incidence of EA	Time to extubation
Preop visit OR	23	6.04 ± 2.63 <sup>a</sup>	5 (21.7%) <sup>a</sup>	4.39 ± 0.58 <sup>b</sup>
Routine visit	23	11.26 ± 3.60	17 (73.9%)	4.60 ± 0.98
Routine+propofol	3	6.30 ± 2.36 <sup>c</sup>	5 (21.7%) <sup>c</sup>	6.47 ± 0.89 <sup>c</sup>
P		< 0.01	< 0.05	< 0.01

presented as mean ± SD. Multiple comparisons using error discovery rate were obtained as follows.

a = P < 0.05 PV group vs. RV group;

b = P < 0.05 PV group vs. RP group;

c = P < 0.05 RP group vs. RV group.





Volatile agents ?



**Cochrane**  
**Library**

Cochrane Database of Systematic Reviews

## Effects of sevoflurane versus other general anaesthesia on emergence agitation in children (Review)

Costi D, Cyna AM, Ahmed S, Stephens K, Strickland P, Ellwood J, Larsson JN, Chooi C, Burgoyne LL, Middleton P

**Editorial group:** Cochrane Anaesthesia, Critical and Emergency Care Group.

**Publication status and date:** New, published in Issue 9, 2014.

**Citation:** Costi D, Cyna AM, Ahmed S, Stephens K, Strickland P, Ellwood J, Larsson JN, Chooi C, Burgoyne LL, Middleton P. Effects of sevoflurane versus other general anaesthesia on emergence agitation in children. *Cochrane Database of Systematic Reviews* 2014, Issue 9. Art. No.: CD007084. DOI: 10.1002/14651858.CD007084.pub2.








Copyright © 2014 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.

# Outcome

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Emergence agitation	65		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
1.1 Halothane	34	3534	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.41, 0.63]
1.2 Isoflurane	6	379	Risk Ratio (M-H, Random, 95% CI)	0.76 [0.46, 1.23]
1.3 Desflurane	6	408	Risk Ratio (M-H, Random, 95% CI)	1.46 [0.92, 2.31]
1.4 Propofol induction and maintenance	14	1098	Risk Ratio (M-H, Random, 95% CI)	0.35 [0.25, 0.51]
1.5 Propofol maintenance after sevoflurane induction	8	738	Risk Ratio (M-H, Random, 95% CI)	0.59 [0.46, 0.76]
1.6 Ketamine anaesthesia	1	20	Risk Ratio (M-H, Random, 95% CI)	0.75 [0.22, 2.52]
1.7 Halothane induction + desflurane maintenance	1	40	Risk Ratio (M-H, Random, 95% CI)	11.00 [1.56, 77.40]
1.8 Halothane induction + sevoflurane maintenance	1	40	Risk Ratio (M-H, Random, 95% CI)	3.0 [0.34, 26.45]
1.9 Midazolam anaesthesia	1	140	Risk Ratio (M-H, Random, 95% CI)	0.02 [0.00, 0.39]



## 2 Isoflurane








Bortone 2006	18/56	28/54		32.3 %	0.62 [ 0.39, 0.98 ]
Le Berre 2001	0/20	6/20		2.9 %	0.08 [ 0.00, 1.28 ]
Meyer 2007	7/29	6/30		16.5 %	1.21 [ 0.46, 3.16 ]
Singh 2009	6/40	7/40		15.8 %	0.86 [ 0.32, 2.33 ]
Singh 2012	4/25	10/25		15.3 %	0.40 [ 0.14, 1.11 ]
Valley 1999	8/20	5/20		17.2 %	1.60 [ 0.63, 4.05 ]
<b>Subtotal (95% CI)</b>	<b>190</b>	<b>189</b>		<b>100.0 %</b>	<b>0.76 [ 0.46, 1.23 ]</b>

Total events: 43 (Other GA), 62 (Sevoflurane)

Heterogeneity:  $\tau^2 = 0.14$ ;  $\chi^2 = 8.28$ ,  $df = 5$  ( $P = 0.14$ );  $I^2 = 40\%$

Test for overall effect:  $Z = 1.12$  ( $P = 0.26$ )

## 3 Desflurane

Cohen 2002	12/50	9/50		22.2 %	1.33 [ 0.62, 2.88 ]
Demirbilek 2004	7/60	6/60		14.9 %	1.17 [ 0.42, 3.27 ]
Singh 2012	7/25	10/25		21.4 %	0.70 [ 0.32, 1.54 ]
Uzun 2003	5/25	3/25		10.1 %	1.67 [ 0.45, 6.24 ]
Valley 2003	11/24	5/24		18.3 %	2.20 [ 0.90, 5.37 ]
Welborn 1996	11/20	3/20		13.2 %	3.67 [ 1.20, 11.19 ]
<b>Subtotal (95% CI)</b>	<b>204</b>	<b>204</b>		<b>100.0 %</b>	<b>1.46 [ 0.92, 2.31 ]</b>

Total events: 53 (Other GA), 36 (Sevoflurane)

Heterogeneity:  $\tau^2 = 0.10$ ;  $\chi^2 = 7.03$ ,  $df = 5$  ( $P = 0.22$ );  $I^2 = 29\%$

Test for overall effect:  $Z = 1.60$  ( $P = 0.11$ )

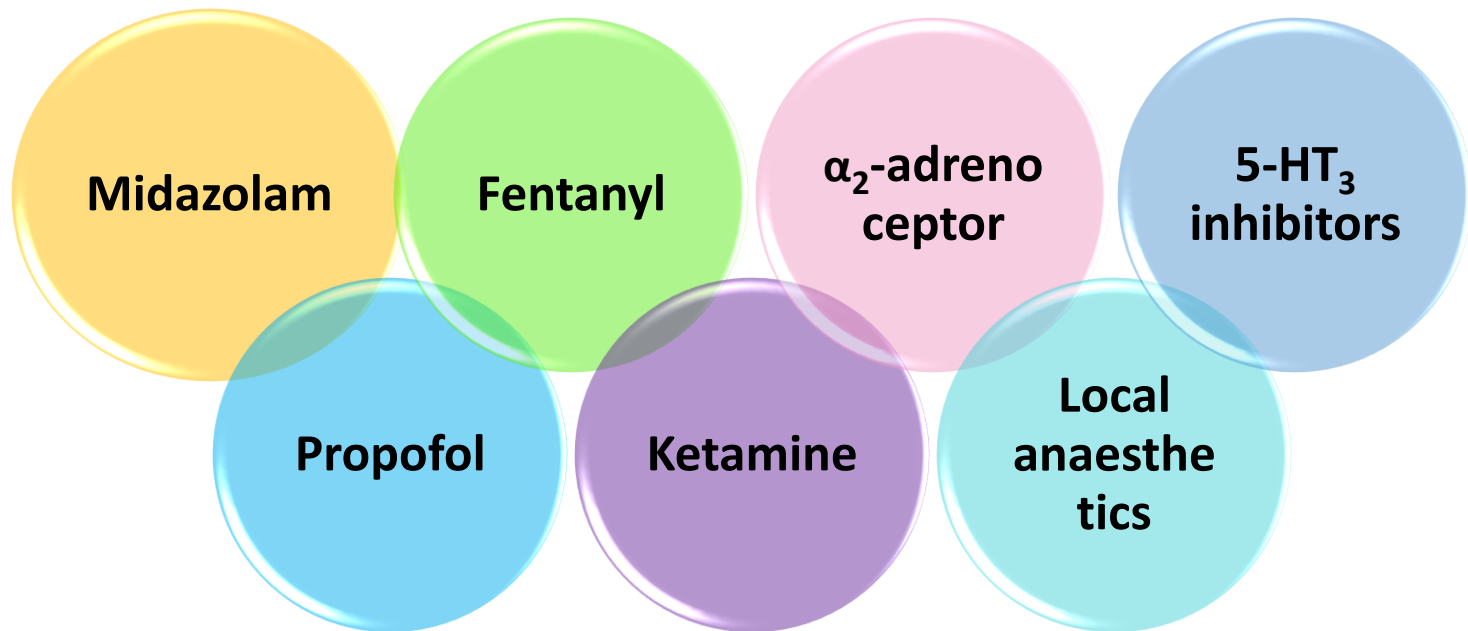
Favor other

0.02 0.1 1 10 50  
Favours Other GA

Favours Sevofl

Favor Sevoflurane

# Pharmacological prevention





# Use of Propofol and Emergence Agitation in Children: A Literature Review

K. Logan Key, CRNA, MSN

Christopher Rich, RN, MSN, MHS

Claire DeCristofaro, MD

Shawn Collins, CRNA, DNP



Sevoflurane  
inhalational  
GA

Propofol as  
an adjunct to  
sevoflurane  
GA

Propofol  
TIVA  
techniques

Study design	Population	Premedication	Analgesia	EA incidence
<b>Sevoflurane only</b>				
Sevoflurane vs propofol induction/halothane maintenance <sup>10</sup>	322 children Age 3-12 y Day surgery or ENT surgery	None	Alfentanil, fentanyl, or regional blocks	Sevoflurane 25.7% Propofol/halothane 9.4%
Sevoflurane vs sevoflurane induction, isoflurane maintenance <sup>6</sup>	128 children Age 1-6 y Subumbilical surgery	None	Penile, caudal, or ilioinguinal/iliohypogastric block	Sevoflurane 51.8% Sevoflurane/isoflurane 32.1%
Sevoflurane only <sup>21</sup>	68 children Age 1-6 y Circumcision	Midazolam 0.5 mg/kg, or clonidine 2 or 4 µg/kg	Penile block and rectal paracetamol 30 mg/kg	Midazolam 60% Clonidine 2 µg/kg 40%, 4 µg/kg 25%
<b>Total intravenous anesthesia (TIVA)</b>				
Sevoflurane vs propofol TIVA <sup>13</sup>	53 children 2-36 mo Ambulatory surgery	None	Fentanyl 2 µg/kg or caudal block	Sevoflurane 23.1% Propofol 3.7%
Sevoflurane vs propofol TIVA <sup>15</sup>	186 children Age 2-11 y ENT surgery	None	Fentanyl 2 µg/kg	Sevoflurane 20%-42% Propofol 5%-11%
<div> The use of a propofol TIVA technique and adjunctive propofol can reduce the incidence of emergence delirium. </div>				
Sevoflurane vs propofol TIVA <sup>9</sup>	Tonsillectomy 16 children Age 1-5 y Eye surgery	Midazolam 0.5 mg/kg PO	ibuprofen 10 mg/kg, and local infiltration of site Acetaminophen 30 mg/kg prn	Sevoflurane 38% Propofol 0%
<b>Propofol as adjunct to sevoflurane</b>				
Propofol 1 mg/kg vs saline <sup>5</sup>	80 children Age 2-6 y Strabismus surgery	Midazolam 0.5 mg/kg PO	Paracetamol 15 mg/kg IV	Propofol 19.5% Saline 47.2%
Propofol 1mg/kg vs saline <sup>14</sup>	84 children Age 2-7 y MRI	None	Nitrous oxide	Propofol 4.8% Saline 26.8%


**Table 3. Emergence Agitation (EA) Studies Divided by Anesthetic Technique With EA Incidence**

ENT indicates ear, nose, and throat; PAED, Pediatric Anesthesia Emergence Delirium; MRI, magnetic resonance imaging; prn, as needed; PO, orally; IV, intravenously.


# Midazolam

Cochrane Database of Systematic Reviews 2014; Effects of sevoflurane versus other general anaesthesia on emergence agitation in children.

## Oral premedication

- No overall reduction in risk of ED
  - RR 0.81, 95% CI 0.59-1.12
- 

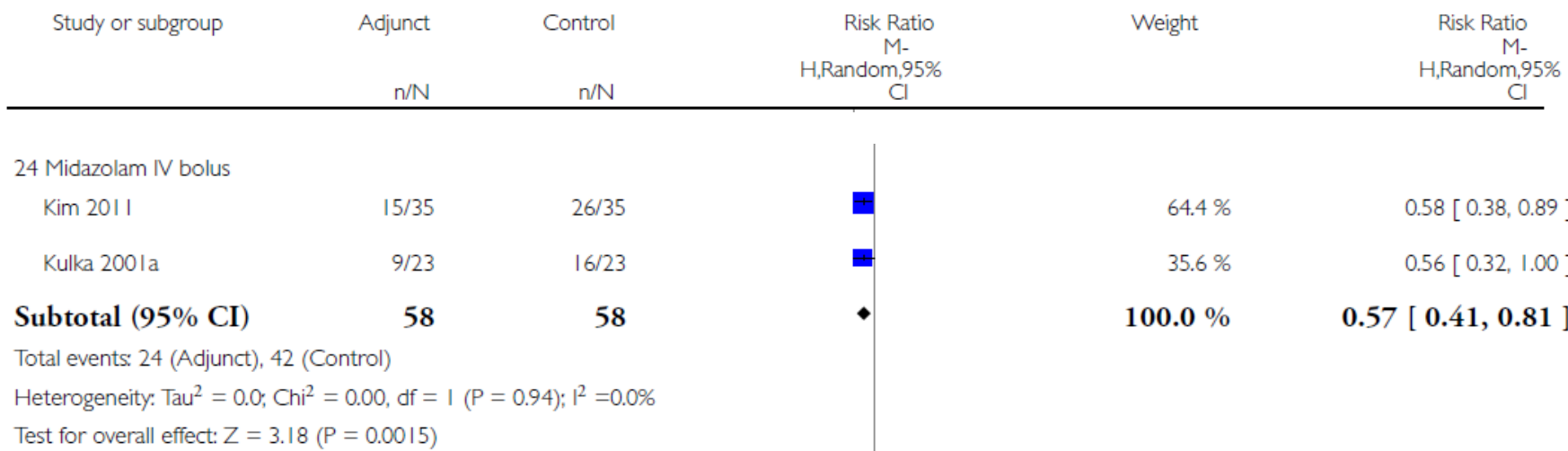
## IV before induction

- No significant difference in PAED score
  - PAED score 6.3 VS 7.2
- 

## IV at the end of anaesthesia

- Significantly reduced the risk of ED
- RR 0.57 95%CI [0.41,0.81]

# Midazolam IV at the end of anaesthesia



Significantly reduced the risk of emergence delirium

# Comparison of the Effects of 0.03 and 0.05 mg/kg Midazolam with Placebo on Prevention of Emergence Agitation in Children Having Strabismus Surgery

Eun Jung Cho, M.D., Seung Zhoo Yoon, M.D., Ph.D., Jang Eun Cho, M.D., Ph.D.,  
Hye Won Lee, M.D., Ph.D.

Midazolam IV before  
the end of surgery



# Results

	Midazolam 0.03 mg/kg (n = 30)		Midazolam 0.05 mg/kg (n = 30)	Saline (n = 30)	P Value
Incidence of emergence agitation*	5 (16.7%)		5 (16.7%)	13 (43.3%)	0.024
Pediatric anesthesia emergence delirium scale score†	10 (8–17)	=	10 (8–17)	12 (9–19)	0.004
No. of patients with pediatric anesthesia emergence delirium score ≥10‡	21 (70%)		19 (63.3%)	28 (93.3%)	0.018
No. of patients with pediatric anesthesia emergence delirium score ≥13§	5 (16.7%)		5 (16.7%)	13 (43.3%)	0.024
Emergence time (min)¶	14.1 ± 3.6	<	17.1 ± 3.4	12.8 ± 4.1	<0.001

Data are presented as numbers of patients (percentage), median (range), or mean ± SD. Multiple comparisons using false discovery rate were obtained as follows:

\* Midazolam 0.03 mg/kg vs. saline ( $P = 0.036$ ), midazolam 0.05 mg/kg vs. saline ( $P = 0.036$ ), midazolam 0.03 mg/kg vs. midazolam 0.05 mg/kg ( $P = 1$ ).

† Midazolam 0.03 mg/kg vs. saline ( $P = 0.0165$ ), midazolam 0.05 mg/kg vs. saline ( $P = 0.0165$ ), midazolam 0.03 mg/kg vs. midazolam 0.05 mg/kg ( $P = 1$ ).

‡ Midazolam 0.03 mg/kg vs. saline ( $P = 0.03$ ), midazolam 0.05 mg/kg vs. saline ( $P = 0.015$ ), midazolam 0.03 mg/kg vs. midazolam 0.05 mg/kg ( $P = 0.584$ ).

§ Midazolam 0.03 mg/kg vs. saline ( $P = 0.036$ ), midazolam 0.05 mg/kg vs. saline ( $P = 0.036$ ), midazolam 0.03 mg/kg vs. midazolam 0.05 mg/kg ( $P = 1$ ).

¶ Midazolam 0.03 mg/kg vs. saline ( $P = 0.385$ ), midazolam 0.05 mg/kg vs. saline ( $P = 0.0003$ ), midazolam 0.03 mg/kg vs. midazolam 0.05 mg/kg ( $P = 0.0009$ ).

0.03mg/kg of midazolam before the end of surgery reduces the incidence of emergence agitation in children having strabismus surgery without delaying the emergence time or causing adverse events.

# Clonidine before induction

- 7 clonidine trials (767 children);  
Clonidine IV or caudal route 0-45 minutes before induction

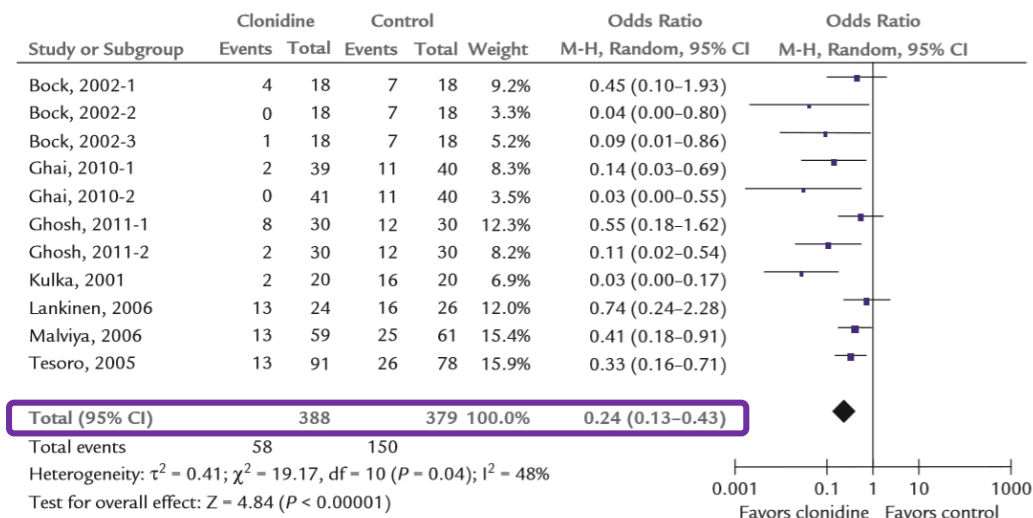


Figure 3. Forest plot of meta-analysis of the effect of prophylactic clonidine for preventing emergence agitation (clonidine,  $n = 388$ ; control,  $n = 273$ ). The center of each blue square shown for each study (first author, year of publication) is the odds ratio for individual trials, and the corresponding horizontal line is the 95% CI. The black diamond represents the pooled OR with the 95% CI. Studies with  $> 1$  intervention group are numbered as author, year of publication-1; author, year of publication -2; and author, year of publication-3.

Significantly decrease incidence of EA  
either via intravenous or caudal route



# Meta-Analysis of Dexmedetomidine on Emergence Agitation and Recovery Profiles in Children after Sevoflurane Anesthesia: Different Administration and Different Dosage

**Min Zhu<sup>1</sup>, Haiyun Wang<sup>1\*</sup>, Ai Zhu<sup>1</sup>, Kaijun Niu<sup>2</sup>, Guolin Wang<sup>1</sup>**

**1** Department of Anesthesiology, Tianjin Research Institute of Anesthesiology, Tianjin Medical University General Hospital, Tianjin 300052, China, **2** Department of Epidemiology, School of Public Health, Tianjin Medical University, Tianjin 300052, China



# Dexmedetomidine

Parameters	Risk ratio (95% CI)		Results
Incidence of EA	M-H. 0.37 [0.30, 0.46]	Favours experimental	Decreased incidence of ED
Post-anesthesia nausea and vomiting	M-H. 0.57 [0.38, 0.85]	Favours experimental	Decreased PONV
Emergence time	IV. 1.16 [0.72, 1.6]	Favours control	Delayed emergence time
Time to extubation	IV. 0.61 [0.27, 0.95]	Favours control	Prolonged time to extubation
Time to discharge from recovery room	IV. 2.67 [0.95, 4.39]	Favours control	Delayed time to discharge from recovery room

A total of 1364 patients from 20 prospective RCTs were included in the meta-analysis.



# Dexmedetomidine Effect on Emergence Agitation and Delirium in Children Undergoing Laparoscopic Hernia Repair: a Preliminary Study

Yingying Sun<sup>1,2</sup>, Yuanhai Li<sup>2</sup>, Yajuan Sun<sup>1</sup>,  
Xing Wang<sup>1</sup>, Hongwu Ye<sup>1</sup> and Xianren Yuan<sup>1</sup>

- Dexmedetomidine IV after induction 10 min before surgery, continue infusion and stop 3-5 min postoperative



# Conclusion

Parameter	Saline (n=24)	0.25 mcg/kg (n=23)	0.5 mcg/kg (n=25)	1.0 mcg/kg (n=25)	
CHIPPS scale	8 (6–9) <sup>a</sup>	6 (5–9) <sup>a</sup>	3 (2–4) <sup>b</sup>	3 (2–4) <sup>b</sup>	<0.001
5-Point scale	3 (3–4) <sup>a</sup>	3 (2–4) <sup>a</sup>	2 (1–2) <sup>b</sup>	1 (1–2) <sup>b</sup>	<0.001
EA frequency	11 (45.8%)	7 (30.4%) <sup>a</sup>	3 (12.0%) <sup>ab</sup>	1 (4.0%) <sup>ab</sup>	0.001
ED frequency	7 (29.1%)	3 (13.0%)	1 (4.0%)	1 (4.0%)	0.341

Scores are presented as the median (IQR) and were analyzed with the Kruskal–Wallis test and the post hoc Mann–Whitney U test.

Categorical variables are presented as proportions and were analyzed with Fisher's exact test.

Dex: dexmedetomidine; CHIPPS: Children and Infants Postoperative Pain Scale; EA: emergence agitation; ED: emergence delirium.

<sup>a</sup>P < 0.05 vs. controls

<sup>b</sup>P < 0.05 vs. Dex 0.25

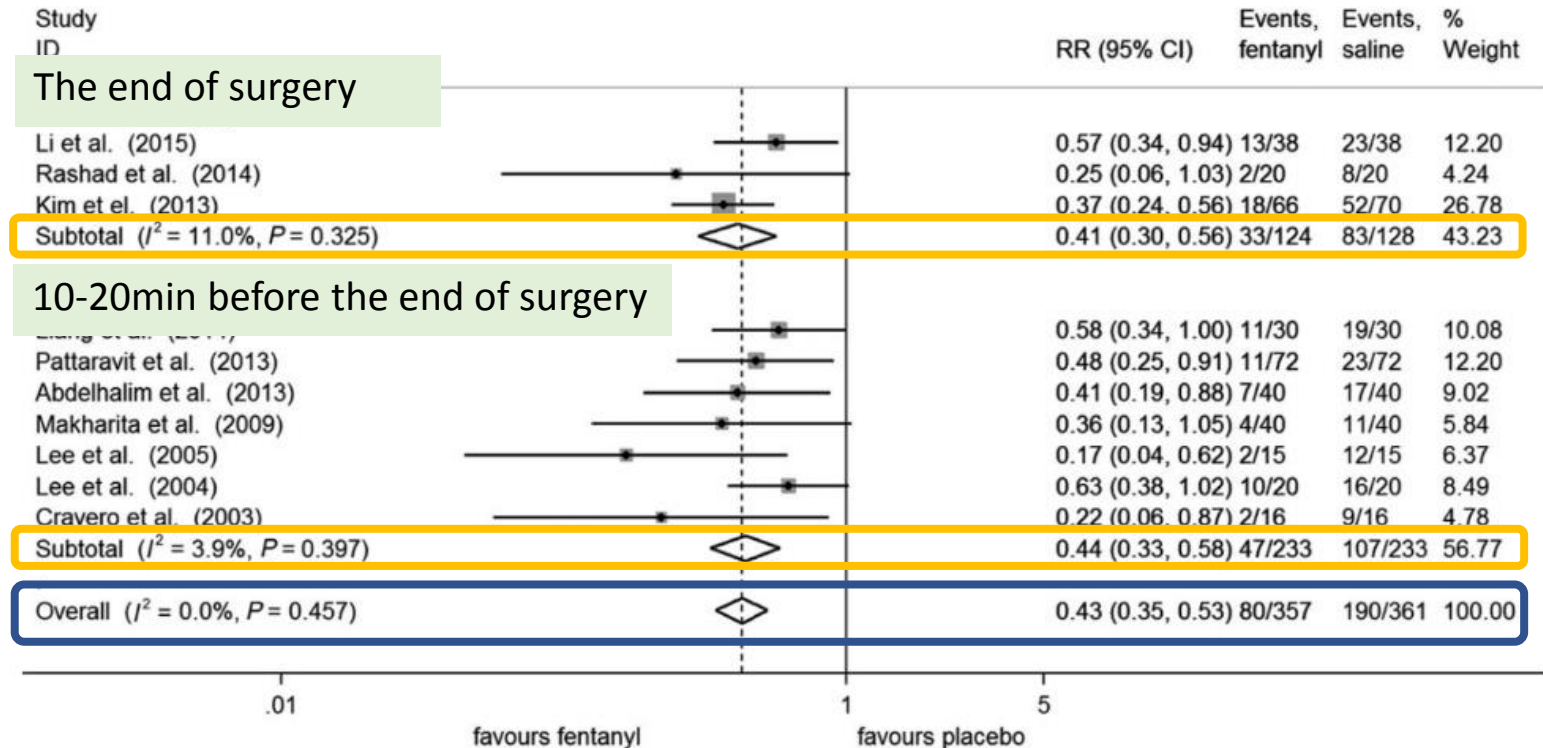


# Effects of intravenous fentanyl around the end of surgery on emergence agitation in children: Systematic review and meta-analysis

Namo Kim | Jin Ha Park | Jong Seok Lee | Taeyang Choi | Min-Soo Kim 

- Included 10 RCT (718 patients)
  - Compared fentanyl (1 mcg/kg) and placebo
  - Sevoflurane inhalation was used for maintenance.
- Children 0-14 years old

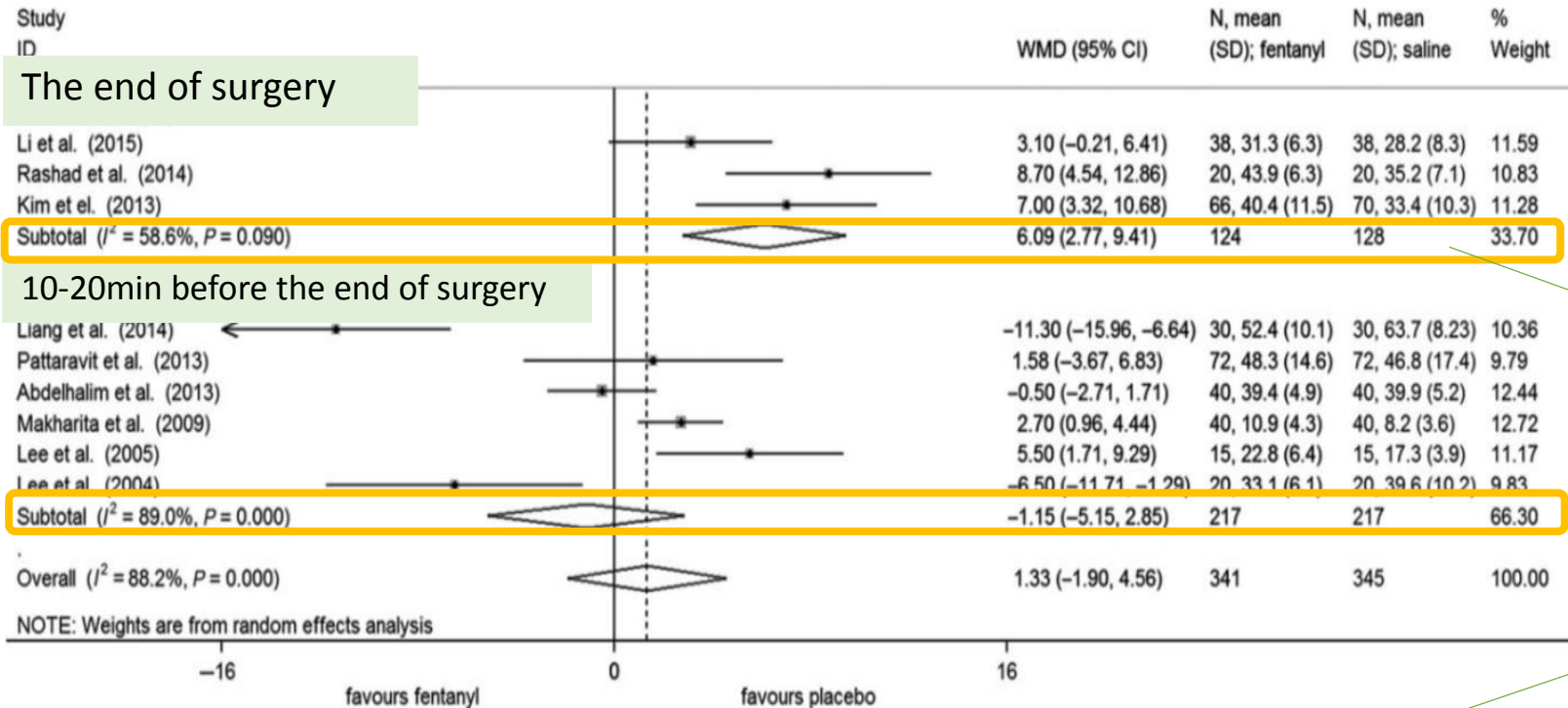
# Results



**FIGURE 2** Forest plot of incidence of emergence agitation between fentanyl and placebo groups

Fentanyl around the end of surgery significantly decreased EA incidence

# Length of PACU stay



**FIGURE 3** Forest plot of length of postoperative care unit stay between fentanyl and placebo groups

Receiving fentanyl at the end of surgery delays PACU stay.

# The effect of ketamine on the incidence of emergence agitation in children undergoing tonsillectomy and adenoidectomy under sevoflurane general anesthesia

Yoon Sook Lee, Woon Young Kim, Jae Ho Choi, Joo Hyung Son, Jae Hwan Kim, and Young Cheol Park

Department of Anesthesiology and Pain Medicine, Ansan Hospital, Korea University College of Medicine, Ansan, Korea

- 93 children, ASA I-II, 2-14 years old, undergoing adenotonsillectomy.
- Three groups : receiving saline(C), ketamine 0.25 mg/kg (K0.25) or ketamine 0.5 mg/kg (K0.5)
- Administered IV the study drugs 10 minutes before the end of surgery

# Result

**Ketamine gr : lower incidence of ED than control group**

**No** hallucination or nightmare were observed in ketamine gr

**Table 5.** Pain Score (Modified CHEOPS), and Agitation Score

Group	C (n = 30)	K0.25 (n = 30)	K0.5 (n = 30)
Modified CHEOPS	8.00 (6.00, 9.00)	3.00 (2.00, 6.00)*	2.00 (1.00, 2.00)*, †
Agitation score (1 : 2 : 3 : 4)	1 : 5 : 14 : 10	11 : 9 : 8 : 2*	17 : 11 : 2 : 0*

Values of modified CHEOPS are median (25%, 75%). Agitation score : 1 = asleep, 2 = awake and calm, 3 = agitated but consolable, 4 = severely agitated and inconsolable. \*P < 0.05 compared with the Group C, †P < 0.05 compared with the Group K0.25.

No significant differences

**Table 4.** Extubation time, Delivery Time, and PONV (Postoperative Nausea, Vomiting)

Group	C (n = 30)	K0.25 (n = 30)	K0.5 (n = 30)
Extubation time (min)	10.24 ± 3.66	11.28 ± 3.19	10.69 ± 3.34
Delivery time (min)	40.00 (40.00, 50.00)	40.00 (40.00, 50.00)	40.00 (36.50, 50.00)
PONV (1 : 2 : 3 : 4)	24 : 4 : 2 : 0	26 : 0 : 4 : 0	23 : 1 : 6 : 0

Values of extubation time are mean ± SD. Values of delivery time are median (25%, 75%). There are no significant differences among the three groups. PONV scale : 1 = none, 2 = retching, 3 = one episode of vomit, 4 = multiple episode of vomit.



# Ketamine and ED

## Oral premedication

- Effective intervention with reduction in risk of EA (Abde Imawgoud 2012; Khattab 2009)

## Ketamine IV bolus after induction

- No reduction in risk of ED compared with placebo (Tsai 2008)

## Ketamine 0.25 mg/kg IV bolus at end of anesthesia

- Effective reduction in risk of EA (Abu-Shahwan 2007; Dalens 2006; Lee 2010a)

# Which's good?



# **Preventing Emergence Agitation Using Ancillary Drugs with Sevoflurane for Pediatric Anesthesia: A Network Meta-Analysis**

Xin Wang<sup>1,2</sup> • Qi Deng<sup>2,3</sup> • Bin Liu<sup>2</sup> • Xiangdi Yu<sup>1</sup>

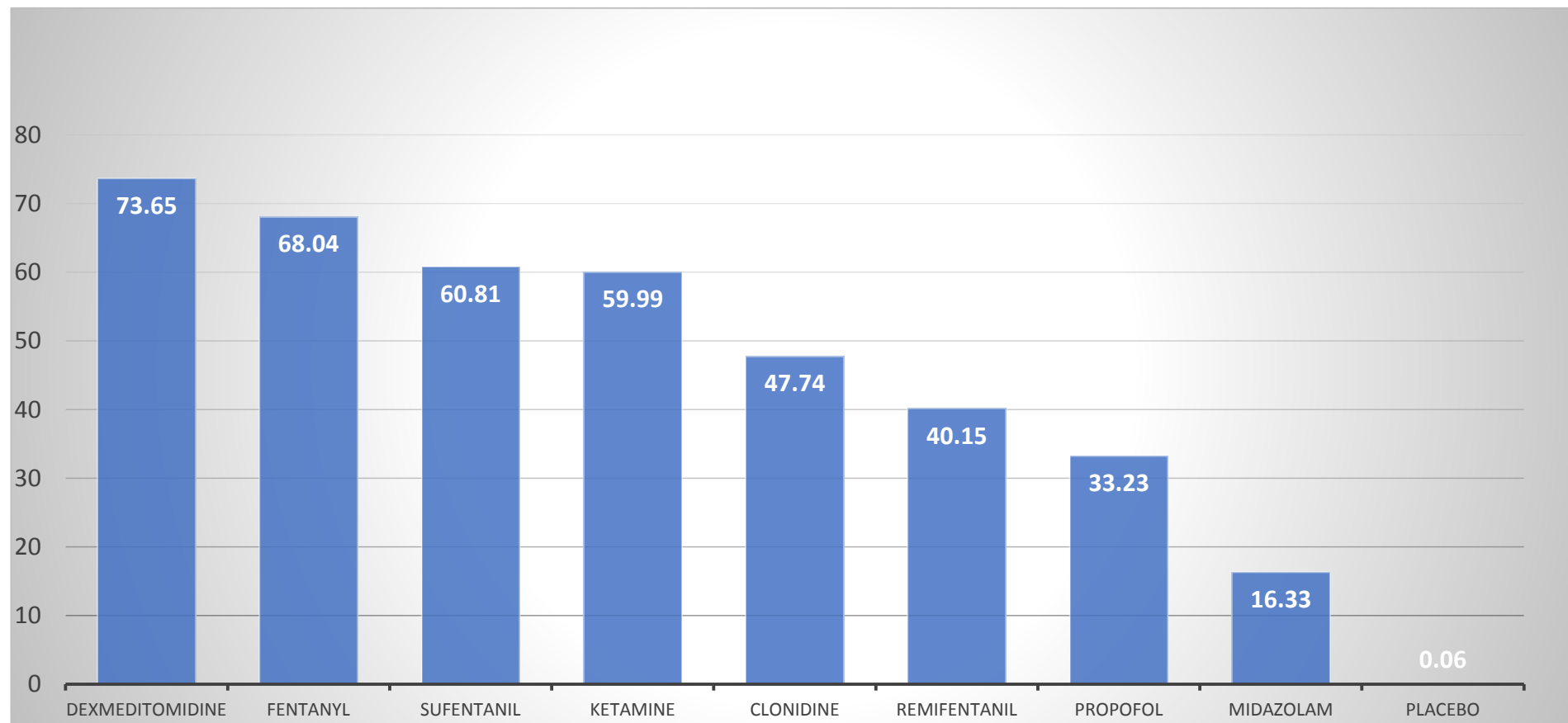
- 67 randomized control trials
- The relative risk of EA associated with eight anesthetic adjuvants was analyzed : ketamine, propofol, dexmedetomidine, clonidine, midazolam, fentanyl, remifentanyl, and sufentanil

**Table 2** Summary odds ratios of EA and heterogeneity for each direct comparison

Comparison	OR (95 % CI)	<i>P</i> -heterogeneity	I-squared	Tau-squared
Dexmedetomidine vs. placebo	<i>0.34 (0.27, 0.43)</i>	0.697	<0.01 %	<0.001
Fentanyl vs. placebo	<i>0.40 (0.29, 0.54)</i>	0.723	<0.01 %	<0.001
Ketamine vs. placebo	<i>0.37 (0.26, 0.52)</i>	0.790	<0.01 %	<0.001
Midazolam vs. placebo	<i>0.63 (0.40, 0.99)</i>	0.211	29.90 %	0.092
Clonidine vs. placebo	<i>0.49 (0.28, 0.85)</i>	0.160	37.00 %	0.169
Propofol vs. placebo	<i>0.50 (0.33, 0.77)</i>	0.146	35.40 %	0.126
Remifentanyl vs. placebo	<i>0.63 (0.45, 0.87)</i>	0.814	<0.01 %	<0.001
Sufentanil vs. placebo	0.56 (0.30, 1.02)	0.660	<0.01 %	<0.001
Fentanyl vs. dexmedetomidine	0.77 (0.38, 1.58)	0.620	<0.01 %	<0.001
Ketamine vs. dexmedetomidine	2.00 (0.46, 8.80)	–	–	<0.001
Midazolam vs. dexmedetomidine	1.28 (0.59, 2.78)	0.303	17.60 %	0.112
Clonidine vs. dexmedetomidine	1.86 (0.67, 5.14)	–	–	0.112
Propofol vs. dexmedetomidine	2.60 (0.85, 7.97)	–	–	0.112
Ketamine vs. fentanyl	1.01 (0.50, 2.06)	0.286	20.70 %	0.118
Clonidine vs. fentanyl	6.00 (0.68, 52.9)	–	–	0.118
Propofol vs. fentanyl	0.50 (0.04, 5.97)	–	–	0.118
Sufentanil vs. fentanyl	1.09 (0.39, 3.08)	0.044	68.00 %	0.569
Midazolam vs. ketamine	1.32 (0.53, 3.30)	–	–	0.569
Propofol vs. ketamine	0.80 (0.16, 4.03)	0.178	44.90 %	0.689
Clonidine vs. midazolam	<i>0.35 (0.13, 0.91)</i>	0.797	<0.01 %	<0.001
Propofol vs. midazolam	1.13 (0.48, 2.68)	–	–	<0.001

*P* value less than 0.05 is considered as significance with italic fonts

# Results



- Based on the surface under the cumulative ranking curve (SUCRA) values

# Summary

Drugs	Prevention	Treatment
Propofol	TIVA or 1 mg/kg iv at the end of surgery	0.5-1 mg/kg iv
Midazolam	0.03 mg/kg iv at the end of surgery	0.1 mg/kg iv
Fentanyl	1 mcg/kg iv at 10-20 minute before surgery 2 mcg/kg intranasal after induction	1-2 mcg/kg iv
Dexmedetomidine	0.2 mcg/kg iv preoperative 0.3 mcg/kg iv at the end of surgery 0.2-1 mcg/kg/hour intraoperative infusion 1 mcg/kg caudal	0.3 mcg/kg iv
Ketamine	0.25 mg/kg iv preoperative or before the end of surgery	
Magnesium sulphate	30 mg/kg iv bolus then 10 mg/kg/hr infusion	
Dexamethasone	0.2 mg/kg iv before induction	
Clonidine	2-4 mcg/kg iv after induction 4 mcg/kg oral or intrarectal preoperative	
Ketorolac	1 mg/kg iv during surgery	
Gabapentin	15 mg/kg oral preoperative	

# Take home message

- Mostly in **preschool-children** after inhaled anesthetics
- ED must be prevented as a result of risk for **self-injury**
- Diagnosis : rule out **pain** and potentially dangerous causes of agitation (**hypoxia, hypotension, hypercarbia, hypoglycemia**)
- Mostly, resolves over 20 minutes, and requires no treatment other than **support, presence of parental, prevention of harm**

