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REVIEW

Emergence Agitation and Delirium: Considerations for Epidemiology and Routine Monitoring in Pediatric Patients

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Abstract: Emergence from anesthesia can be associated with a wide spectrum of cognitive and behavioral dysregulation in children, including delirium or acute brain dysfunction. This period of neurobehavioral recovery can be further confounded by pain, anxiety, and fear. The implementation of monitoring for level of consciousness, pain, and delirium using valid pediatric tools is necessary to avoid misdiagnosis due to overlapping symptomatology and support appropriate management. Understanding the epidemiology of delirium in the post-operative setting will require consistent use of accurate terminology in the medical literature. The current interchangeable use of the terms "emergence agitation" and "emergence delirium" needs to be highlighted and awareness of differences in patient conditions and assessment tools is essential. We discuss epidemiology of emergence agitation and delirium in the pediatric population, and the challenges for future delineation of monitoring and management. Furthermore, we describe the possible impact of long-term consequences of emergence delirium among infants and children, and the necessary areas of future research.

Keywords: emergence, delirium, agitation, excitation, pediatrics, postoperative, sedation, perioperative

Clinical Case

A 3-year-old anxious male with obstructive sleep apnea presents for tonsillectomy and adenoidectomy. His intraoperative anesthetic care includes an inhalational induction with nitrous oxide/oxygen/sevoflurane, followed by intravenous (IV) catheter placement, intubation, and maintenance of general anesthesia with sevoflurane and analgesia with opioid administration. Upon emergence in the PACU, he is thrashing about in the bed, crying, and not following commands.

Introduction

Emergence from general anesthesia can be complicated by alterations in level of consciousness and mental status, often encompassing disruptive behaviors observed during the immediate post-anesthesia period particularly in pediatric patients. In the 1960s, Eckenhoff et al first described their observations of "neurologic excitement" during emergence from general anesthesia, with patients being in a dissociated state of consciousness.[1] This period of behavioral dysregulation has been interchangeably referred to as emergence excitation, emergence agitation (EA), and emergence delirium (ED). However, these terms are not synonymous with one another. Agitation is an

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"unpleasant state of extreme arousal",[2,3] and can be a commonly observed symptom in patients suffering from pain, anxiety, fear, and more complex neurobehavioral syndromes such as delirium. Pediatric patients commonly exhibit oppositional behaviors in the setting of unfamiliar stressors; therefore, postoperative agitation alone will not always suggest delirium.[4] Delirium, or acute brain dysfunction, is defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM) as a disturbance of consciousness and cognition characterized by an acute change or fluctuating course of mental status or awareness, a cardinal feature of inattention, and the inability to receive, process, store, or recall information.[2,5] Delirium or acute brain dysfunction occurs in the setting of systemic disease or derangement such as hypoxia, hypotension, electrolyte abnormality, or as a consequence of sedation choice/duration (BRAIN MAPS[6]). (Figure 1) Whereas in the anesthesia literature, emergence delirium (ED) is described as a state of mental confusion, agitation, and disinhibition marked by some degree of hyperexcitability during recovery from general anesthesia.[7] In order to promote greater understanding of the neuropsychiatric recovery of infants and children during the complex process of emergence, applying well defined, standard terms should be paramount.[4] The goal becomes using tools that distinguish between conditions that may have similar symptoms or behaviors (agitation, pain, delirium) so that the epidemiology of the post-anesthesia period can be better understood and, more importantly, patients can receive the appropriate care.

Delirium Subtypes

In the setting of delirium, the imbalance in excitatory and inhibitory neurotransmission can lead to non-specific manifestations consisting of a wide-range of behaviors observed across afflicted patients.[6] The continuum of manifestations can complicate diagnosis when a valid delirium screening tool is not used. These same manifestations are used to categorize delirium into subtypes including hyperactive, hypoactive, and mixed.[8]

Patients with hyperactive delirium are often more readily identified because they exhibit characteristic heightened psychomotor behaviors or "positive symptomatology," ranging from mild agitation to combativeness, or even psychosis. Although hyperactive delirium may be more easily recognized, it is the least common form of both adult and pediatric ICU-delirium (<10%).[8–10] The traditional terms of Emergence Agitation and Emergence Delirium may be consistent with hyperactive delirium in some patients following anesthesia, however, the current assessment tools used in the PACU do not all specifically rely on DSM criteria for delirium diagnosis. Indeed, the presence of agitation alone is not imperative for the diagnosis of delirium, rather agitation is a symptom. Though agitated patients require immediate hands-on management within the PACU, the discernment

B - Bring oxygen (i.e. hypoxemia, decreased cardiac output, anemia)

R - Remove or Reduce drugs that are deliriogenic (i.e. anticholinergics, benzodiazepines)

A - Patient Atmosphere (i.e. lights, noise, family presence, non-mobility)

I - Immobilization, Inflammation, Infection

N - New organ dysfunction or failure

M - Metabolic disturbances (i.e. ↑↓Na+, ↑↓K+, ↓ glucose, ↓ Ca++, alkalosis, acidosis)

A - Awake (i.e. sleep-wake cycle disturbance prior to procedure, anxiety)

P - Pain (i.e. not enough analgesia OR pain treated and now excessive drug dosing)

S - Sedation (i.e. residual anesthesia, ongoing sedation for perceived agitation or anxiety)

Figure 1 Consideration of causes for delirium "BRAIN MAPS".[6] Delirium develops due to various disease states or imbalances that lead to acute brain dysfunction. Much emphasis has been placed on excessive sedation/anesthesia as a first-line cause of delirium. However, it should be highlighted that common postoperative complications such as hypoxia, hypoventilation, pain, and foreign patient atmosphere/caregivers may be prevalent and delirium being a sensitive and early sign of possible postoperative problems. BRAIN MAPS can be used to quickly review possible delirium causes. Reproduced from Smith HAB, Brink E, Fuchs C, Ely EW, Pandharipande PP. Pediatric delirium: monitoring and management in the pediatric intensive care unit. *Pediatr Clin North Am.* 2013;60(3):741–760. doi:10.1016/j.pcl.2013.02.010, with permission from Elsevier.[6]

of etiology remains an important challenge for anesthesia and critical care clinicians.

Patients who suffer from hypoactive delirium exhibit "negative symptomatology" ranging from apathy, to withdrawal, or lethargy, and often go unnoticed by the medical team. Indeed, patients with "quiet delirium" rarely require 1:1 care and are often referred to as "good" patients.[6] Parents, however, may alert the medical team that their child is "just not themselves." This rarely results in a change in medical care or further assessment, and felt to be part of the normal recovery from anesthesia. This subtype of delirium is the most common among both adult and pediatric ICU-delirium (>50%).[8–10] As we do not routinely assess for hypoactive delirium in the PACU, the impact of hypoactive delirium on outcomes following general anesthesia is not known. Similarly, patients with delirium who are hospitalized and monitored over time may oscillate between positive and negative symptoms, and classified as mixed delirium. Understanding these concepts will help guide the ongoing conversation regarding accurate diagnosis of delirium and recognition of agitation in the post-anesthesia state.

Emergence Behaviors

Many pediatric patients emerging from general anesthesia will suffer a period of dysregulated behavior. Malarbi et al completed an observational study in children aged 18 months - 6 years assumed to have Emergence Delirium by clinical observation alone, demonstrating symptoms such as eye staring or averting, involuntary movements, kicking, and inconsolability.[11] Children may also exhibit psychomotor agitation and neuropsychiatric derangement during emergence including: moaning, thrashing, back arching, inconsolable crying, yelling, kicking, and pulling at lines or bandages, or emotional lability, and altered levels of consciousness.[12] Patients with extremes of behavioral dysregulation may be unable to be comforted even with familiar objects such as a favorite toy or parental presence. While many of these behaviors may occur in patients with delirium, the lack of consistent use of an objective tool for screening limits the advancement of knowledge regarding the emergence period in children.[13]

Emergence Delirium/Agitation – Prevalence and Risk Factors

The incidence of ED/EA is highly variable in the literature, ranging from 10–80%.[14–16] Patient characteristics, anesthetic technique, surgical case type, and a host of different metrics used to assess for ED/EA all contribute to this variance in reported incidence. Emergence delirium/agitation typically presents in the early phase of emergence, on average 14 minutes (± 11 minutes) following cessation of general anesthesia, however ED/EA has been reported as late as 45 minutes following conclusion of general anesthesia.[17] The course of ED/EA is often a self-limited phenomenon and therefore the benefit of medical intervention remains controversial. However, associated consequences such as untimely loss of intravenous catheters or drainage tubes, patient or staff injury, parental and staff dissatisfaction, and increased utilization of PACU resources remain concerning.[18,19] Long-term outcomes such as postoperative cognitive dysfunction or maladaptive behaviors in children following general anesthesia remain poorly delineated and any associations with ED have not been studied.

Risk factors for EA/ED are presented in three major categories: patient-related, anesthesia-related, and surgical factors. Patient related risk factors associated with an increased incidence of EA/ED include male gender, preschool age, higher preoperative anxiety level, and baseline sleep-disordered breathing.[20] Younger patients that tend to be more emotional or impulsive, less social or adaptable at baseline appear to be at particularly high risk for the development of EA/ED.[17,21,22] The intensity of preoperative anxiety is influenced by a host of factors including parental anxiety, young age, previous medical experiences, and immature social skills. Patients with preoperative anxiety are six times more likely to develop EA/ED compared to those who are less anxious ($p < 0.005$).[23,24] Mohkamkar et al[1] demonstrated that if individuals experienced agitation during induction of anesthesia that they were much more likely to have agitation upon emergence. Moreover, agitation upon emergence was significantly associated with ED in the post-anesthesia unit (OR 4, 95% CI 1.7–9.4).[25]

Precipitating factors such as anesthesia exposure and surgical intervention also impact the likelihood of EA/ED. Intravenous anesthesia is not commonly associated with EA/ED, touted as having a protective effect, versus the nearly four times more common occurrence following volatile agents.[14,26] A step-wise titration protocol for discontinuation of sevoflurane was not associated with a decrease in the development of EA/ED.[27] Rapid versus slow emergence may lead to greater risk of emergence delirium, but this relationship has yet to be clearly demonstrated.[28] Emergence time was found to impact

EA in a recent study of 121 pediatric patients undergoing dental rehabilitation where high-dose midazolam premedication was associated with a longer emergence time and lower rate of agitation upon emergence.[25] In the transition from the general anesthesia to recovery, patients with symptoms of EA/ED more often are reported to have high pain scores, which emphasizes the challenges we currently have in differentiating between pain and EA/ED.[21]

Finally, surgical risk factors for EA/ED appear to be linked with the type of procedure such as ear, nose, throat (ENT) or ophthalmologic interventions, and the length of procedure, with shorter interventions associated with an increased incidence of EA/ED.[1] This may be related to the abrupt cessation of volatile anesthesia and emergence from anesthesia versus the actual length of surgical intervention. Interestingly, Eckenhoff et al[29] surmised that a feeling of suffocation during emergence from anesthesia following head and neck surgery was responsible for the high frequency of observed emergence agitation. The approach to anesthesia should consider type and length of surgical procedures, necessary emergence style (i.e. awake, deep), and immediate postoperative issues (i.e. pain) in order to minimize the impact of all of these factors to the development of emergence agitation or delirium.

Emergence Delirium/Agitation – Pathophysiology

There is limited understanding of the pathophysiology of EA/ED. Working hypotheses have included uncontrolled pain, pre-operative anxiety, and differential clearance of various anesthetic agents.[30] Although severe, unrelenting pain may very well be a precipitating factor for the development of delirium, it is not a suggested predictive measure as delirium can clearly occur in the absence of pain.[31] In fact, even patients undergoing "painless" procedures such as general anesthesia for MRI have been reported to experience EA/ED.[32] The theory of differential clearance describes how various volatile anesthetic agents are cleared in distinctive ways from the central nervous system leading to varying recovery rates of cognitive functions.[17,33] Hence emergence delirium may be an imbalance in the rate of recovery for a patient's arousal state versus their content of consciousness.[34] This may lead to an "awake" patient but one who is unable to perceive information from the environment and respond or interact appropriately.

Patient Assessment

Emergence Agitation Scales

Emergence agitation is most commonly referred to as a state of mild-moderate restlessness and distress that, unlike delirium, is not always associated with a significant change in behavior or cognition.[35] The intensity of agitation can be readily observed and scored by using tools such as the CRAVERO and WATCHA scales.[36–38] The Cravero and Watcha scales rank levels of consciousness or arousal, being versions of typical sedation scales such as the Richmond Agitation-Sedation Scale (RASS)[39] used in both the postoperative and ICU environments.(Table 1) Using the RASS, caregivers observe the patient for spontaneous awakening and eye opening (RASS 0) and varied levels of agitation (RASS +1 to +4). If no spontaneous eye opening, then the caregiver stimulates the patient with voice, observing levels of depressed arousal (RASS −1 to −3). If no response to voice, then physical stimulus is provided with either response to touch (RASS −4) or no response (RASS −5), which is considered comatose. The Watcha scale is a four level arousal scale ranging from a "calm" patient (Score of 1) to "agitation with thrashing around" (Score of 4).[13,40] A severely elevated level of arousal on the Watcha scale (Score of 3 or 4) may be consistent with EA. The Cravero scale categorizes five levels of arousal ranging from "obtunded with no response to stimulation" (Score of 1) to "thrashing behavior that requires restraint" (Score of 5).[41] After attempts of active calming, patients who have severe levels of agitation on the Cravero scale (Score of 4 or 5) are referred to as EA.[12,41] Some researchers suggest that emergence agitation is analogous to emergence delirium in patients with severe levels of agitation, as agitation is reported more commonly than depressed levels of arousal in patients thought to have emergence delirium.[12,17] This argument highlights the lack of understanding of delirium versus agitation. Agitation is not a DSM-criterion for delirium, and symptoms of agitation are more commonly reported in the anesthesia literature in part due to the lack of monitoring for all delirium subtypes in the post-anesthesia care unit. Both the Watcha and Cravero scales are level of consciousness scales, assessing for levels of agitation, and may identify some patients with coinciding hyperactive delirium. However, symptoms used to describe levels of agitation measured by the Cravero and Watcha scales are also symptoms consistent with untreated pain and in valid and reliable pain assessment scales, such as the Faces, Legs, Activity, Cry and Consolability (FLACC) scale, the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS), and the Children's and

Table 1 Comparison of a Common Level of Consciousness or Sedation Scale with Pediatric Scales for Emergence Agitation (EA)

Patient Response or Symptom	Level of Consciousness Scales		
	RASS[a]	WATCHA[b]	CRAVERO[c]
Combative: violent, immediate danger to staff	+4	4	5
Aggressive: pulls to remove tubes or catheters	+3	3	
Agitated: non-purposeful movement, may cry and inconsolable	+2		4
Anxious: apprehensive, consolable cry	+1	2	3
Spontaneously awake and attentive	0	1	
Not fully alert: sustained awakening and eye contact to voice	−1		
Briefly awakens with limited eye opening/contact to voice	−2		2
Movement or eye opening to voice but no eye contact	−3		
No response to voice. Some response to physical stimulation	−4		
Comatose: No response to voice or physical stimulation	−5		1

Notes: [a]Richmond Agitation-Sedation Scale (RASS) used for routine monitoring of level of consciousness or level of sedation. [b]The WATCHA behavior scale used to determine emergence agitation (EA) based on observation (Level 3 or 4). [c]The CRAVERO scale assesses for behaviors consistent with EA including Level 4 or 5.

Infants' Postoperative Pain Scale (CHIP-PS).[42–44] Therefore, other considerations during the assessment of agitation, in particular, is the high likelihood that it is associated with pain, anxiety, hunger, or parental separation and should not be assumed to be a consequence of delirium or even emergence from general anesthesia.[13]

Emergence Delirium Tools

The ability to accurately differentiate hyperactive delirium from other sources of agitation requires the assessment of more complex neurobehavioral symptoms.[4] Alarmingly in critically ill patients, delirium goes undetected in up to three out of four patients when clinicians do not use a structured delirium screening tool.[45,46] The Pediatric Anesthesia Emergence Delirium (PAED) scale (Table 2) assesses for DSM criteria for delirium including inattention (eye contact with the caregiver), disorganized thinking or dysregulated systems (unawareness of surroundings), changes in cognition (decrease in purposeful actions), and a disturbance in psychomotor behavior or acute alteration of consciousness (restlessness or inconsolability).[27] Each of these five subdomains is scored using a Likert scale (not at all, just a little, quite a bit, very much, extremely), which may be cumbersome in a busy clinical setting, though worthwhile for delirium screening.[12] A score of 9 or higher is consistent with hyperactive delirium, also known as emergence delirium. Though the PAED incorporates DSM criteria, it does not require the cardinal feature of inattention for delirium diagnosis.[15] This deviates from the requirements of more robust and interactive delirium tools used in the ICU-setting that require inattention and altered/fluctuating mental status for delirium presence.[9,47,48] Furthermore, it does not sufficiently screen for all delirium subtypes, including hypoactive delirium, the most common subtype reported in both adults and children in the ICU.

Table 2 The Pediatric Anesthesia Emergence Delirium (PAED)[15] Scale[a]

Delirium Symptom	Not at All	Just a Little	Quite a Bit	Very Much	Extremely
Child makes eye contact with the caregiver	4	3	2	1	0
Child's actions are purposeful	4	3	2	1	0
Child is aware of his/her surroundings	4	3	2	1	0
Child is restless	0	1	2	3	4
Child is inconsolable	0	1	2	3	4

Notes: [a]Patients are observed for each of the 5 symptoms of delirium. Once an observation is complete, the clinician scores the severity of that delirium symptom subjectively using the Lickert scale ("not at all," "just a little," "quite a bit," "very much," and "extremely"). A total score of 10 or greater may be consistent with Emergence Delirium.

ICU Delirium Assessment

Advances in delirium epidemiology has been fueled by the creation and implementation of highly valid and reliable delirium bedside tools in the pediatric ICU setting in all patients from infancy to adolescence and either on or off mechanical ventilation.[9,47–50] Further study of emergence in the post-anesthesia period, especially in the pediatric population, may benefit from tools that are efficient, easy to use, and help delineate behavioral symptoms from hyperactive and hypoactive delirium. The Preschool Confusion Assessment Method for the ICU (psCAM-ICU) (specificity of 91% and sensitivity of 75%) and the Pediatric CAM-ICU (pCAM-ICU) (specificity of 99% and a sensitivity of 83%) are highly valid and reliable bedside tools for delirium screening (Table 3).[9,48,51] The pediatric CAM-ICU series follow a standardized approach to delirium assessment using DSM criteria, and Plum and Posner's' definition of consciousness to assess for the key features of both arousal and content of consciousness. Patients are first assessed using a sedation scale (RASS) for their level of consciousness, as patients need to be at least reactive to voice (RASS −3 or above) in order to be clinically assessed for delirium (i.e. not comatose). The ps/pCAM-ICU then both assess for key DSM features of delirium: 1) fluctuation or an acute change in mental status, 2) inattention, 3) an acute alteration level of consciousness, and 4) disorganized systems/thinking. Delirium is present when a patient demonstrates Features 1 and 2, plus either Feature 3 or 4. This hierarchal approach allows for quick and efficient assessment (i.e. if Feature 1 or 2 are not present, then delirium is not present). The psCAM-ICU was adapted from the pCAM-ICU to assure that assessments for inattention and disorganized systems/thinking were developmentally appropriate for critically ill patients less than 5 years of age given the significant variation of language and cognitive maturity in the younger pediatric population.

Management of Emergence Agitation and Delirium

Appropriate patient management depends on adequate postoperative assessment, including monitoring of level of consciousness, pain, and delirium using valid bedside tools.

Preoperative Strategies

Non-pharmacologic strategies used in the preoperative setting to reduce both patient and parental preoperative anxiety have shown effectiveness in reducing the incidence of EA/ED.[52,53] The impact of preoperative interventions on the development of EA/ED remains unresolved, however a recent RCT comparing oral benzodiazepine versus tablet-based interactive distraction (TBID) demonstrated improved baseline anxiety, tolerance of mask induction, earlier discharge, and lower rates of ED at 15 minutes post-emergence in the TBID group.[54] Preoperative administration of intranasal dexmedetomidine (1–2 mcg/kg) at least 20 minutes prior to induction was associated with less preoperative anxiety and postoperative agitation, via PAED assessment, without prolonging postoperative recovery compared with placebo during a propofol TIVA.[55] Preoperative oral dexmedetomidine, compared to oral benzodiazepine, was associated with significantly lower PAED scores ($p<0.05$) and ED rates [0% in Dex group, 19% in Midaz group ($p=0.01$)].[56] Other agents with efficacy in the prevention of emergence delirium include preoperative administration of gabapentin,[57] intraoperative magnesium infusion,[58] intraoperative dexamethasone,[59] and midazolam.[60,61] Oral gabapentin (5 mg/kg) was shown to significantly reduce the incidence of EA by 20% in a cohort of 70 children aged 2–6 years of age undergoing strabismus surgery receiving desflurane maintenance.[62]

Intraoperative Strategies

The class of alpha-2 agonists, including clonidine[14,60,63] and dexmedetomidine, have shown success in the prevention of emergence delirium when administered either systemically or via a regional technique. Use of dexmedetomidine in the prevention of emergence delirium has gained particular interest given that the medication also serves as an adjunct in the treatment of analgesia and prevention of postoperative nausea and vomiting.[64,65] In multiple smaller cohort randomized controlled trials, administration of dexmedetomidine as an intravenous bolus (0.13–0.5 mcg/kg over 5–10 minutes) before the end of the procedure and/or low-dose continuous intraoperative infusion (0.4 mcg/kg/h) during sevoflurane general anesthesia is associated with significant reductions in rates of ED.[66–70] Concerns have been raised that dexmedetomidine may be associated with increased postoperative care unit length of stay,[71] however this has not been consistent across prospective pediatric studies.[66] Despite this potential disadvantage, intraoperative dexmedetomidine administration has been associated with fewer adverse events in the PACU and less need for rescue opioid for pain.[66,71]

Total intravenous anesthesia (TIVA) with Propofol has been shown to be effective for both the prevention and treatment of EA/ED symptoms.[72] An induction dose alone or a bolus following mask induction with volatile agents are not associated with a decrease in ED.[14] Propofol administration just prior to emergence demonstrated mixed results at lower doses (1 mg/kg IV),[14,73] compared to significant reductions in ED prevalence with higher doses (3mg/kg IV).[73,74]

The additive benefit of multiple intravenous agents on prevalence or duration of EA/ED has not been demonstrated. Cao et al reported that in a RCT of propofol anesthesia during tonsillectomy with added use of dexmedetomidine (1 mcg/kg

Table 3 The Preschool (psCAM-ICU)[9] and Pediatric (pCAM-ICU)[48] Confusion Assessments for the ICU[a]

	Preschool CAM-ICU (psCAM-ICU)[a] Less Than 5 Years of Age	Pediatric CAM-ICU (pCAM-ICU)[a] ≥ 5 Years of Age	Feature Present?[c]
Feature 1: Mental Status[b]	Acute change in mental status? **OR** Fluctuation in mental status?	Acute change in mental status? **OR** Fluctuation in mental status?	**NO** → STOP - Delirium Absent **YES** → Assess Feature 2
Feature 2: Inattention[b]	Show 10 pictures/mirror and count number patient has eye contact. Inattention present ≥ 3 no eye contact	Vigilance A: ABADBADAAY "Squeeze my hand every time you hear the letter 'A'." Inattention present ≥ 3 errors	**NO** → STOP - Delirium Absent **YES** → Assess Feature 3
Feature 3: Altered level of consciousness	Does the patient currently have an altered level of consciousness?	Does the patient currently have an altered level of consciousness?	**YES** → STOP - **Delirium Present** **NO** → Assess Feature 4
Feature 4: Disorganized Brain	1) Sleep-wake cycle disturbance? **OR** 2) Patient unaware of surroundings and inconsolable?	Ask 4 yes/no questions and give 1 two-step command Feature 4 present ≥ 2 errors	**YES** → STOP - **Delirium Present** **NO** → STOP - Delirium Absent

Notes: [a]The Preschool Confusion Assessment Method for the ICU (psCAM-ICU) and the Pediatric CAM-ICU (pCAM-ICU) are highly valid and reliable pediatric delirium screening tools used in preschool (neonate – 5 years) and school-aged (≥ 5 years) critically ill patients who are at least responsive to voice. [b]The cardinal features (acute change or fluctuating mental status and inattention) are required for delirium diagnosis using the hierarchal structure of these tools. [c]Following the ps/pCAM-ICU algorithm, once three features have been identified as "YES" or "PRESENT" then delirium is present and the assessment is complete.

bolus and 0.5 mcg/kg/h continuous infusion) had no affect on ED rates using the PAED compared to Propofol TIVA alone.[71] Whereas, Tsiotou et al duplicated this anesthetic protocol in a similar sixty-patient cohort undergoing tonsillectomy and demonstrated a significant reduction in "ED" assessed using the WATCHA with both propofol and dexmedetomidine.[75] This demonstrates the need to consistently use language describing outcomes and understand the difference between EA and ED and the assessment tools that are specific for both. Likely both studies may be correct in that use of dexmedetomidine in the setting of a propofol TIVA further decreases EA (WATCHA) upon emergence but does not further decrease the rates of ED (PAED) in the post-anesthesia care unit.

Acute Treatment

The evidence to support acute treatment of EA/ED remains ambiguous. Cleary patients with severe agitation may be at risk for self-harm or hurting others, and therefore the decision to treat becomes more straightforward for clinicians. The caregiver must quickly weigh the patient history, procedure, and recent course in the postoperative recovery unit to determine the most appropriate treatment. Contributing factors may include acute pain, absence of family, or restrictive elements such as peripheral IV, cast, dressing, or sensory changes following surgery (i.e. ophthalmologic). If a contributing factor can be quickly identified, then the clinician may be able to address that specific issue to improve agitation or delirium. However, the situation may require immediate response, and in these situations, reasonable methods for decreasing the severity and duration of the hyperactive symptoms include bolus administration of propofol (0.5–1 mg/kg IV),[14,76,77] fentanyl (1–2.5 mcg/kg IV),[41,78] dexmedetomidine (0.5 mcg/kg IV),[14,79,80] or haloperidol (0.025–0.05 mg/kg IV).[81] Of note, antipsychotics do not have an FDA indication for use in children with delirium, and attention to possible side effects such as prolonged QTc are necessary if use is deemed appropriate. With any acute intervention, the care team will have to monitor adequacy of ventilation and oxygenation and should be able to rescue acutely if needed. Remember that these interventions treat manifestations of hyperactive delirium, though do not "treat" the delirium. Delirium will resolve with correction of the causative insults such as residual volatile anesthesia effects, hypoxia, acidemia, or hypotension (BRAIN MAPS).

Long-Term Consequences

Emergence delirium has been associated with an increased risk of transient postoperative maladaptive behaviors.[82] Maladaptive behaviors exhibited by children can range from increased general anxiety to sleep disturbances, nighttime crying, separation anxiety, temper tantrums, and enuresis. However, the relationship between the presence of emergence delirium and postoperative maladaptive behaviors is complex and influenced by confounding factors such as preoperative anxiety level in both the patient and the parent.[21,23,83] Further research is needed to answer the very important questions of whether the occurrence and management of EA/ED is truly important for the well being of our patients following discharge to home.

Summary

Hyperactive behaviors during emergence have been described by different terms such as emergence excitation, agitation, and delirium. Literature provides evidence of a period of behavioral dysregulation, usually hyperactive in nature, and in its severest forms can place the patient and caregiver at risk for harm. However, it is important to recognize that there is a significant void in the understanding of the full spectrum of post-anesthesia delirium and agitation. The ability to accurately describe behavioral dysregulation during emergence hinges on our ability to have access to tools for the assessment of levels of consciousness and agitation, pain, and delirium. Future studies are needed to further define the full spectrum of cognitive and behavioral dysregulation as well as to better understand the potential mitigation strategies and long-term consequences associated with emergence agitation and delirium.

Case-Based Learning Discussion

1. You are called to the bedside of a thrashing, inconsolable 5-year-old male s/p incision and drainage of a neck abscess. Two PACU nurses are attempting to hold the patient and prevent him from pulling out his IV and his drain at his surgical site. What is your differential diagnosis? What are your initial concerns for this patient? How would you further assess the patient? What is your final management strategy?
2. A colleague comes to you and asks how you determine whether a patient has emergence agitation or delirium. How would you define EA/ED? What would you tell your colleague in regard to appropriate patient assessment for hyperactive behaviors? What challenges exist in measuring the incidence of emergence delirium?
3. Describe the risk factors for the development of EA/ED. What risk factors are modifiable to decrease the development of EA/ED?
4. In your discussion of risks and benefits of anesthesia with the patient's family you mention emergence delirium. The patient's mother wants to know how emergence delirium will affect her child. What would you tell her about the potential consequences associated with emergence delirium both acute and long term?
5. You are asked to give a lecture to staff in the post-anesthesia recovery unit (PACU) at your institution regarding the differences between emergence agitation and delirium. What are the key features you would focus on in your education? How would you promote differentiating these terms?

Disclosure

The authors report no conflicts of interest in this work.

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