Paediatric emergence delirium

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Revalidation FOR ANAESTHETISTS
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Key points

Emergence delirium (ED) is a transient state of marked irritation and disassociation after the discontinuation of anaesthesia in some patients which does not respond to consoling measures.

ED is much more likely to occur in paediatric patients between 2 and 5 yr of age undergoing relatively painful procedures under inhalation anaesthesia.

Various causes of ED have been proposed, including rapid emergence after the use of short-acting volatile anaesthetics and the intrinsic characteristics of such agents.

Preventative measures and treatment options include the use of premedication, analgesic adjuvants, single dose of propofol at the conclusion of the case, and comforting by a known party in the recovery room.

Children who have ED are more likely to have new-onset postoperative maladaptive behavioural changes.

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Definition and measurement scales

A child with emergence delirium (ED) is in a 'dissociated state of consciousness in which the child is irritable, uncompromising, uncooperative, incoherent, and inconsolably crying, moaning, kicking, or thrashing'.[1] ED can disrupt the surgical repair, be distressing for parents and staff and may cause parental dissatisfaction with their child's care.

Many scales have been proposed to evaluate the incidence and severity of ED, and a variety of scales are used in clinical practice and for research purposes. Agitation due to pain is a significant confounding factor for the evaluation of the presence or measurement of the degree of ED.[2] The Cravero scale (Table 1) has five steps from obtunded and unresponsive to wild thrashing behaviour requiring restraint.[3] A score of ≥ 4 (from crying and difficult to console to wild thrashing) for a 5 or more min duration despite active calming efforts is regarded as indicative of ED. The Paediatric Anaesthesia Emergence Delirium (PAED) scale (Table 2) is validated but is difficult to use in routine clinical practice.[2] The Watcha scale (Table 3) is a simpler tool to use in clinical practice and may have a higher overall sensitivity and specificity than the PAED and Cravero scales.[4] It is more practical to use a simple scale to detect delirium and then use the PAED scale to measure its degree.[5]

Incidence and risk factors

There have been a wide range of reported figures for the incidence of ED in paediatric populations, ranging from 2% to 80%.[1 6] Differences in study design and methodology account for some measure of the variation, in particular the use of disparate rating systems for ED and the wide range of surgical and anaesthetic contexts under study. Thus, there is no consensus on the incidence even within particular subgroups of paediatric patients, for example, those undergoing identical surgeries or presenting with similar psychological profiles.

But the totality of the literature does identify significant risk factors for ED pertaining to anaesthetic, surgical, and patient characteristics (Table 4). The introduction of short-acting volatile anaesthetics has been historically associated with the increased incidence of ED. In non-surgical settings, with patients undergoing magnetic resonance imaging (MRI), sevoflurane has been shown to increase the risk of ED when compared with halothane.[3] More generally, anaesthetic techniques that result in rapid emergence from anaesthesia increase the risk. Indeed, a recent meta-analysis showed that propofol, ketamine, α_2-adrenoreceptor agonists, fentanyl, and preoperative analgesia were effective in reducing the risk of ED presumably by delaying emergence and reducing postoperative pain.[6]

While pain is not the sole cause for ED, surgery associated with elevated postoperative pain has been thought to increase the risk of ED. The site of surgery has been proposed as a risk factor, as well. Otorhinolaryngological and ophthalmological procedures have been shown to increase the risk of ED in comparison with urological and general surgery procedures, pointing to the possibility that surgeries affecting the head and neck may be relatively more likely to induce ED.[7]

Younger patients, particularly in the age range from 2 to 5 yr of age, are at increased risk of ED.[8] Preoperative anxiety, as measured by the modified Yale Preoperative Anxiety Scale, has been shown to increase the risk of ED for each increment of 10 points in the child's state anxiety score.[9] Temperament, as reflected in children who are more emotional, more impulsive, less social, and less adaptable to environmental changes, has been identified as a risk factor for ED.[1]

Aetiology

Sudden emergence from anaesthesia into a disordered state of consciousness or into an

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unfamiliar environment has been proposed as a cause of ED. However, the incidence of ED in patients receiving propofol is markedly lower than those receiving sevoflurane, despite the similar rapid emergence profile of both agents.[10]

Elevated postoperative pain has been suggested to underlie ED. But given that ED is seen in patients undergoing MRI, pain cannot be the sole cause. Studies in patients undergoing MRI are particularly useful since this removes pain as a confounding variable allowing for more controlled investigation of ED. A study performed in 2000 looked at 32 children that were undergoing sedation for MRI scanning. The patients were randomized to receive either sevoflurane or halothane for the maintenance of anaesthesia. An increase in the incidence of ED was found with sevoflurane compared with halothane, and there was no increase in time to discharge when comparing the two groups. A second study in 2003 again included patients undergoing MRI scanning with sevoflurane used for maintenance. Thirty-two children were randomized to receive either placebo (saline) or fentanyl 1 $\mu g\ kg^{-1}$ 10 min before the end of the scan. The incidence of ED significantly decreased in the fentanyl group, and there was no difference in time to discharge between the two groups.[11] It is worth noting that while postoperative pain is not the sole cause of ED, the degree of pain produced by a surgical procedure can change the characteristics of the observed ED and may affect the efficacy of non-analgesic adjuvants such as propofol used to treat or prevent ED.[5]

Along with an historical increase in the incidence of ED correlating with the introduction of modern short-acting inhalation anaesthetics, studies with patients undergoing MRI support the theory that there are intrinsic properties of inhalation anaesthetic that are primarily responsible for ED. Since all inhalation anaesthetics, even halothane, increase the risk of ED, while shorter-acting agents increase the incidence further, there may be an underlying mechanism of action of inhalation anaesthetics triggering ED which has yet to be fully elucidated. Volatile anaesthetics may affect brain activity by interfering with the balance between neuronal synaptic inhibition and excitation in the central nervous system.[1]

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

Table 2 PAED scale (from Bajwa and colleagues,[4] 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

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

Table 4 Possible risk factors for ED[1]

Factor
Rapid emergence from anaesthesia
Use of short-acting volatile anaesthetic agents
Postoperative pain
Surgery type
Age
Preoperative anxiety
Child temperament

Preventative strategies and treatment options

Prophylactic measures include the co-administration of propofol, midazolam, or fentanyl, but the risks associated with their use must be weighed against the self-limiting nature of ED[1] (Table 5). The efficacy of propofol is dependent on the timing of administration. Due to the rapid pharmacokinetics of propofol, a bolus of 1 $mg\ kg^{-1}$ given at the end of the procedure or continuous infusion used during maintenance of anaesthesia results in increased concentrations during emergence resulting in a decreased incidence of ED.[6]

Perioperative analgesia has been shown to be effective in preventing ED. Several analgesics have been studied for the prevention of ED including: fentanyl (dose 1 $\mu g\ kg^{-1}$ i.v. given 10 min before the end of a procedure), ketamine (0.25 $mg\ kg^{-1}$ i.v. given at the end of procedure, or as a premedication 6 $mg\ kg^{-1}$ orally), and α_2-adrenoreceptor agonists such as clonidine (caudally 1–3 $\mu g\ kg^{-1}$; i.v. 2–3 $\mu g\ kg^{-1}$) and dexmedetomidine (0.15–0.3 $\mu g\ kg^{-1}$).[1] These preventative strategies increase sedation and therefore should be

Table 5 Preventative measures[10]

Medication
Propofol
Ketamine
α_2-Adreno-receptor agonist
Fentanyl
Perioperative analgesia

Table 6 Treatment options[6]

Medication
Fentanyl
Propofol
Midazolam
Reuniting with parent

balanced against the risk of prolonging emergence or delaying discharge from the post-anaesthesia care unit.

However, prevention is important as the experience of ED may increase the incidence of new-onset postoperative maladaptive behaviour changes such as general anxiety, night-time crying, enuresis, separation anxiety, and temper tantrums for up to 14 days after surgery.[9]

While sevoflurane is a very effective induction agent, the use of isoflurane or propofol for the maintenance of anaesthesia may reduce the risk of ED. Studies have shown positive effects for propofol, pain prevention, ketamine, and α_2-adrenoreceptor agonists with no evidence of effectiveness for midazolam or 5-HT_3 antagonists.[6]

Once ED is established, the most common interventions are pharmacological (Table 6), whereas it may be the case that simply being reunited with a parent provides the quickest recovery.[1]

Conclusions

ED is a recognized complication most often associated with sevoflurane or desflurane anaesthesia in young children. It is distressing for children, parents, and staff but is self-limiting. Pain is a significant confounding factor. Propofol and other adjuvants may reduce the risk but may prolong recovery. Further research is required to define the best way to minimize this distressing adverse effect of anaesthesia.

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Please see multiple choice questions 1–4.