Identifying Pediatric Emergence Delirium by Using the PAED Scale: A Quality Improvement Project

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ABSTRACT

Pediatric emergence delirium is a postoperative phenomenon characterized by aberrant cognitive and psychomotor behavior, which can place the patient and health care personnel at risk for injury. A common tool for identifying emergence delirium is the Level of Consciousness-Richmond Agitation and Sedation Scale (LOC-RASS), although it has not been validated for use in the pediatric population. The Pediatric Anesthesia Emergence Delirium Scale (PAED) is a newly validated tool to measure emergence delirium in children. We chose to implement and evaluate the effectiveness and fidelity of using the PAED Scale to identify pediatric emergence delirium in one eight-bed postanesthesia care unit in comparison with the traditional LOC-RASS. The overall incidence of pediatric emergence delirium found by using the LOC-RASS with a retrospective chart review (3%) was significantly lower than the incidence found by using the LOC-RASS (7.5%) and PAED Scale (11.5%) during the implementation period. Our findings suggest that the PAED Scale may be a more sensitive measure of pediatric emergence delirium, and, in the future, we recommend that health care personnel at our facility use the PAED Scale rather than the LOC-RASS. AORN J 99 (April 2014) 480-494. © AORN, Inc, 2014. http://dx.doi.org/10.1016/j.aorn.2013.08.019

Key words: pediatric emergence delirium, Pediatric Anesthesia Emergence Delirium Scale, PAED Scale, Level of Consciousness Richmond Agitation and Sedation Scale, LOC-RASS, quality improvement.

The term emergence delirium is defined as “a mental disturbance during the recovery from general anesthesia consisting of hallucinations, delusions, and confusion manifested by moaning, restlessness, involuntary physical activity, and thrashing about in the bed.” 1(p19) Although emergence delirium occurs in patients of all ages, it appears to occur three to eight times more frequently in the pediatric population. 2-9 Children who experience emergence delirium postoperatively are at risk for unintentional self-injury, including removal of catheters and drains as well as wound dehiscence. 10 Additionally, management of pediatric emergence delirium requires extra attention from nursing personnel, placing undue strain on nurse-to-patient ratios and resource allocation in the
postanesthesia care unit (PACU). A recent study showed that 49% of children who developed emergence delirium required extra PACU personnel to care for them compared with only 15% of children not experiencing emergence delirium. Pediatric emergence delirium also can place the RN at risk for injury if he or she tries to restrain the child to keep the child from hurting himself or herself.

One of the keys to managing pediatric emergence delirium is prompt recognition of the condition by anesthesia and PACU personnel. However, to date, there is not a recognized standard assessment to identify pediatric emergence delirium. Consequently, a variety of rating and visual analog scales are used, many of which have not been validated in the pediatric surgical population. This practice variation, combined with differing anesthetic techniques, likely contributes to the wide range in the incidence of pediatric emergence delirium (ie, 2% to 80%) that is reported in the literature.

DESCRIPTION OF THE PROBLEM
At our facility, health care providers use the Level of Consciousness-Richmond Agitation and Sedation Scale (LOC-RASS) to identify pediatric emergence delirium in the PACU. Although the LOC-RASS is a valid and reliable measure of sedation and agitation in critically ill adults, it has not been validated in the pediatric population. The Pediatric Anesthesia Emergence Delirium (PAED) Scale is a newly validated measure of emergence delirium for children.

REVIEW OF THE LITERATURE
Much of the pediatric emergence delirium research is focused on determining the etiology of emergence delirium and on using pharmacological interventions to reduce its incidence. The cause of pediatric emergence delirium is likely multifactorial; however, the following characteristics, either individually or in combination, have been identified in children who develop emergence delirium more frequently. The incidence is highest among children who

- are younger than six years of age,
- have preoperative anxiety, and
- emerge rapidly from general anesthesia.

Additionally, the use of sevoflurane and surgical procedures involving the head and neck are associated with an increased risk of developing pediatric emergence delirium. Several commonly used IV medications (eg, propofol, fentanyl, ketamine, dexmedetomidine) that are administered at various times during the perioperative period are associated with a decreased incidence of pediatric emergence delirium.

Although these findings offer information about preemptive medication management for children at risk for developing emergence delirium, the true effect of these strategies remains unknown because patients often are not assessed with a validated pediatric tool. Furthermore, without appropriate tool use, it is difficult to differentiate between emergence delirium and the signs and symptoms of pain because both emergence delirium and pain may be characterized by restless behavior. One of the greatest attributes of the PAED Scale, however, is that it was developed by using a theoretical framework of delirium, focusing on changes in consciousness and cognition, which permits differentiation of emergence delirium behaviors from those behaviors associated with pain.

The PAED Scale consists of five characteristics that are each scored by using a 5-point Likert scale. The scores are summed into a final composite score to determine the presence or absence of pediatric emergence delirium. Two items, “the child makes eye contact with the caregiver” and “the child is aware of his [or] her surroundings,” respectively, are reflections of the child’s state of consciousness and ability to focus attention and to thoughtfully organize external stimuli. One item, “the child’s actions are purposeful,” addresses changes in cognition that cause the child to behave in a manner
outside of what is deemed appropriate. Two additional items, “the child is restless” and “the child is inconsolable,” are measures of psychomotor and emotional behavior, respectively, that are associated with delirium. Although the last two items also may indicate that the patient is experiencing pain, assessing these measures in conjunction with other indicators of consciousness and cognition helps the health care provider differentiate between emergence delirium and pain.\textsuperscript{12}

The developers of the PAED provided strong evidence of measurement reliability and validity, with an internal consistency of 0.89, with delirium characteristics of the \textit{Diagnostic and Statistical Manual of Mental Disorders},\textsuperscript{19} interobserver reliability of 0.84 (95\% confidence interval [CI], 0.76-0.90), and sensitivity and specificity of 0.64 and 0.86, respectively, when the composite PAED scores were higher than or equal to 10.\textsuperscript{12}

In contrast, the LOC-RASS originally was developed as “a clinically useful tool to assess the level of consciousness and agitated behavior in (adult) [intensive care unit (ICU)] patients [to] guide sedation therapy and improve communication among health care providers.”\textsuperscript{14} The LOC-RASS can be an effective component of an algorithm to identify pediatric emergence delirium, but it should be used in conjunction with the PAED Scale.\textsuperscript{15} To our knowledge, no published literature compares LOC-RASS scores with the construct of pediatric emergence delirium, nor has a threshold score for the presence of pediatric emergence delirium been identified for the LOC-RASS. Although the PAED Scale originally was developed to assess for emergence delirium among patients between the ages of 18 months and six years of age because of a higher propensity for emergence delirium development within this population, the assessment criteria appear to be applicable to pediatric patients outside of this age group.\textsuperscript{12}

\textbf{PROJECT GOALS AND METHODS}

The primary goal of this project was to evaluate the identification of pediatric emergence delirium by implementing and evaluating the use of the PAED Scale in the children’s PACU at our facility. We compared the incidence of pediatric emergence delirium as determined by using the LOC-RASS during a retrospective chart review to the incidence as determined by using the PAED Scale during the implementation period. Additionally, given that the LOC-RASS remained in use throughout the project, we examined differences in the incidence of pediatric emergence delirium by using the LOC-RASS between the retrospective and implementation periods. A secondary goal was to assess whether patient characteristics (ie, age, gender, medical diagnosis of attention deficit hyperactivity disorder [ADHD], premedication with midazolam, parental presence on induction, type of anesthetic maintenance, type of surgery) predicted the development of pediatric emergence delirium during the implementation period.

Our final goal was to assess the fidelity (ie, a quality measurement of a tool or intervention available to the health care providers that, when used correctly, results in an accurate or intended outcome) of the PAED Scale by evaluating the structure, process, and outcome of implementation
according to the Quality of Care Framework. Measures included the following factors:

- **Structure**—Are PACU RNs using the PAED Scale consistently and appropriately?
- **Process**—Are the attending anesthesiologists responding to episodes of pediatric emergence delirium when notified by a PACU RN?
- **Outcome**—Are patients experiencing subsequent or sustained episodes of pediatric emergence delirium during the next assessment period after pharmacological treatment?

**SETTING**

We conducted this quality improvement project in an eight-bed children’s PACU housed within a 928-bed academic facility in the southeastern United States. Anesthesia professionals (ie, certified registered nurse anesthetists [CRNAs], anesthesia residents, attending anesthesiologists), and RNs provide perioperative services for approximately 5,800 pediatric patients who present to our facility annually for surgical and diagnostic procedures with a daily PACU census, ranging from 15 to 35 patients. The anesthesia professionals work collaboratively within an Anesthesia Care Team Model to manage preoperative anxiety, intraoperative anesthesia and analgesia, postoperative pain, and cardiovascular or respiratory events. The RNs perform preoperative and postoperative assessments, manage postoperative pain, and notify the anesthesia professionals—primarily attending anesthesiologists—of deteriorations in a patient’s status.

**SAMPLE**

We used a convenience sample of 400 patients, 200 from the retrospective audit and 200 from the implementation period. We included any patient 17 years of age or younger who presented to the children’s preoperative area and who subsequently returned to the PACU after undergoing general anesthesia for a surgical or diagnostic procedure in the sample for each period. Only those patients who were transported to an ICU or recovered outside of the children’s PACU were excluded from this project. Retrospective patient data were retrieved from perioperative electronic health records exactly one year before the implementation period. We chose this time period to avoid influence from the education that was required for perioperative personnel in the implementation period.

A power analysis, based on an estimated 15% incidence of pediatric emergence delirium, indicated that a sample size of 150 patients in each period would provide 80% power to detect group differences in the incidence of pediatric emergence delirium. However, we decided to include 200 children in each group in case the incidence of pediatric emergence delirium was less than expected. We estimated the incidence based on a prospective cohort study that included 521 patients between three and seven years of age that showed that 18% of the patients undergoing general anesthesia for an outpatient surgical procedure experienced an episode of emergence delirium in the postoperative period.

More recent studies using the PAED Scale to assess for the presence or absence of pediatric emergence delirium have shown incidences ranging from 4.8% to 47.2%, depending on the type of maintenance anesthetic used or the administration of prophylactic medication.
the retrospective chart review from the patients’ PACU records. The number of LOC-RASS assessments conducted on any one patient from the retrospective chart review ranged from one to three, and the time between assessments was not standardized. This was in contrast to the way LOC-RASS and PAED Scale scores were collected during the implementation period.

During the implementation period, the RNs used the LOC-RASS and PAED Scale to assess for pediatric emergence delirium during four time periods separated by 10-minute intervals. We chose 10-minute time intervals based on a previous study that used a similar protocol to compare the incidence of pediatric emergence delirium found by using the PAED Scale to the incidence found by using the Watcha behavior scale for emergence delirium, the Cravero emergence agitation scale, and by an experienced anesthesia observer. In our project, we denoted the first assessment time period as “Time 0,” which corresponded with arrival in the PACU. The second, third, and fourth assessment time periods occurred 10 minutes, 20 minutes, and 30 minutes after arrival in the PACU, respectively.

**PAED**
The PAED Scale consists of five characteristics that are each scored by using a 5-point Likert scale. The first three items are scored in reverse order:

- 4 = not at all
- 3 = just a little
- 2 = quite a bit
- 1 = very much
- 0 = extremely

Items four and five are scored in regular order:

- 0 = not at all
- 1 = just a little
- 2 = quite a bit
- 3 = very much
- 4 = extremely

Individual scores for each item are then added together to determine the composite score for a particular time period. We set the threshold score for the presence of pediatric emergence delirium by using the PAED Scale at higher than or equal to 10 based on sensitivity and specificity reported in the literature.

**LOC-RASS**
The LOC-RASS was developed to “establish a clinically useful tool to assess the level of consciousness and agitated behavior in ICU patients that might guide sedation therapy and improve communication among health care providers.” One of the salient features is the single-item scoring system, which negates the need to add multiple subscale scores and can be completed quickly through observation and assessment of patient responses to auditory and physical stimuli. The LOC-RASS was found to have high interrater reliability (0.956) and strong construct validity with respect to a visual analog scale (r = 0.84-0.98, all P < .0001).

The LOC-RASS assesses five levels of sedation:

- −5 = unarousable with no response to voice or physical stimulation
- −4 = deep sedation with no response to voice but movement to physical stimuli
- −3 = moderate sedation with movement to voice but no eye contact
- −2 = light sedation and briefly awakens (ie, less than 10 seconds) with eye contact to voice
- −1 = drowsy (ie, not fully alert) but has sustained (ie, more than 10 seconds) awakening with eye contact to voice

A score of zero corresponds to a calm state of alertness. Positive scores on the LOC-RASS continuum denote some level of agitation:

- +1 = restless, anxious, or apprehensive but movements are not aggressive or vigorous
- +2 = agitated, frequent, nonpurposeful movements or ventilator dyssynchrony
- +3 = very agitated, pulls on or removes tubes or catheters, or has aggressive behavior toward personnel
We set the threshold score for the presence of pediatric emergence delirium by using the LOC-RASS at higher than or equal to +2 because the corresponding characteristics are more closely aligned with the definition of emergence delirium that we used for our project. Additionally, setting the threshold score at +1 would have classified all patients as having emergence delirium who were not sedated or who were in a calm state. Comparatively, the PAED Scale allows the potential for alterations in behavior and cognition beyond that of being in a calm and alert state, thus we chose to include the attributes associated with a LOC-RASS of +1 within the acceptable range of emergence characteristics.

**Fidelity**

Members of PQIT used the fidelity data that RNs in the pediatric PACU collected during the implementation period to evaluate implementation of the PAED Scale.

- We assessed the construct of fidelity structure by examining the number of patients receiving PAED and LOC-RASS scores as documented by the RNs during all four assessment periods relative to the total number of patients who presented to the PACU. We felt that successful implementation of the innovation would have been achieved if 85% or more of all patients were assessed by using the LOC-RASS and PAED Scale in all four assessment time periods.

- We evaluated the construct of the fidelity process by examining how anesthesia and nursing professionals used the patient assessment data from the LOC-RASS and PAED Scale. Thus, the process examined the number and type of anesthesia professionals’ responses to each patient who met the criteria for pediatric emergence delirium, as communicated by the PACU RN, relative to the total number of patients who met the criteria for pediatric emergence delirium. A response was defined as coming to the patient’s bedside, writing an order for or administering medication, or a combination of both. We considered a provider response rate of 85% or more to be a positive reflection of this measure.

- We measured the construct of fidelity outcome by examining the number of patients who
experienced a second (ie, either subsequent or sustained) episode of emergence delirium during the RN assessment period after pharmacological intervention compared with the number of patients receiving no pharmacological intervention. We defined a subsequent or sustained emergence delirium episode as a PAED score of higher than or equal to 10 or LOC-RASS of higher than or equal to +2 in the ensuing assessment time period. We set an overall rate of 15% or fewer patients experiencing subsequent or sustained emergence delirium after pharmacological intervention as a positive measure for this construct.

An answer of “N/A” to the fidelity questions meant the questions were not applicable to the patient (ie, the patient did not experience an episode of emergence delirium [ie, LOC-RASS < +2 or PAED < 10 during each assessment period] and required no pharmacological intervention). The fidelity questions were

- Did you call the attending anesthesiologist to report a PAED score of higher than or equal to 10?  
- Did you call the attending anesthesiologist to report a LOC-RASS score of higher than or equal to +2?  
- Did the attending anesthesiologist come to the bedside or order or administer medication?  
- If medication was administered, did the patient experience a sustained or subsequent episode of emergence delirium during the next assessment period (ie, 10 minutes later)?

**IMPLEMENTATION AND DATA COLLECTION**

After the PQIT received approval from the internal review board for the project through an expedited review process, and five days before implementation of the PAED Scale, a member of the PQIT conducted an educational inservice program for the PACU RNs. This inservice program focused on the implications of pediatric emergence delirium and the proposed plan to implement the PAED Scale into the PACU RNs’ assessment. The RNs who were unable to attend the inservice program received individual education before project implementation.

After the inservice program, the RNs were given the opportunity to practice using the PAED Scale. Two members of the PQIT were available during the five-day trial period to answer questions and address any concerns expressed by the RNs as they practiced using the new assessment tool. During this same time period, a member of the PQIT contacted all anesthesia professionals who had the potential to care for pediatric patients during the PAED Scale implementation period in person or via e-mail if they were not readily available to inform them of the implementation start date and of their data collection responsibilities. Additionally, a member of the PQIT asked the anesthesia professionals not to change their current practices of managing pediatric emergence delirium.

Preoperative RNs, anesthesia professionals, and PACU RNs worked cooperatively to collect prospective perioperative data on 200 pediatric patients during a three-week period. Specific responsibilities during the implementation period included the following:

- A preoperative RN placed the PAED Data Collection Form in the front of each patient’s chart in the preoperative area, and this form stayed in the chart until the patient was discharged from the children’s PACU.
- The CRNAs and resident anesthesiologists documented patient age and gender, premedication with midazolam, the effectiveness of midazolam administration in reducing the patient’s anxiety, medical diagnosis of ADHD, parental presence during induction, type of maintenance anesthetic, and type of procedure.
- The PACU RN completed the remainder of the PAED Data Collection Form during the postoperative period, which consisted of LOC-RASS
and PAED assessments, along with answering the project fidelity questions. A member of the PQIT posted laminated copies of the PAED Scale on the tables in each of the recovery bays to ensure that the RNs had instant access to the assessment criteria. Nurses conducted assessments for each patient by using the PAED Scale and LOC-RASS during all four assessment time periods. The RNs documented both scores on the PAED Data Collection Form at the time of the assessment and notified the attending anesthesiologist if the patient met the threshold score criteria for experiencing pediatric emergence delirium by using either assessment tool, regardless of the findings from the other tool. The decision to provide a pharmacological intervention was left to the discretion of the attending anesthesiologist. The RNs documented whether the attending anesthesiologist met the criteria of a “response” and whether the patient experienced a subsequent or a sustained episode of pediatric emergence delirium at the next assessment time period. The RNs placed the PAED Data Collection Form in a locked box after the patient was discharged from the PACU and a member of the PQIT collected all of the forms before the start of the next day. After the implementation period, a member of the information technology team pulled the retrospective information consisting of LOC-RASS and patient characteristic data from the patients’ charts.

**DATA ANALYSIS**

A member of the PQIT and a statistician analyzed data by using SAS/STAT® 9.3 software. We used descriptive statistics to determine frequency distributions among the patient characteristic and fidelity data collected during the respective assessment time periods. We compared age by using a Wilcoxon rank sum test as a result of non-normality of the distribution, and we compared nonparametric data, including gender, premedication with midazolam, parental presence at induction, and type of maintenance anesthetic by using Fisher exact tests to identify differences between the retrospective and implementation periods. We used z scores and corresponding ESs to test for differences in the proportion of patients who experienced pediatric emergence delirium relative to the patients who did not as determined by the LOC-RASS and PAED Scale used in their respective periods. Additionally, we used logistic regression models to determine whether any significant differences between group variables or patient characteristic data collected during the implementation period relative to PAED Scale scores (ie, age younger than or equal to six years; premedication with midazolam; a medical diagnosis of ADHD; parental presence at induction; sevoflurane used for maintenance anesthetic; procedures involving the ear, nose, and throat) were associated with the development of pediatric emergence delirium. The level of significance was set at \( P = .05 \) for all tests.

**RESULTS**

Members of the PQIT and a statistician analyzed data from 200 patients in both the retrospective and implementation periods (\( N = 400 \)). Perioperative data collected for 49 patients were not included in the analysis because these patients did not receive PAED Scale and LOC-RASS assessments during all four time periods. There were no statistically significant differences between retrospective and implementation groups with respect to age, gender,
or parental presence at induction. Various patient characteristics that were analyzed to determine statistically significant differences in patient characteristics are demonstrated in Table 1.

We found that the proportion of patients receiving midazolam preoperatively was significantly higher during the implementation period compared with the retrospective period \( (P = .002) \). Seventy-nine (95.2\%) of the anesthesia professionals who administered the midazolam documented that the medication was effective for relieving patients’ preoperative anxiety. We also found a significant difference \( (P = .049) \) in the type of maintenance anesthetic used between the two periods, with sevoflurane being the most frequently used in each. We evaluated the potential confounding effects of preoperative midazolam administration and maintenance anesthetic during the retrospective and implementation periods to determine whether these variables affected the incidence. A logistic regression model, including variables “group” (ie, retrospective, implementation periods), and “premedication with midazolam,” demonstrated that midazolam administration was not a significant

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Retrospective period</th>
<th>Implementation period</th>
<th>( P^{a} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>( N = 200^{b} )</td>
<td>( N = 198^{b} )</td>
<td>( .511^{c} )</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>7.9 (5.2)</td>
<td>7.6 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Minimum, maximum</td>
<td>0.1, 17</td>
<td>0.1, 17</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>( .421^{d} )</td>
</tr>
<tr>
<td>Male n/N (%)</td>
<td>107/200 (53.5%)</td>
<td>116/200 (58%)</td>
<td></td>
</tr>
<tr>
<td>Female n/N (%)</td>
<td>93/200 (46.5%)</td>
<td>84/200 (42%)</td>
<td></td>
</tr>
<tr>
<td>ADHD(^{e})</td>
<td>N/A(^{f})</td>
<td>12/196 (6.1%)</td>
<td></td>
</tr>
<tr>
<td>Premedication with midazolam</td>
<td>55/200 (27.5%)</td>
<td>85/200 (42.5%)</td>
<td>( .002^{d} )</td>
</tr>
<tr>
<td>Premedication with midazolam effective</td>
<td>N/A(^{f})</td>
<td>79/83 (95.2%)</td>
<td>N/A(^{f})</td>
</tr>
<tr>
<td>Parental presence at induction</td>
<td>43/200 (21.5%)</td>
<td>53/197 (26.9%)</td>
<td>( .241^{d} )</td>
</tr>
<tr>
<td>Maintenance anesthetic</td>
<td>( N = 181^{b} )</td>
<td>( N = 198^{b} )</td>
<td>( .049^{d} )</td>
</tr>
<tr>
<td>Sevoflurane</td>
<td>166/181 (91.7%)</td>
<td>181/198 (91.4%)</td>
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</tr>
<tr>
<td>Isoflurane</td>
<td>3/181 (1.7%)</td>
<td>11/198 (5.6%)</td>
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<tr>
<td>Desflurane</td>
<td>1/181 (0.6%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total IV anesthesia</td>
<td>11/181 (6.1%)</td>
<td>6/198 (3.0%)</td>
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</tr>
<tr>
<td>Type of surgery</td>
<td>( N = 196^{b} )</td>
<td>( N = 198^{b} )</td>
<td></td>
</tr>
<tr>
<td>Dental</td>
<td>7 (3.6%)</td>
<td>10 (5.1%)</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>24 (12.2%)</td>
<td>14 (7.1%)</td>
<td></td>
</tr>
<tr>
<td>Endoscopy</td>
<td>24 (12.2%)</td>
<td>35 (17.7%)</td>
<td></td>
</tr>
<tr>
<td>MRI/CT</td>
<td>5 (2.6%)</td>
<td>15 (7.6%)</td>
<td></td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>9 (4.6%)</td>
<td>11 (5.6%)</td>
<td></td>
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<tr>
<td>Orthopedics</td>
<td>32 (16.3%)</td>
<td>22 (11.1%)</td>
<td></td>
</tr>
<tr>
<td>General surgery</td>
<td>38 (19.4%)</td>
<td>26 (13.1%)</td>
<td></td>
</tr>
<tr>
<td>Urology</td>
<td>23 (11.7%)</td>
<td>16 (8.1%)</td>
<td></td>
</tr>
<tr>
<td>Other(^{g})</td>
<td>34 (17.4%)</td>
<td>49 (24.8%)</td>
<td></td>
</tr>
</tbody>
</table>

\( CT = \) computed tomography; \( ENT = \) ears, nose, and throat; \( Max = \) maximum age; \( Min = \) minimum age; \( MRI = \) magnetic resonance image.

\(^{a}\) \( P \) is significant at \( \leq .05 \).

\(^{b}\) The \( N \) for each individual characteristic represents the number of patients with documented data. Total charts reviewed in the retrospective period \( = 200 \).

\(^{c}\) Total patient encounters in the implementation period \( = 200 \). \( N < 200 \) represents data that were not collected for a particular variable.

\(^{d}\) Medically diagnosed with attention deficit hyperactivity disorder.

\(^{e}\) Wilcoxon two-sample test.

\(^{f}\) Fisher exact test.

\(^{g}\) Information not available.

\(^{h}\) Minor procedures performed (ie, bronchoscopy, cutaneous arteriovenous malformation treatments, bone marrow biopsy, lumbar punctures with or without administration of intrathecal chemotherapy).
covariate \( (\chi^2_{1} = 1.90; P = .1685) \). Similarly, the logistic regression model with the variables “group” and “maintenance anesthetic” also indicated that the covariate maintenance anesthetic was not statistically significant \( (\chi^2_{3} = .002; P = .99) \). Thus, we did not include these two variables in the primary analysis of the emergence delirium outcomes as described below.

A medical diagnosis of ADHD was not commonly recorded in the perioperative electronic health record; therefore, we could not ascertain the incidence of ADHD among the retrospective group for comparison. Data regarding ADHD were collected during the implementation period to determine whether ADHD was associated with the development of pediatric emergence delirium. Only 12 of the patients (6.1%) had a medical diagnosis of ADHD documented in their charts. The varied frequency distribution of the types of surgery did not allow for statistical analysis of this variable.

The overall incidence of pediatric emergence delirium in the implementation period by using the LOC-RASS and PAED Scale were 7.5% and 11.5%, respectively, whereas the incidence was only 3% during the retrospective period. The incidence of pediatric emergence delirium found by using the LOC-RASS during the retrospective period was significantly lower than the incidence found by using the LOC-RASS \( (z = -2.02; P = .043) \) and the PAED Scale \( (z = -3.28; P < .001) \) during the implementation period. However, the incidence of pediatric emergence delirium was not significantly different between the PAED Scale and LOC-RASS assessments during the implementation period \( (z = -1.02, P = .31) \). It should be noted that pediatric emergence delirium was identified in 12 patients with both the LOC-RASS \( (\geq +2) \) and the PAED score \( (\geq 10) \) during the implementation period. Differences in assessment findings also were evident; pediatric emergence delirium was identified in 11 patients with the PAED Scale alone and in three patients with the LOC-RASS alone. The subgroups were pulled out to show that each tool identified patients with pediatric emergence delirium independent of the other tool that suggested that these patients did not have emergence delirium.

Effect sizes (ESs) associated with each tool in its respective time period were calculated to determine the clinical significance of the differences in pediatric emergence delirium incidence found by using each tool. The comparison between the incidence of emergence delirium found by using the PAED scale during the implementation period and that found by using the LOC-RASS during the retrospective period resulted in an ES = 0.79 (odds ratio [OR] = 4.2 [95% CI, 0.996-6.902]). The ESs are an expression of the strength of relationship between two variables, ranging from 0–1.0, independent of the statistical significance \( (P) \). The higher the ES, the higher the probability that the dependent variable (ie, incidence of emergence delirium) was influenced by the independent variable (ie, assessment tool), suggesting that use of the PAED scale in the implementation period was more likely to identify patients experiencing emergence delirium than use of the LOC-RASS in the retrospective period. The comparison between the incidence of emergence delirium found by using the LOC-RASS during the implementation period and that found by using the LOC-RASS during the retrospective period resulted in an ES = 0.53 (OR = 2.6 [95% CI, 1.672-10.556]). The comparison between the incidence of emergence delirium found by using the PAED scale and that found by using the LOC-RASS during the implementation period resulted in an ES = 0.26 (OR = 1.6 [95% CI, 0.810-3.171]). This suggests that use of the PAED scale may have influenced the

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**Use of the PAED scale in the implementation period was more likely to identify patients experiencing emergence delirium than use of the LOC-RASS in the retrospective period.**

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LOC-RASS scores in the implementation period because each tool was used simultaneously to identify patients who experience emergence delirium, resulting in a smaller ES between the tools compared during the implementation period.

In examination of the 23 patients with pediatric emergence delirium identified by using the PAED Scale, neither age younger than or equal to 6 years; premedication with midazolam; a medical diagnosis of ADHD; parental presence at induction; anesthesia maintained with sevoflurane; nor ear, nose, and throat procedures predicted the development of pediatric emergence delirium (Table 2). Only one variable, premedication with midazolam, trended positively toward being associated with developing pediatric emergence delirium within this population, \((\chi^2 = 3.445; P = .063)\).

We assessed the effectiveness of program implementation through compliance with the assessments (ie, structure), provider response rate to notification of pediatric emergence delirium per the assessments (ie, process), and overall rate of patients experiencing subsequent or sustained emergence delirium after pharmacological intervention (ie, outcome). Two hundred of the 249 patients who presented to the children’s PACU during the implementation period received assessments during all four time periods by using both the PAED Scale and LOC-RASS for an overall compliance rate of 80.3%, which was less than the set standard of more than or equal to 85%. Only the fidelity process measure (ie, provider response rate \(\geq 85\%\)) met the established criteria set for the fidelity measures. Attending anesthesiologists were notified of 13 of the 15 pediatric emergence delirium cases (86.7%) assessed by using the LOC-RASS and 16 of the 23 pediatric emergence delirium cases (69.6%) assessed by using the PAED Scale. Attending anesthesiologists “responded” to all cases of which they were notified, either by coming to the bedside, ordering or administering a medication, or a combination of both, for an overall response rate of 100%.

Thirteen of the 26 patients identified with an episode of pediatric emergence delirium by using either assessment tool received medication; six (46.2%) were given fentanyl and seven (53.8%) were given dexmedetomidine. The decision to administer fentanyl versus dexmedetomidine in response to emergence delirium was based on provider preference because emergence delirium is self-limiting and will resolve with time. The attending anesthesiologists were not asked to document their emergence delirium assessment; therefore, we could not determine whether they chose to administer medication based on their determination that the patients were experiencing pain or emergence delirium. Five of these 13 patients experienced a subsequent or sustained episode of pediatric emergence delirium in the next

**TABLE 2. Logistic Regression Analysis of Patient Characteristics and Association With Pediatric Emergence Delirium**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>(\chi^2)</th>
<th>(\chi^2_3)</th>
<th>(P)</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (\leq 6) y</td>
<td>0.124</td>
<td>1</td>
<td>.724</td>
<td>1.173</td>
<td>0.483-0.847</td>
</tr>
<tr>
<td>ADHD(^a)</td>
<td>2.021</td>
<td>1</td>
<td>.155</td>
<td>0.366</td>
<td>0.091-1.464</td>
</tr>
<tr>
<td>Premedication with midazolam</td>
<td>3.445</td>
<td>1</td>
<td>.063</td>
<td>0.431</td>
<td>0.177-1.048</td>
</tr>
<tr>
<td>Parental presence at induction</td>
<td>0.165</td>
<td>1</td>
<td>.685</td>
<td>0.821</td>
<td>0.318-2.214</td>
</tr>
<tr>
<td>Sevoflurane(^b)</td>
<td>0.645</td>
<td>1</td>
<td>.422</td>
<td>1.725</td>
<td>0.456-6.527</td>
</tr>
<tr>
<td>ENT surgery</td>
<td>0.286</td>
<td>1</td>
<td>.592</td>
<td>1.765</td>
<td>0.220-14.161</td>
</tr>
</tbody>
</table>

\(^a\) Medically diagnosed with ADHD.  
\(^b\) Anesthesia maintained with sevoflurane.
assessment period. Therefore, the rate of subsequent or sustained pediatric emergence delirium after pharmacological intervention (38.5%) was higher than fidelity outcome measure set standard of less than or equal to 15%.

**DISCUSSION**

The primary goal of this quality improvement project was to evaluate the identification of pediatric emergence delirium by implementing and evaluating the use of the PAED Scale in the children’s PACU at our facility. The retrospective chart review revealed that only 3% of patients experienced pediatric emergence delirium during this time period when they were assessed by using only the LOC-RASS. Although this incidence rate was within the range reported in the literature (ie, 2% to 80%13), it was significantly lower than the incidence found by using either the LOC-RASS or PAED Scale during the implementation period (ie, 7.5% and 11.5%, respectively).

It could be argued that the incidence of pediatric emergence delirium that we found between the two time periods was a result of heightened awareness of emergence delirium among anesthesia and nursing personnel during the implementation period. However, analysis of our findings suggests that the PAED Scale may be a more sensitive assessment of pediatric emergence delirium after emergence from general anesthesia. In addition to the z scores and corresponding P values, the associated ESs suggested that the use of the PAED had a clinically significant effect on the identification of pediatric emergence delirium during the implementation period. We attributed this significant difference to the fact that, unlike the PAED Scale, the LOC-RASS was not designed to identify pediatric emergence delirium, nor has it been validated in the pediatric population.12,14,15 The PAED Scale can be used to detect disturbances in several psychomotor characteristics simultaneously, which allows providers to assess both cognition and behavior at the same time.

The PAED Scale can be used to detect disturbances in several psychomotor characteristics simultaneously, which allows providers to assess both cognition and behavior at the same time.

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of the PAED Scale, which may have influenced the RNs’ LOC-RASS assessments. However, 11 patients who met criteria for experiencing pediatric emergence delirium when using the PAED Scale did not meet the criteria when using the LOC-RASS. These findings suggested that, even when a validated pediatric emergence delirium assessment tool is used, the LOC-RASS led to under-identification of emergence delirium among our pediatric patients.

A secondary goal of the project was to compare patient characteristics among and within the two time periods, and to determine whether any of the characteristics of the patients in the implementation period were associated with the development of emergence delirium. The only significant differences that we noted between the groups during each time period pertained to administration of midazolam in the preoperative area and the type of maintenance anesthetic used during the surgical procedure, and neither variable was found to be a significant contributing factor to the development of pediatric emergence delirium. Midazolam trended toward a positive correlation, but it was not associated with the development of emergence delirium. The use of midazolam is provider-specific and not a standard of care in our institution. There was no identifiable reason for the significant increase in midazolam administration in the preoperative area during the implementation period.

Preoperative anxiety and fear are commonly experienced among children who present for surgery.16 The decision to administer midazolam always has been left to the discretion of the anesthesia professional and is based on a subjective assessment of the child’s level of preoperative anxiety. Introduction of new anesthesia professionals (ie, attending anesthesiologists, residents, CRNAs) to the pediatric perioperative setting may have contributed to increased use of midazolam; however, the effect of this variable is unknown because provider-specific practices were not tracked. Similarly, the type of maintenance anesthetic used was left to the discretion of the anesthesia professional unless the use of volatile agents was contraindicated during certain neuro- logical procedures. Therefore, we could not determine the exact source of the difference in anesthetic maintenance between the two time periods but was likely because of provider preference.

None of the patient characteristics entered into the regression model were predictive of the development of pediatric emergence delirium during the implementation period. This could be attributed in part to the low incidence of pediatric emergence delirium. Additionally, neither parental presence at induction nor a medical diagnosis of ADHD have been shown to be specifically associated with the development of pediatric emergence delirium; however, we included these measures in the analysis because they are associated with separation anxiety and impulsive behavior, respectively, which have been identified as potential factors that increase the risk of emergence delirium development.16,23 The lack of variability in maintenance anesthetic practices and the low number of ear, nose, and throat procedures performed during the implementation period may have influenced the insignificant findings related to these patient characteristics.

Our final goal was to assess the fidelity of the PAED Scale during the implementation period as it related to the Quality of Care Framework measures (ie, structure, process, outcome).21 The RNs completed LOC-RASS and PAED Scale
assessments of the majority of the patients (80.3%), indicating adoption of the practice change. We attributed the lack of higher compliance to two factors. First, RNs documented their assessment findings on the PAED Data Collection Form rather than as part of their standard documentation practices. The second factor was the high acuity and patient workload that was associated with our patient population. Our children’s PACU provided postoperative recovery services for patients with a wide range of comorbidities, and the patient turnover rate was high at times, both of which may have contributed to some patients not being assessed according to protocol.

The attending anesthesiologists were very responsive to episodes of pediatric emergence delirium when they were notified by the RNs. The reason some RNs did not report episodes of emergence delirium is unknown. It is possible that the RNs did not feel confident with their assessment findings, or, if medication orders were already in place, they may have felt that they did not need to contact the attending anesthesiologist despite being asked to do so as part of the project protocol. When the episodes of pediatric emergence delirium were reported, the overall response rate among the attending anesthesiologists was 100%, suggesting that the attending anesthesiologists valued the PAED Scale findings.

Analysis of fidelity outcomes suggests that medication administration was not a definitive treatment for all cases of pediatric emergence delirium. Medication administration effectively abated emergence delirium in eight of the 13 patients. However, analysis of our findings suggests that it is important to weigh the risks and benefits of medication administration, including its effects on respiratory, cardiovascular, and neurological function, which may prolong the length of stay in the PACU. In addition, interventions to keep the patient safe until the episode of emergence delirium subsides should be used, such as securing IV catheters to prevent removal; padding bed siderails; and maintaining a calm, quiet environment.

CONCLUSION
Analysis of our findings suggests that the PAED Scale may be a more sensitive measure for pediatric emergence delirium within our children’s PACU than the LOC-RASS, and that anesthesia and nursing professionals were capable of using the scale effectively to identify and respond to episodes of emergence delirium. Future goals should be to institute the PAED Scale as standard of care when assessing for the presence of pediatric emergence delirium, build on the current knowledge base, discover ways to improve communication between health care personnel, and help prevent patient and personnel injury when episodes of pediatric emergence delirium do occur.

Editor’s note: SAS/STAT—Statistical Analysis System is a registered trademark of Statistical Analysis System Institute, Inc, Cary, NC; 1982.

References


