

Application of the Pediatric Anesthesia Emergence Delirium Scale to Enhance Recognition in  
the PACU

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Date of Submission: 01/28/2020

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## **Abstract**

### **Purpose of Project**

Pediatric emergence delirium (ED) is a unique postoperative occurrence. With varying prevalence, manifesting as hyperactivity, disorientation, non-purposeful movement, incoherence, and potential for self-harm. Due to its unpredictability and distressing presentation, pediatric emergence delirium requires prompt recognition and accurate identification. However, the PAED scale is under-utilized and emergence delirium assessment is not consistently performed by anesthesia providers. This postoperative phenomenon continues to evolve within literature as there remains unanswered questions pertaining to identification, prevention, treatment, and long-term impacts. A gap in the knowledge translation exists for properly identifying, treating, and preventing pediatric emergence delirium. Within the hospital selected for this study's intervention, there are no guidelines or diagnostic assessment tools used for pediatric ED.

### **Methodology**

The project design incorporated a quantitative and qualitative, multiple cohort presentation for [REDACTED] nurse anesthesia residents, PACU registered nurses, and anesthesia providers. This project incorporated a pretest/posttest intervention survey to evaluate current knowledge gaps, assess baseline understanding of pediatric ED, provide evidence-based treatment interventions, risk reduction strategies, and utilization of the PAED assessment scale. The presentation took place at [REDACTED] [REDACTED] during a scheduled nurse anesthesia program meeting. A separate professional presentation was conducted at a tertiary academic medical center in north-central New Jersey. Recruitment strategy consisted of a PAED flyer distributed to all anesthesia cohorts via [REDACTED] email, in addition to all project participants at the tertiary hospital. Primary outcome measures focused on increased confidence levels with use of the PAED scale, prevention strategies, identification and understanding pediatric emergence delirium.

### **Results**

There was a higher level of understanding the defining behaviors of ED following post-survey. In addition, there were increased levels of understanding how to use the PAED scale, and higher knowledge and confidence in the level of ED prevention.

### **Implications for Practice**

The implementation of the PAED scale improves recognition and treatment response time. Increasing provider clinical awareness enhances recognition of the triggers and signs of pediatric ED. Application of the PAED scale at in the PACU improves health outcomes for highly specialized patient population. There was a significant decrease in existing knowledge gaps in properly identifying, treating, and preventing pediatric ED. This project serves as a foundation for further researchers to focus on comparative randomized control trials to determine accepted pharmacologic treatment in the acute setting of pediatric ED.

## **Introduction**

Pediatric emergence delirium (ED) is a unique postoperative occurrence; with varying prevalence, manifesting as hyperactivity, disorientation, non-purposeful movement, incoherence, and potential for self-harm (Rosen, Mervitz, & Cravero, 2016). Above all else, the most defining and distressing characteristic of pediatric ED is inconsolability. It is estimated that over 450,000 children under the age 18 receive general anesthesia for surgeries annually (Kamienski, McCartney, McLaughlin, & Pallaria, 2018). Research indicates that ED is two to three times more likely to transpire in children than in adults (Nair & Wolf, 2017). Since its first published description in 1960, pediatric emergence delirium continues to be a common occurrence, with the precise etiology still under investigation (Mason, 2017). Due to its unpredictability and ambiguous presentation, there is increasing pressure by clinicians and researchers to develop standardized diagnostic tools and treatment modalities for pediatric emergence delirium. The Pediatric Anesthesia Emergence Delirium (PAED) scale is a validated identification tool with high sensitivity and specificity (Mason, 2017). According to Holzman, Mancuso and Polaner (2016) the specific choice of measurement tool is not as vital as the reliable and recurring use of the tool. Measurement tools are ineffective unless clear, cogent communication is utilized among interdisciplinary healthcare providers. Routine application of assessment tools, such as the PAED scale, improves diagnostic accuracy, which ultimately leads to faster execution of treatment (Thom, 2017). Unfortunately, the PAED scale is under-utilized and research shows that pediatric ED assessment is not consistently performed by anesthesia providers and PACU nurses.

## **Background and Significance**

From a historical perspective, emergence delirium has been firmly established within the practice of anesthesia since the 19<sup>th</sup> century and was first documented in 1819 (Olympio, 1991). The exact nomenclature has changed over the years as ED was grouped within the phenomenon of postanesthetic excitement and postanesthetic psychosis (Olympio, 1991). Interestingly, the terms emergence agitation and emergence excitement are synonyms for ED and are used interchangeably within existing bodies of literature. Emergence delirium in the pediatric population was first described in 1960 by authors Smessaert et al. and Eckenhoff et al. (Mason, 2017). A fundamental issue concerning pediatric ED is the application of a reliable, clinically valid assessment tool. An observation of the literature index indicates that no universal assessment tool is used at the bedside (Ringblom, Wahlin, and Proczkowska, 2018). Prior to the development of the PAED scale in 2004 by researchers Sikich and Lerman, emergence delirium diagnostic criteria were based on anecdotal clinical experiences. Observational behavioral is paramount when diagnosing pediatric delirium because of the intrinsic communication limitations among infants and children (Thom, 2017). The PAED scale is psychometrically sound with high inter-rater reliability and is the most used tool in the post anesthesia period (Ringblom, Wahlin, and Proczkowska, 2018).

Emergence delirium in the postoperative period is not exclusive to children receiving general anesthesia. ED has been identified in both the adult and pediatric population with higher prevalence impacting children (Stamper et al., 2014). Pediatric ED continues to remain a common issue following general anesthesia with reported incidence as high as 50 percent in children under the age of six (Lerman, 2018). Contemporary research still has yet to determine a single definitive cause; however, multiple factors have been identified. The most significant offenders for pediatric emergence delirium can be broken down into categories that include:

patient factors, anesthesia technique, and surgery type (Holzman, Mancuso & Polaner, 2016). The most cited predisposing risk factors are ages two-five, the use of volatile anesthetics; especially Sevoflurane, ENT surgery, preoperative patient anxiety, and male gender (Mason, 2017; Holzman, Mancuso, & Polaner, 2016). Emergence delirium has the potential to result in significant injury to the patient and staff caregivers. If left untreated, ED can prolong PACU stays and places a substantial burden on nurse-to-patient ratios (Stamper et al., 2014). According to authors Rosen, Mervitz, and Cravero (2016) pediatric ED is clinically prevalent, often occurring multiple times in a given day, with severe cases requiring significant resource allocation and treatment from healthcare providers. Emergence delirium is reported to require up to six times more nursing care than standard patients recovering from general anesthesia (Greiner & Kremer, 2019). In cases where the child is not at risk for self-harm, ED is self-limiting and will resolve on its own, although there are documented reports of symptoms lasting longer than forty-five minutes (Holzman, Mancuso, & Polaner, 2016). Modern research has yet to determine if pediatric ED has any long-term impacts or permanent sequela on the developing child, despite the recently issued warnings about general anesthetic exposure to infants under three years old and pregnant mothers in their third trimester (Mason, 2017; U.S. Food and Drug Administration, 2016).

### **Needs Assessment**

According to Huett et al. (2017), 1229 questionnaires were analyzed from members of the German Society of Anesthesiology, which among them 88 percent stated ED as a clinical problem and five percent said they used an assessment score to define ED. At national, state and local levels, PACU nurses and anesthesia providers should be routinely educated on the signs and symptoms of emergence delirium in the post anesthesia recovery period. There is no “gold

standard” intervention for pediatric ED; hence, there is a great deal of intervariability drug selection among clinicians. The frequency of ED and disproportionate application ED assessment scales indicate a need to further educate healthcare providers on the prevalence, identification, and existing evidence-based treatment modalities. The hospital site selected to focus our project was a large, tertiary academic medical hospital in north central New Jersey. No guideline or diagnostic tool was used for pediatric emergence within this selected institution.

### **Problem Statement**

Since its discovery in 1960, emergence delirium continues to be a clinical disturbance. To date, there is an increasing pressure by clinicians and researchers to develop standardized diagnostic tools and treatment modalities for pediatric emergence delirium. Modern literature reviews denote the PAED scale as the most cited and proven pediatric ED assessment scale (Mason, 2017). Unfortunately, the PAED scale is under-utilized and research shows that pediatric ED assessment is not consistently performed by anesthesia providers and PACU nurses. A gap in the knowledge translation exists for properly identifying, treating, and preventing pediatric emergence delirium. In an effort to improve pediatric ED clinical competence, our project focused on the application of the PAED scale to enhance interobserver reliability within the PACU.

Our project focused question is, “Will the use of the PAED scale quick reference badge holder improve pediatric ED identification among interprofessional health care providers?”

Using the PICO(T) format, our clinical question for this project encompasses:

**Population:** third year nurse anesthesia residents, second year nurse anesthesia residents, PACU registered nurses, anesthesiologists, and certified registered nurse anesthetists

**Intervention:** Implementation of the PAED scale to improve clinical competency in recognition and identification of pediatric ED

**Comparison:** Utilizing the PAED scale during the post anesthetic recovery in comparison to the standard of care, which at the present time does not include assessment or intervention tools

**Outcome:** Did the PAED scale enhance staff perception and awareness for pediatric ED and improve clinical competence?

### **Aims and Objectives**

Our aim for this project was to improve and enhance pediatric ED assessment in the PACU. Decreasing the incidence of pediatric ED focuses on prevention and education rather than medical treatment (Mason, 2017). Prompt identification is essential to mitigate the potential for self-inflicted harm during acute episodes of ED. The identified phenomenon of pediatric ED is not without its challenges and barriers. Ideally, an emergence delirium screening tool would meet the following objectives and criteria:

- Involve collaborative efforts among PACU RNs, CRNAs, MDAs, and Parents
- Identify staff knowledge gaps concerning pediatric ED through pre-test/post-test surveys
- Implement the PAED scale screening tool into clinical practice
- Provide quick reference PAED scale badge holder to all project participants
- Perform quantitative and qualitative data analysis questionnaires with a post-post survey
- Determine the incidence of pediatric ED and effectiveness of the PAED scale

### **Review of the Literature**



To gain further insight on emergence delirium and assess current practices in pediatric anesthesia, a thorough review of existing literature was conducted. Using the Rutgers University Smith Library website, research articles on pediatric emergence delirium were synthesized from: Medline, CINAHL, Scopus, PsychINFO, and the Joanna Briggs Institute. An extensive search of grey literature was conducted on the American Association of Nurse Anesthetists and the American Society of PeriAnesthesia Nurses websites. The following keywords were used during the search: “*child*”, “*infant*”, “*adolescent*”, “*youth*”, “*delirium*”, “*emergence delirium*”, “*emergence agitation*”, “*emergence excitement*”, “*PAED*”, “*emergence delirium scale*”, “*PAED scale*”, “*pediatric emergence delirium*”, and “*anesthesia recovery*”. Inclusion criteria was based on original publication within the past 10 years and articles written in English. Articles pertaining to delirium outside the post anesthesia recovery period and the adult population were excluded from this project. Combinations of keywords yielded 47 results; however, only 22 articles met the inclusion criteria.

### **Pediatric Emergence Delirium**

Nearly five decades after the first published article on maladaptive behavior following general surgery, the postoperative phenomenon known as pediatric emergence delirium continues to evolve within existing bodies of literature due to the fact that there remain unanswered questions pertaining to accurate identification, prevention, treatment, and long-term impacts (Mason, 2017; Lerman, 2018).

The overall reported incidence of pediatric ED varies among the multiple studies of literature, mainly because clinical reporting of pediatric ED is not the standard of care (Bonanno, Pierce, Badeaux, & FitzSimons, 2016; Mason, 2017; Stamper et al., 2014). Despite the varied occurrence, pediatric ED has significant potential for a multitude of adverse events including the

inadvertent removal of intravenous catheters and drains, self-harm, wound dehiscence, and increased length of stay (Mason, 2017; Nair & Wolf, 2018; Ringblom et al., 2018). Most importantly, pediatric ED is distressing to all parties involved: child, parent, and healthcare professional.

It is widely accepted in academia that pediatric ED is self-limiting and will resolve; however, the duration and severity of symptoms fluctuates and is unique to each child. More importantly, pediatric ED remains unpredictable despite interventions to mitigate its incidence. Treatment interventions for pediatric ED is largely centered on pharmacological prevention strategies in the postoperative setting in conjunction with non-pharmacological techniques (Mason, 2017; Nair & Wolf, 2018; Jang, 2017). The most consistent practice to reduce pediatric ED is the avoidance of volatile anesthetics; specifically Sevoflurane, and opting to perform total intravenous anesthesia (TIVA) (Mason, 2017).

The challenge for healthcare professionals in accurately identifying pediatric ED is to separate ED from pain and other variable causes like hypoxia or hypercarbia (Mason, 2017; Ringblom, Wahlin & Proczkowska, 2018; Lerman, 2018). A differential diagnosis for pediatric ED can be accomplished with emergence delirium rating scales. Currently, the most widely utilized and endorsed pediatric ED scale is the PAED scale (Mason, 2017; Lerman, 2018; Somaini, Engelhardt, Fumagalli, & Ingelmo, 2016). According to authors, Somaini et al. (2016) the distinguishing, hallmark feature of pediatric ED following general anesthesia is ‘no eye contact’ and ‘no awareness of surroundings’.

### **Risk Factors**

To date, no single causation has been determined to precisely explain pediatric ED. Comprehensive bodies of literature categorize major contributors to emergence delirium into

patient factors, anesthetic technique, and type of surgery (Rosen, Mervitz, & Cravero, 2016). The most cited are age, gender, and the use of low soluble volatile anesthetics.

### **Patient Factors**

Postoperative ED is most commonly displayed in younger children; specifically, ages two to ten years old (FitzSimons, Bonanno, Pierce, & Badeaux, 2017; Mason, 2017). The most impacted age group is two- five-year-old children. Preoperative anxiety strongly correlates with pediatric ED. According to Nair and Wolf (2018), for every ten percent increase in preoperative anxiety scores the likelihood of ED is augmented by ten percent. Patient anxiety based on pre-existing behaviors combined with influences from parental anxiety places a child at higher risk for emergence delirium (Mason, 2017; Jang, 2017; Nair & Wolf, 2018). Precise statistical data for pediatric preoperative anxiety differs greatly throughout the literature. Another important contributor to pediatric ED is a prior history of pediatric ED, although the caveat to experiencing pediatric ED is unique to each child and is a case by case presentation.

### **Anesthetic Technique**

The use of volatile anesthetics with low blood-gas solubility to include both Sevoflurane and Desflurane is broadly considered the greatest contributor to pediatric ED (Mason, 2017; Nair & Wolf, 2018; Lerman, 2018). This is due to the fact that most pediatric patients are induced with inhalational anesthetics (FitzSimons, Bonanno, Pierce, Badeaux, 2017). Sevoflurane has the greatest predisposition for pediatric ED because of its pharmacokinetic and pharmacodynamic advantages over other potent inhalational anesthetics. It is postulated that the pathogenesis of pediatric ED following rapid emergence from volatile anesthetics is a direct result of neurodevelopmental and neurochemical disruption (Lerman 2018; Nair & Wolf, 2018; Kamienski, McCartney, McLaughlin, & Pallaria, 2018). Neurotoxicity and the conceivable

repercussions this imparts on a child's developing brain remain uncertain (Levy, 2019).

Compelling evidence from observational human studies have highlighted the apprehension and possible correlation linking exposure to long term negative effects (Rosenblatt, Kremer, Swanson, & Shah, 2019). Most notable are gray matter changes seen on MRI scans, expressive language problems, listening comprehension, and academic learning difficulties. The conceptual belief of general anesthetics causing neurodevelopmental changes is a great concern for healthcare providers, parents, and patients. (Levy, 2019).

Total intravenous anesthesia (TIVA) is a well-described alternative to volatile anesthetics with decreased incidence of pediatric ED (Mason, 2017, Nair & Wolf, 2018). Propofol has been proven to provide great utility in decreasing pediatric ED. Not only can it be effectively used as a sole anesthetic agent but it can be combined with Sevoflurane as a maintenance adjunct (Mason, 2017; Lerman, 2018). The use of Propofol at 1mg/kg following Sevoflurane anesthesia is the most authenticated intervention for decreasing pediatric ED (Mason, 2017; Nair & Wolf, 2018; Lerman, 2018). The administration of narcotics such as Fentanyl and Remifentanyl are best suited as TIVA adjuncts. Preoperative narcotics do not decrease the likelihood of pediatric ED (Mason, 2017; Lerman, 2018). Numerous studies in recent literature link dexmedetomidine as an effective means to decrease pediatric ED. Dexmedetomidine can be administered preoperatively, intraoperatively, and postoperatively. An intraoperative infusion of 0.2-1mcg/kg/hour or 0.3mcg/kg bolus during emergence are two effective reduction strategies (Mason, 2017; Nair & Wolf, 2018; FitzSimons, Bonanno, Pierce, Badeaux, 2017).

### **Surgery Type**

Surgeries that involve the ears, nose, throat, and eyes have the highest reported prevalence of pediatric ED (Mason, 2017; Nair & Wolf, 2018). Also noteworthy is the incidence

of ED following pain-free procedures. As a matter of interest, pediatric ED is not exclusive to perioperative and postoperative painful, noxious operations (Lerman, 2018; Nair & Wolf, 2018). Children undergoing general anesthesia for non-painful procedures such as an MRI still experience ED (Costi et al., 2015).

## **Prevention Strategies**

### **Pharmacological Interventions**

Practice patterns to prevent pediatric ED include the avoidance of volatile anesthetics, opting for TIVA technique and the administration of preemptive, prophylactic sedative and anxiolytic medications (Nair & Wolf, 2018; Lerman, 2018). Inconsistencies within literature surrounds preoperative oral midazolam as an effective intervention to decrease pediatric ED (Nair & Wolf, 2018; Lerman, 2018; Mason, 2017). The preventative role midazolam plays in pediatric ED is questionable. Additionally, the use of narcotics preoperatively is still under investigation. Justification for prophylactic ED treatment is a challenge because pediatric ED is age dependent and the incidence can vary significantly (Lerman, 2018). Furthermore, having a high-risk stratification score is no guarantee pediatric ED will manifest in the post anesthesia period. Specific treatment choices for pediatric ED is provider dependent and often based on anecdotal experience (Rosen, Mervitz, & Cravero, 2016; Lerman, 2018). Evidence-based prophylaxis has yet to determine a ‘gold standard’ for treatment options (Mason, 2017; Lerman, 2018). The most recognized prophylactic interventions include: a single dose Propofol bolus (1mg/kg) at the end of surgery, a single dose Fentanyl bolus (1mcg/kg) at the end of surgery, or a single dose of Dexmedetomidine bolus (0.3-1mcg/kg) during emergence (Mason, 2017; Lerman, 2018; Nair & Wolf, 2018). Ketamine is unique because it has preventive applications preoperatively, intraoperatively, and postoperatively. Ketamine can be administered intranasally

(2mg/kg) during preop, given as a maintenance infusion (1mg/kg/hour) or administered as a single bolus dose of (0.25mg/kg) at the end of the case (Mason, 2017; Lerman, 2018; Nair & Wolf, 2018).

### **Non-Pharmacological Interventions**

Numerous studies have demonstrated the importance of distraction techniques to alleviate pediatric and parental anxiety prior to surgery. Strategies to decrease pediatric ED include the use of educational materials such as pamphlets, videos, and games (Mason, 2017; Kamiensk et al., 2018). Multimedia platforms also provide distraction as well as parental presence during induction are two correlative practices to decrease pediatric ED (Jang, 2017; Mason, 2017; Nair & Wolf, 2018). The overall effectiveness of these interventions is arguable and not without substantial implementation barriers. More importantly, improving health literacy by educating parents on pediatric ED is a proven, cost-effective intervention to reduce pediatric ED (Mason, 2017; Nair & Wolf, 2018). Family member presence during emergence delirium, while distressing and unpleasant to witness, is one of the most overlooked behavioral strategies to attenuate delirigenic behavior. Current literature suggests that management strategies to decrease adult delirium has application to the pediatric population.

### **Pediatric ED Assessment Scales**

From a historical perspective, pediatric ED assessment scales were mainly for research purposes with very little application into clinical practice (Ringblom et al., 2018). The challenge for pediatric ED assessment is to correctly differentiate between the overlapping features of pain, agitation, and postoperative delirium (Mason, 2017; Nair & Wolf, 2018). Common pediatric ED assessment scales include the Cravero, Watcha, and the PAED scales. Comparative studies among pediatric ED assessment scales is lacking. Despite this, the PAED scale is the most cited

and used assessment tool for children over two years old (Mason, 2017; Nair & Wolf, 2018). The PAED scale, created by researchers Sikich and Lerman (2004), combines elements from both the observational pain scale; Face, Legs, Activity, Cry, Consolability (FLACC) and the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS). The PAED scale constructors also included two key assessment categories emblematic to ED: 'the child is restless' and 'the child is inconsolable'. All five characteristics on the PAED scale help address psychomotor consciousness and cognition, irrespective of pain. The presence of pediatric ED most positively correlates with 'no awareness of surrounding', 'no purposeful movement', and 'no eye contact' (Mason, 2017; Somaini et al., 2016). The most accepted assessment score for treatment is greater than 12; however, validation scores vary in the literature (Nair & Wolf, 2018). Research shows that PAED scores above 12 indicate 100 percent sensitivity and 94.5 percent specificity when diagnosing emergence delirium (Lerman, 2018). The PAED scale receives criticism for high false positive rates and lengthy assessment time; however, multiple studies have established its reliability, validity, and internal consistency (Mason, 2017; Ringblom et al., 2018; Stamper et al., 2014). Current research in adult emergence delirium indicates that the PAED scale has been applied in clinical studies with success (Greiner & Kremer, 2019).

In order for the PAED scale to be most effective, all pediatric patients require baseline assessment scores prior to receiving general anesthesia (Mason, 2017). This enables the healthcare provider to have a comparative reference score. Assessment criteria for pediatric ED is lacking in clinical practice, despite reputable assessment tools like the PAED scale (Mason, 2017; Nair & Wolf, 2018). The reported incidence of pediatric ED following general anesthesia correlates to the importance of adopting screening tools such as the PAED scale in the PACU.

## **Treatment**

To date, the most recognized, prevailing treatment for pediatric ED is the administration of Propofol 0.5mg-1mg/kg or dexmedetomidine 0.3 mg/kg (Nair & Wolf, 2018). It is important to note that all treatment interventions may prolong PACU recovery time and require increased need for monitoring and assessment. Treatment for pediatric ED in conventional practice is based upon anecdotal experience. Research shows that a variety of different medications, administration routes, and timing of administrations exist (FitzSimons et al., 2017; Mason, 2017; Rosen et al., 2016). Future research needs to focus on comparative randomized control trials to determine accepted pharmacologic treatment in the acute setting of pediatric ED.

### **Theoretical Framework**

The conceptual framework that underpins this proposal is the Ottawa model. The Ottawa model supplies the framework of this project beginning with the identification of gaps in knowledge, overcoming barriers, and evaluation of the knowledge translation strategies for effectiveness. The Ottawa model has been used in nursing to remove implementation barriers and supports adoption of new innovations (Graham & Logan, 2004). This model is comprised of three main sections: assess barriers and support; monitor intervention and degree of use, and evaluates outcomes (Hogan & Logan, 2004).

Section 1 focuses on three subgroups: evidence-based innovation, potential adopters and practice environment. Evidence-based innovation involves the developmental process of appropriately identifying and recognizing the PAED scale and incorporating its use in the post-anesthesia recovery setting. The potential adopters are all anesthesia providers along with PACU nurses. However, current practice at this facility and those reviewed in the literature, indicate the PAED assessment is under-utilized. Furthermore, the lack of a measuring scale indicates a need to educate healthcare providers on the prevalence, identification, and evidence-based treatment modalities available. The practice environment consists of the



patients, hospital culture, and anesthesia department. All together, these environments may need to be constructively corrected in order to facilitate the adoption of the PAED scale throughout the perioperative department.

The section 2 of the ottawa model includes implementation of intervention strategies and adoption. It is crucial to identify knowledge gaps related to pediatric ED. This was accomplished through the use of pre/post-tests and a PowerPoint presentation for all project participants. Once the PAED scale is adopted and utilized, follow-up becomes an essential part of the implementation process to ensure the scale's effectiveness, comprehension and usefulness.

## **Methodology**

### **Study Design**

The authors objectives for this quality improvement project were to determine provider knowledge gaps, improve pediatric emergence delirium assessment, and enhance pediatric ED recognition. Ultimately, this project was intended to improve health outcomes by augmenting safety and effectiveness of pediatric anesthesia services. Quality improvement projects initiate change via practice improvement through a variety of methods to enhance healthcare processes and outcomes (Moran, Burson, & Conrad, 2017). The project design incorporated a quantitative and qualitative, multiple cohort presentation for [REDACTED] nurse anesthesia residents, PACU registered nurses, and anesthesia providers. This project incorporated a pretest/posttest intervention survey to evaluate current knowledge gaps, assess baseline understanding of pediatric ED, provide evidence-based treatment interventions, risk reduction strategies, and utilization of the PAED assessment scale.

A post lecture survey was completed thirty days after the initial presentation for all participants who incorporated the PAED into clinical practice. Specific data points were compared between cohort groups of nurse anesthesia residents. The surveys incorporated close-ended responses, multiple choice questions, and Likert-type scales. The Likert-type questions were scaled to generate sufficient variance. All surveys were originated based off the International Association for Medical Education research design questionnaires by authors Artino et al. (2014). All survey questions were visually designed in accordance with best practices for questionnaire design research. Each survey question was developed and evaluated to determine content validity, reliability, and construct (Artino et al., 2014). The surveys were reviewed by the faculty team members. The pre-and post-educational surveys were administered through the Qualtrics online survey software.

The data gathered was analyzed to evaluate the effectiveness of the presentation and the use of the PAED assessment scale in clinical practice. This was achieved with the use of univariate, descriptive statistics and categorical variables.

### **Setting**

A scholarly, professional presentation was completed by the authors for all cohorts. The presentation for the [REDACTED] nurse anesthesia residents took place at [REDACTED] [REDACTED] during a scheduled nurse anesthesia program meeting. The date coincided with didactic lecture and did not pose a scheduling or time conflict. A separate professional presentation was conducted at a tertiary academic medical center in north-central New Jersey during a morning meeting, in an effort to capture the most participation from the unit.

### **Study Population**

Subject participation was divided among cohorts to include nurse anesthesia residents, anesthesia providers and PACU registered nurses. Anesthesia providers include anesthesiologists and certified registered nurse anesthetists. The [REDACTED] nurse anesthesia participants were divided into sections to include year- three, senior residents and year-two, junior residents. The cohorts are numbered based on entry into the nurse anesthesia program and clinical experience. [REDACTED] nurse anesthesia year-three cohort perform full time clinical, whereas the year-two cohort perform in clinical part-time.

### **Subject Recruitment**

A PAED recruitment flyer was developed and distributed to all anesthesia cohorts via [REDACTED] email. Additionally, the recruitment flyer was distributed to all project participants at the tertiary hospital. The pediatric ED flyer included all pertinent information to the study: synopsis overview, objectives, location, date, and time. Please see Appendix H for the project recruitment flyer.

### **Consent Procedure**

Consent for the study was obtained through a written participant agreement. Prior to conducting the pre-test study and scholarly presentation, the authors stated the purpose and objectives of the study, explained the consenting procedures, stated and defined the risks, and answered all questions. All obtained consents were completed on a volunteer basis. There were no personal identifiers on any of the surveys. All information and data obtained were de-identified to provide anonymity. Please refer to consent in Appendix for consent.

### **Risks/Harms**

Every effort was made to minimize and mitigate the physical, psychological, social, economic, and legal risks of this study intervention. No physical risk to include pain, illness, or

injury were brought about by the methods and procedures. The psychological risks of depression, guilt, and altered behavior are negligible. A potential psychological risk exists with the PAED assessment scale. Performing pediatric ED assessments may have placed the project participant at heightened risk for clinical stress and assessment anxiety. No social or economic risks existed that placed the project participant in situations to include loss of relationships, embarrassment, lack of respect, loss of wages, and loss of employment. There were no legal risks associated with this study. There was no collection of sensitive data or protected health information (PHI). All data collection was filled out anonymously.

### **Subject Costs and Compensation**

All subject participants enrolled voluntarily and did not accrue any costs. At no point during the project, were subjects given compensation for participating.

### **Study Interventions**

A pre-test survey was given to each subject participant prior to conducting the pediatric emergence delirium presentation. The pre-test survey consisted of multiple-choice questions pertaining to pediatric ED characteristics, evidence-based treatments, and risk reduction strategies. The pre-test survey was self-administered with closed-ended responses, Likert style questions, and multiple-choice questions. A 20 minute scholarly PowerPoint presentation followed the pre-test survey for all participants. Following the presentation, a post-intervention survey was conducted to evaluate the effectiveness of the pediatric ED presentation. Additionally, at the conclusion of the presentation, the PAED assessment scale badge was given to all project participants. Approximately 30 days after the initial intervention, a follow-up evaluation was performed to capture data on the PAED assessment scale. Allowing 30 days to

elapse provided sufficient exposure to a variety of pediatric surgical cases. The PAED assessment badge reference is attached in Appendix E.

### **Outcomes to be Measured**

One of the primary goals for this quality improvement project was to assess the effectiveness of the PAED scale during the post-anesthetic recovery period. Data collection and analysis was done with a pre-intervention survey to gauge baseline knowledge on pediatric emergence delirium. The pre-intervention survey can be found in Figure 5. Another important outcome was the overall effectiveness of the scholarly presentation on pediatric ED. A post intervention survey on pediatric ED was performed after the presentation. Additionally, a post-posttest survey was performed thirty days after the initial presentation.

Gauging clinical competence improvement was accomplished through a follow up survey thirty days from the pre-test intervention. Specifically, the incidence of pediatric ED and effectiveness of the PAED scale were compared between the [REDACTED] nurse anesthesia residents and registered nurses in the PACU. Equally vital, were the number of times the PAED scale was used to diagnose pediatric ED and if pharmacological interventions were initiated for symptom management. The PAED scale survey can be found in Appendix F.

### **Project Timeline**

The project proposal presentation took place on April 29<sup>th</sup>, 2019. IRB project submission occurred on May 21<sup>st</sup>, 2019 and lasted approximately one month. After obtaining IRB approval, the authors followed the project timeline listed in Appendix G.

### **Resources Needed**

All financial costs and project materials were paid for by the authors. The estimated total costs for the project was budgeted for \$250-300.

## **Evaluation Plan**

### **Data Maintenance**

Data collection was performed through the Qualtrics online survey software. Only the chief investigating authors and project chair had access to the survey questions and outcomes. All surveys and consents were generated and stored securely with the use of Qualtrics database. Data analysis was performed on password-protected computers. Only the authors of the study had access to the data analysis results. The surveys and consents were de-identified and did not include any protected health information. Subject participation is by invitation only from the primary investigators. All survey data and consents were destroyed after initial analysis was completed and professional reporting started.

### **Data Analysis Plan**

Data was analyzed to assess the effectiveness and efficiency of the scholarly PowerPoint presentation and the use of the PAED assessment scale in clinical practice. This was attained with the use of descriptive statistics and categorical variables. Competency levels and confidence levels were assessed with a follow-up survey 30 days from the pre-test intervention. The Qualtrics software securely stored all question responses without any personal identifiers. Additionally, study participants could access the surveys through the use of their personal electronic devices. The survey link was locked to allow only a single response in an effort to prevent ballot box stuffing.

## **Project Findings**

Both senior (n=21) and junior (n=22) [REDACTED] Resident Registered Nurse Anesthetists (RRNA) were surveyed to assess clinical confidence in emergence delirium education, clinical confidence in ability to identify patients at risk, understanding of the PAED scale, understanding

how to use the PAED, understanding of prevention strategies, and understanding of the major defining behaviors of emergence delirium. The senior and junior [REDACTED] RRNA were compared within their perspective groups through pre-test and post-test survey data. Please refer to Appendix F for the specifics of the survey questions. Mean demographics for years of experience among project participants include senior RRNA (7 years), junior RRNA (6 years), CRNA (n=9, 7 years), MDA (n=5, 12 years), and PACU nurses (n= 4, 10 years).

### **Senior RRNA**

A paired samples t-test was utilized to compare means between the pre-survey and post-survey results with significance set at  $p \leq 0.05$ . All survey responses for senior RRNA showed statistically significant improvements. There was significant difference in the scores for understanding the major defining behaviors of emergence delirium pre-survey ( $m=2.82$ ,  $sd=.983$ ) and post survey ( $m=4.34$ ,  $sd=.582$ );  $t(20)=-5.98$ ,  $p=\leq 0.01$ . The same applies to understanding how to use the PAED scale pre-survey ( $m=2.23$ ,  $sd=1.04$ ) and post-survey ( $m=4.42$ ,  $sd=.676$ );  $t(20)=-8.602$ ,  $p=\leq 0.01$ . Lastly, subjects level of emergence delirium prevention improved pre-survey ( $m=2.80$ ,  $sd=.928$ ) and post-survey ( $m=4.47$ ,  $sd=.601$ );  $t(20)=-7.513$ .

Similarly, a positive outcome measure applies to confidence levels with emergence delirium assessment pre-survey ( $m=2.71$ ,  $sd=.845$ ) and post-survey ( $m=4.42$ ,  $sd=.746$ );  $t(20)=-7.44$ ,  $p=\leq 0.01$ . Overall clinical confidence in education of parents improved pre-survey ( $m=2.52$ ,  $sd=.601$ ) and post-survey ( $m=4.33$ ,  $sd=.730$ );  $t(20) = -9.50$ ,  $p=\leq 0.01$ ; along with identifying patients at risk pre-survey ( $m=2.47$ ,  $sd=1.12$ ) and post-survey ( $m=4.33$ ,  $sd=.577$ );  $t(20)=-5.97$ ,  $p=\leq 0.01$  respectively.

### **Junior RRNA**

The above-mentioned improvements can be applied to junior RRNA, but to a much higher degree of significance and certainty. There was significant difference in the scores for understanding the major defining behaviors of emergence delirium pre-survey ( $m=1.69$ ,  $sd=.1.06$ ) and post survey ( $m=4.08$ ,  $sd=.848$ );  $t(21)=-9.03$ ,  $p\leq 0.01$ . The same can be said for participants level of understanding regarding the PAED scale pre-survey ( $m=1.21$ ,  $sd=.421$ ) and post-survey ( $m=4.89.43$ ,  $sd=6.25$ );  $t(21)=-3.2$ ,  $p\leq 0.01$ . Additionally, junior RRNA level of emergence delirium prevention improved pre-survey ( $m=1.30$ ,  $sd=.558$ ) and post-survey ( $m=3.95$ ,  $sd=.824$ );  $t(21)= -13.609$ .

Likewise, confidence levels improved dramatically with participants ability to educate parents pre-survey ( $m=1.26$ ,  $sd=.448$ ) and post-survey ( $m=3.69$ ,  $sd=1.06$ ;  $t(21)= -10.81$ ,  $p\leq 0.01$ ; and identifying patients at risk pre-survey ( $m=1.21$ ,  $sd=.421$ ) and post-survey ( $m=4.08$ ,  $sd=.598$ );  $t(21)= -19.81$ ,  $p\leq 0.01$ .

### **Academic Hospital Participants**

There were similarities in the scores, but no statistical significance among MDAs, CRNAs, and PACU nurses understanding of the major defining behaviors of emergence delirium. The pre-survey ( $m= 4.20, 4.5, 4.25$  and  $sd= .447, .755, 1.50$ ) and the post-survey ( $m= 4.20, 4.50, 4.75$  and  $sd= .447, .534, .500$ ). The same applies to the participants' understanding regarding the use of the PAED scale, with pre-survey ( $m=3.80, 4.50, 3.75$  and  $sd=1.09, .534, 1.89$ ) and post-survey ( $m= 4.40, 4.75, 4.00$  and  $sd= .547, .462, .816$ ). Finally, there was significant improvement in the level of emergence delirium prevention with pre-survey ( $m= 4.00, 4.50, 4.00$  and  $sd=.707, .534, 1.41$ ) and post-survey ( $m= 4.60, 4.87, 4.50$  and  $sd=.547, .353, .577$ ).

### **30-Day Follow-Up Results**



Retention and overall effectiveness of the intervention was assessed through a 30 day follow-up survey aimed at three objectives: did project participants improve clinical confidence with emergence delirium assessment, did understanding of the PAED scale increase, and how likely were participants to use the scale in clinical practice. Clinical confidence levels did improve among senior RRNA ( $m=4.59$ ,  $sd=.503$ ) when compared to junior RRNA ( $m=3.63$ ,  $sd=.657$ );  $t(42)=5.405$ ,  $p\leq 0.01$ . There was no difference between levels of understanding, but it was not statistically significant with senior RRNA ( $m=4.36$ ,  $sd=.657$ ) and junior RRNA ( $m=4.36$ ,  $sd=.581$ );  $t(42)=.000$ ,  $p>0.05$ . Finally, senior RRNA had a higher level of reported PAED application ( $m=4.63$ ,  $sd=.492$ ) when compared to junior RRNA ( $m=3.68$ ,  $sd=.646$ );  $t(42)=5.510$ ,  $p\leq 0.01$ .

### **Project Limitations**

Our survey questions were condensed and consolidated to prevent respondent break-off while accessing mobile devices. This was accomplished by formatting our surveys to increase participant completion rates. It is possible that junior RRNA data was biased due to the fact that this cohort group was not in full-time clinicals nor did they have prior exposure to the pediatric population. Additionally, a 30 day follow-up survey was not completed for participants at the large academic medical institution due to time constraints and participation fatigue from the initial intervention.

### **Economic/Cost Benefit of Project**

Early recognition is essential to mitigate the potentially adverse consequences of pediatric ED. Research into long-term sequela of pediatric emergence delirium is limited, but gaining popularity due to an influx of adverse case reports. One of the major issues with pediatric emergence delirium is underreporting and adaptation of a standardized assessment scale

(Mason, 2017). The PAED scale increases patient safety and therefore, improves overall healthcare. Standardizing assessment allows for prompt medical treatment if situationally necessary. Additionally, the number of negative outcomes and injuries that result from unrecognized and untreated emergence delirium could potentially diminish. Further, negative outcomes from pediatric ED has detrimental impacts on healthcare institutions as pediatric ED can extend length of stay, places an increased burden on human resources, and is associated with short- and long-term morbidity (Snell, 2017). The overall economic and cost-savings benefits would require emergence delirium to be included as vital sign parameter to trend the number of pediatric emergence cases.

### **Impact on Healthcare Quality/Safety**

The optimal effectiveness and longevity of the PAED scale in clinical practice has the potential to manufacture many beneficial outcomes. Adopting a standardized assessment tool improves overall pediatric anesthesia recovery. An often-overlooked component to managing pediatric emergence delirium is parental involvement (Snell, 2017). Incorporating the PAED scale has the potential to decrease parental anxiety and improve parental satisfaction (Mason, 2017; Snell, 2017). Increasing pediatric ED clinical competence enhances quality of care and promotes improved outcomes. Pediatric ED will continue to be clinically significant as anesthetic techniques evolve and the demand for specialized pediatric surgeries grows.

### **Policy Implications**

This project serves as a platform to improve the overall care for pediatric surgical patients through evidence-based interventions. Literature shows that identifying pediatric ED is challenging and providing care to pediatric surgical patients is demanding and highly specialized. Development of the PAED scale into practice will require a change in the standard

of care. Adoption of the assessment tool into practice is paramount to enhancing pediatric health outcomes and increasing pediatric ED awareness. Ultimately, pediatric ED should be included as vital sign parameter and recorded during the post-anesthetic recovery period.

### **Plans for Sustainability and Translation**

In order for the PAED scale to sustain use in practice in the PACU, the authors evaluated outcomes and clinical competence improvement amongst staff with a follow-up survey 30 days from the pre-test intervention.

### **Plans for Dissemination and Professional Reporting**

The plans for dissemination of the DNP project include poster board presentations through the [REDACTED] Anesthesia program and at the state level including New Jersey Association of Nurse Anesthetists annual conference meetings. If there is an opportunity to present at any capacity at the national level, it will be considered as well. Additional reporting will be accomplished through manuscript development and submission to a peer reviewed journal for potential publication.

### **Summary**

Emergence delirium during the post-anesthetic recovery period is a common problem in pediatric anesthesia. Due to its unpredictability and overlapping symptom manifestations of pain, it becomes a challenge for healthcare professionals to accurately identify pediatric ED. Both short-term and long-term negative outcomes associated with pediatric ED are well documented in literature. Authors Ringblom, Wahlin, and Proczkowska (2018) stated that the PAED scale is psychometrically sound with high interrater reliability and is the most used tool in the post-anesthesia period. Despite the reputable research, there still exists a gap in knowledge translation amongst nurses and anesthesia providers in the PACU in properly identifying, treating, and

preventing pediatric emergence delirium. Bridging the knowledge gaps and raising awareness on the topic of pediatric ED is the terminal goal for this DNP project. In an effort to improve pediatric ED clinical competence, our project focused on the application of the PAED to enhance interobserver reliability within the PACU. As a result, we expected positive outcomes including clinical competence improvement amongst anesthesia providers and nurses in the PACU.

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## Appendix A

Table 1

*Table of Evidence*

Article	Date/Author	Evidence Type, Level, & Quality	Study Purpose	Sample, Sample Size, Setting	Study findings that help answer the EBP Question	Limitations/Comments
1	Bonanno, L. S., Pierce, S., Badeaux, J., & FitzSimons, J. J. (2016). Effectiveness of preoperative intranasal dexmedetomidine compared with oral midazolam for the prevention of emergence delirium in pediatric patients undergoing general anesthesia: a systematic review protocol.	Quantitative  Level III/B  Systematic Review Protocol	Determine the effectiveness of preoperative intranasal Precedex compared to oral Versed for the prevention of pediatric ED general anesthesia	N/A  Number of articles found by search not included in publication	-Search strategy aimed to discover published and unpublished studies on pediatric ED  -Search terms were appropriate to EBP question and extensive  -In depth overview of pediatric ED identification, assessment, risk factors, and treatment.  -Quantitative data and pharmacological interventions were supported by evidence	-Inclusion criteria articles were for studies only using the PAED scale  -ASA I and II patients for elective/ambulatory surgery. All healthy participants  -Extremely narrow topic of interest for systematic review  -Only English language published studies used  -Assessed methodological quality of quantitative data  -Did not add new information to the topic of interest; only hypothesized a potential benefit of Precedex versus Midazolam  -3 step approach to Literature Search & Databases used: Medline, CINAHL, Scopus, and ProQuest Dissertations and Theses
2	Costi, D., Ellwood, J., Wallace, A., Ahmed, S., Waring, L., & Cyna, A. (2015). Transition to propofol after sevoflurane anesthesia to prevent emergence agitation: a randomized controlled trial. <i>Paediatric Anaesthesia</i> , 25(5), 517-523. doi:10.1111/pan.12617	Quantitative  Level I/B  Double Blind RCT	Determine whether initiating Propofol 3mg/kg over 3 minutes at the end of Sevoflurane anesthesia would decrease the incidence of pediatric ED	N= 230, 218 children analyzed  Ages: 1-12 (ASA I-II)  MRI scans with Sevoflurane general anesthesia	-ED was assessed by a blind interviewer using the PAED scale and Watcha scale until 30 min after emergence  -ED was assessed at 5-minute intervals with PAED score >12 and Watcha score >3 meeting criteria for ED  -Secondary outcomes gained: peak PAED scores, emergence time, time in	-Small increase in recovery time with Propofol infusion, but no difference in time to discharge home  -Propofol reduces incidence of ED with Sevoflurane and improves the quality of emergence  -Exclusion criteria: allergy to Propofol, family history of MH, performance of any other painful procedure

					<p>PACU, time to hospital discharge</p> <p>-Incidence of ED was lower with Propofol in both assessment scale groups PAED (29% vs. 7%, <math>P&lt;0.001</math>) Watcha (39% v. 15%, <math>P&lt;0.001</math>)</p>	<p>-Utilized LMA and all patients received oral Versed 0.5mg/kg preoperatively</p> <p>-Propofol started prior to completion of procedure could reduce time spent in PACU</p> <p>-Study needs to be replicated in surgical setting to compare/contrast results</p>
3	<p>FitzSimons, J., Bonanno, L. S., Pierce, S., &amp; Badeaux, J. (2017). Effectiveness of preoperative intranasal dexmedetomidine, compared with oral midazolam, for the prevention of emergence delirium in the pediatric patient undergoing general anesthesia: a systematic review.</p>	<p>Quantitative</p> <p>Level III/B</p> <p>Systematic Review</p>	<p>- Determine the effectiveness of preoperative intranasal Precedex compared to oral Versed for the prevention of pediatric ED general anesthesia</p>	<p>74 articles identified</p> <p>0 articles eligible for critical appraisal</p> <p>Keywords: Dexmedetomidine, Emergence delirium, intranasal midazolam, pediatric</p>	<p>-PAED is the only validated scale used specific to the pediatric population</p> <p>-Highest level of sensitivity and specificity for detecting ED is a score <math>&gt;10</math></p> <p>Measured ED as a primary outcome with specific ED assessment scales and revealed a lack of existing literature</p> <p>-Wide range of interventions, administrations routes, and timing of drug administrations presented a challenge for the reviews specific question</p>	<p>- Included reference appendix for excluded studies with a rationale for exclusion</p> <p>-Two independent research reviewers verified search strategy and results</p> <p>-No conclusions can be made comparing Precedex to Versed for pediatric ED prevention due to a lack of evidence</p> <p>-Data extraction and synthesis could not be completed</p> <p>-Systematic review and search strategy could be performed again in the future when present/ongoing studies looking at Precedex and ED prevention have been published</p>
4	<p>Hudek, K. (2009). Emergence delirium: a nursing perspective. <i>Aorn j</i>, 89(3), 509-520. doi:10.1016/j.aorn.2008.12.026</p>	<p>Qualitative</p> <p>Level V/B</p> <p>Case Report and Clinical Experience</p>	<p>-Author conveyed the challenges and issues with nursing care for patients experiencing emergence delirium</p> <p>-Discussed perioperative risk factors, pathogenesis, incidence, and treatment of ED</p>		<p>-Addressed the importance of documenting the presence of ED and the value of including this assessment as a vital sign metric</p> <p>-Highlighted the significance of collaborative assessment efforts among nurses, physicians, and anesthesia providers</p> <p>-Stressed the importance of patient education and having ED talks be included in the patients plan of care</p>	<p>-Authors assessment of agitation was not specific to anesthesia emergence delirium</p> <p>-Provided a comprehensive nursing care plan for patients at risk for ED</p> <p>-The case presentation for pediatric emergence delirium was described/diagnoses as “adverse reaction to anesthesia” and was not related to ED</p>

5	Jang, O. (2017). <i>Efficacy of Two Screen-Based Approaches to Relieving Preoperative Anxiety in Young Children: Preliminary Data</i> . (M.S.), Boston University, Ann Arbor. Retrieved from: ProQuest Dissertations & Theses Global database. (10265539)	Quantitative  Level II/C  Randomized Intervention Trial	-Objective of this study was to determine whether the Bedside Entertainment Theater (BERT) decreased pediatric anxiety prior to general anesthesia more than standard hand-held screens	N= 60 children  Ages 4-10 ASA I & II Non-Emergent Outpatient Surgery	-Secondary outcome assessments were emergence delirium (PAED scale) and post-operative pain (Post-operative Pain Measure)  -Preoperative anxiety is a major risk factor for developing pediatric ED following general anesthesia  -ED increases 10% for every 10-point increase in a child's preoperative anxiety (mYPAS)  -PAED scale was selected because of high inter-observer reliability and reliability  -Mean PAED scale for both intervention groups were 5.2. Each intervention group had >1 reported cases of ED	-ED was diagnosed with PAED score >10  -5 assessment time periods took place: preoperative holding area, entrance to OR, at induction, after emergence, and 1 week follow up  -Primary outcomes measured were preoperative anxiety (modified Yale Preoperative Anxiety Scale), and induction compliance (Induction Compliance Checklist)  -Results do not show difference between the interventions in relieving preoperative anxiety for children undergoing general anesthesia  --Evaluated the efficacy of non-pharmacological interventions. Children receiving oral midazolam were excluded from the study, which is not the standard of care  - No True Control Group  -No Control for: surgery types, anesthesia behavior, and hospital behavior staff
6	Kamienski, M. C., McCartney, M. A., McLoughlin, M., & Pallaria, T. (2018). Pediatric emergence delirium: A case study. <i>Journal of PeriAnesthesia Nursing</i> . doi:10.1016/j.jopan.2018.05.011	Qualitative  Level V/A  Case Report	-Listed risk factors for pediatric ED, discussed evidence-based practice interventions, and reviewed literature conducted on pediatric ED pathogenesis	N/A	-Identified gaps in practice for pediatric ED assessment  -The PAED scale has a positive correlation with clinical judgement scores  -Provided a definition unique to emergence delirium  - Limited data exists but literature suggests a correlation to increased morbidity and mortality associated with ED	-Case study listed in publication was a severe case/representation of pediatric ED  -Few published studies exist looking into long term impacts of pediatric ED  -Discussed anesthetic agent's role in brain development  -Emergence delirium can have significant maladaptive behavior changes following surgery

						-Listed pharmacological and nonpharmacological interventions for pediatric ED
7	Makkar, J. K., Bhatia, N., Bala, I., Dwivedi, D., & Singh, P. M. (2016). A comparison of single dose dexmedetomidine with Propofol for the prevention of emergence delirium after desflurane anesthesia in children. <i>Anaesthesia</i> , 71(1), 50-57. doi:10.1111/anae.13230	Quantitative  Level II/B  Randomized Control Trial	-To determine whether a small dose of either intravenous dexmedetomidine or Propofol given prior to the end of surgery will decrease the incidence of ED in children undergoing infra-umbilical surgery under desflurane anesthesia.	N=100	-Dexmedetomidine given at a dose of 0.3mcg/kg over 5 minutes, 15 minutes before the end of surgery, showed a significance in reduction of ED in children in the post-op phase.	-Discharge time not recorded.
8	Mason, K. P. (2017). Paediatric emergence delirium: a comprehensive review and interpretation of the literature. <i>British Journal of Anaesthesia</i> , 118(3), 335-343. doi:10.1093/bja/aew477	Qualitative  Level V/A  Integrative Review	-To review and analyze published literature on ED in order to have a comprehensive understanding of the factors associated with the incidence of ED.	80 articles		-Search strategy with inclusion and exclusion criteria was not listed, despite having 80 article references  -Methodological quality was not provided
9	Nair, S., & Wolf, A. (2018). Emergence delirium after paediatric anaesthesia: new strategies in avoidance and treatment. <i>BJA Education</i> , 18(1), 30-33. doi:10.1016/j.bjae.2017.07.001	Qualitative  Level V/B	-Understanding the condition of ED, new techniques to decrease incidence, and treatment modalities to resolving ED.	Ireland/Engl and	-The exact mechanism of ED remains elusive.  -Best treatment is a2 agonists and Propofol as single dose.	
10	Ringblom, J., Wahlin, I., & Proczkowska, M. (2018). A psychometric evaluation of the Pediatric Anesthesia Emergence Delirium scale. <i>Paediatric Anaesthesia</i> , 28(4), 332-337. doi: <a href="https://dx.doi.org/10.1111/pan.1334">https://dx.doi.org/10.1111/pan.1334</a>	Quantitative  Level III/B	- With a psychometric approach, to evaluate the PAED scale, and focus on the factor structure.  -To test the reliability of the PAED scale.	N = 122	-One factor solution and satisfactory reliability support the use of the PAED scale in the post-operative period.	-Small choice of keywords utilized.  -Inconsistencies with the cut-off value of the PAED scale.

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11	Rohlik, G.M., Fryer, K.R., Tripathi, S. Duncan, J.M., Coon, H.L., Padhya, D.R., & Kahoud, R.J. (2018). Overcoming barriers to delirium screening in the Pediatric Intensive Care Unit, <i>38</i> (4), 57-67. doi: 10.4037/ccn2018227	Quantitative  Level I/B  RCT	- Identification and recognition of patient specific barriers to delirium assessment in the Pediatric ICU.	-80 randomized patients  -16 bed PICU within a tertiary academic center located in the Midwest.	-Implementation of valid delirium assessment tool like the PAED.  -Search terms were appropriate to EBP question.	- Low number of positive screen results  - Lack of documentation of completed assessments  - Incidences of delirium were not considered reliable due to low compliance rates and poor measures.
12	Rosen, H.D., Mervitz, D., & Cravero, J.P. (2016). Pediatric Emergence Delirium: Canadian Pediatric Anesthesiologists' experience., <i>26</i> (2), 207-12. doi: 10.1111/pan.12812	Qualitative  Level V  Web based survey	- To recognize and determine practice routines from experienced pediatric anesthesiologists on the diagnosis, treatment and prevention of emergence delirium.	-209 participants who had email contact info available from membership with CPAS  -Academic health centers throughout Canada.	-First study geared towards recognizing practice patterns in prevention and treatment of ED from experienced clinicians.	- Significant response bias between responders and nonresponses along with the specific wording of questions.  -The desired population had a lack of randomized sampling.  -Small selection of keywords  -Authors suggest further studies to focus on defining the term emergence delirium.
13	Sikich, N. & Lerman, J. (2004). Development and psychometric evaluation of the pediatric anesthesia emergence delirium, <i>100</i> (5), 1138-45.	Qualitative  Level V	- Five hypotheses were utilized to predict validity of the PAED scale to minimize measurement error in the assessment of ED.	-21 of 27 scale items were considered valid, only 5 items became the scale (comprised of 100 children: 56 males, 44 females).  - Canada	-Internal consistency of the PAED scale was 0.89.  -PAED scale is a reliable tool based on the scale's reliability and validity to measure ED in children.  - Scale evaluation testing the reliability of the PAED scale was tested in 46 out of 50 children.	-Adjectives used for the response questions were not specifically defined.
14	Somai, M., Engelhardt, T., Fumagalli, R., & Ingelmo, P. M. (2016). Emergence delirium or pain after anaesthesia-- how to distinguish between the two in	Quantitative  Level III/B  Retrospective Chart Review	-Identification of individual observation domains of several scales including PAED, FLACC, CHIPP, and CHEOPS, and	N = 512 (children) and total of 2048 evaluations.  - Canada	-Children with ED demonstrated 'no eye contact' and 'no awareness of surroundings;' the correlation with these two characteristics had a high sensitivity to identify ED	-This study being a retrospective analysis of 3 different prospective observational studies.  -Risk factors of ED were not described efficiently.

	young children: a retrospective analysis of observational studies. <i>British Journal of Anaesthesia</i> , 116(3), 377-383. doi:10.1093/bja/aev552		deciphering between ED and pain.		during the first 15 min after awakening.	
15	Stamper, M. J., Hawks, S. J., Taicher, B. M., Bonta, J., & Brandon, D. H. (2014). Identifying pediatric emergence delirium by using the PAED Scale: a quality improvement project. <i>Aorn j</i> , 99(4), 480-494. doi:10.1016/j.aorn.2013.08.019	Qualitative  Level V/B  Quality Improvement Project	- To identify Pediatric ED by implementing and evaluating the PAED compared to the RASS scale in the children's PACU.  -To assess if patient characteristics were a key determinant in the development of Pediatric ED during the implementation period.	N = 400 (200 from retrospective and 200 from implementation period).  -In an eight bed PACU within a 928- bed academic hospital in southeastern U.S.	-PAED scale is a more sensitive assessment of Pediatric ED after general anesthesia.  -Only 3% of patients experienced ED during the study time period.	

## Appendix B

## Medline Search Strategy

<input type="checkbox"/>	# ▲	Searches
<input type="checkbox"/>	1	exp Child/
<input type="checkbox"/>	2	exp Infant/
<input type="checkbox"/>	3	(child or children or infant? or baby or babies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
<input type="checkbox"/>	4	exp Adolescent/
<input type="checkbox"/>	5	adolescen*.mp.
<input type="checkbox"/>	6	exp Young Adult/
<input type="checkbox"/>	7	youth?.mp.
<input type="checkbox"/>	8	1 or 2 or 3 or 4 or 5 or 6 or 7
<input type="checkbox"/>	9	exp Delirium/di [Diagnosis]
<input type="checkbox"/>	10	exp Emergence Delirium/
<input type="checkbox"/>	11	pediatric delirium.mp.
<input type="checkbox"/>	12	emergence agitation.mp.
<input type="checkbox"/>	13	exp Confusion/
<input type="checkbox"/>	14	emergence excitement.mp.
<input type="checkbox"/>	15	9 or 10 or 11 or 12 or 13 or 14
<input type="checkbox"/>	16	emergence delirium scale.mp.
<input type="checkbox"/>	17	delirium diagnostic tool.mp.
<input type="checkbox"/>	18	PAED.mp.
<input type="checkbox"/>	19	pediatric anesthesia emergence delirium scale.mp.
<input type="checkbox"/>	20	exp Anesthesia Recovery Period/
<input type="checkbox"/>	21	PAED scale.mp.
<input type="checkbox"/>	22	16 or 17 or 18 or 19 or 20 or 21
<input type="checkbox"/>	23	8 and 15 and 22
<input type="checkbox"/>	24	limit 23 to english language
<input type="checkbox"/>	25	limit 24 to yr="2008 -Current"

*Figure 1.* Medline search strategy and associated terminology used for article inclusion



## Appendix C

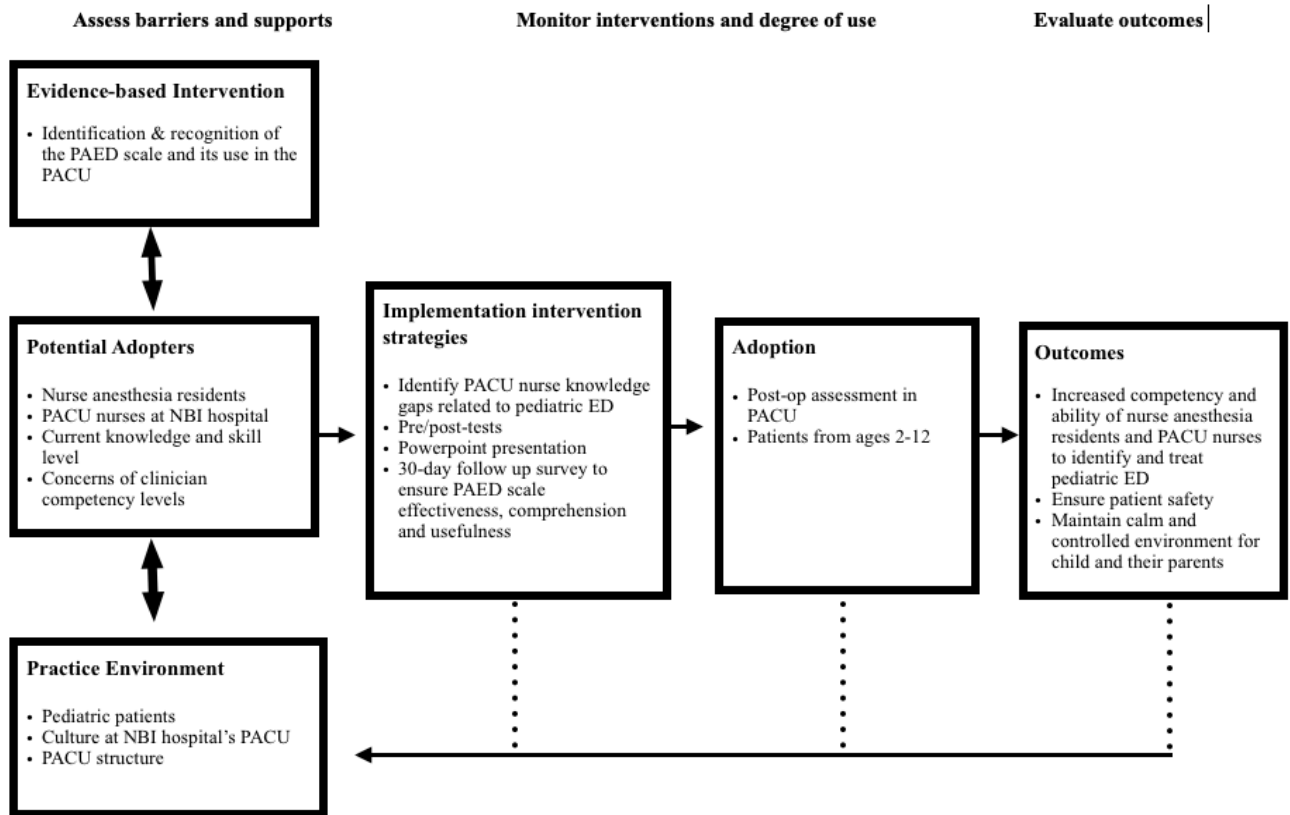
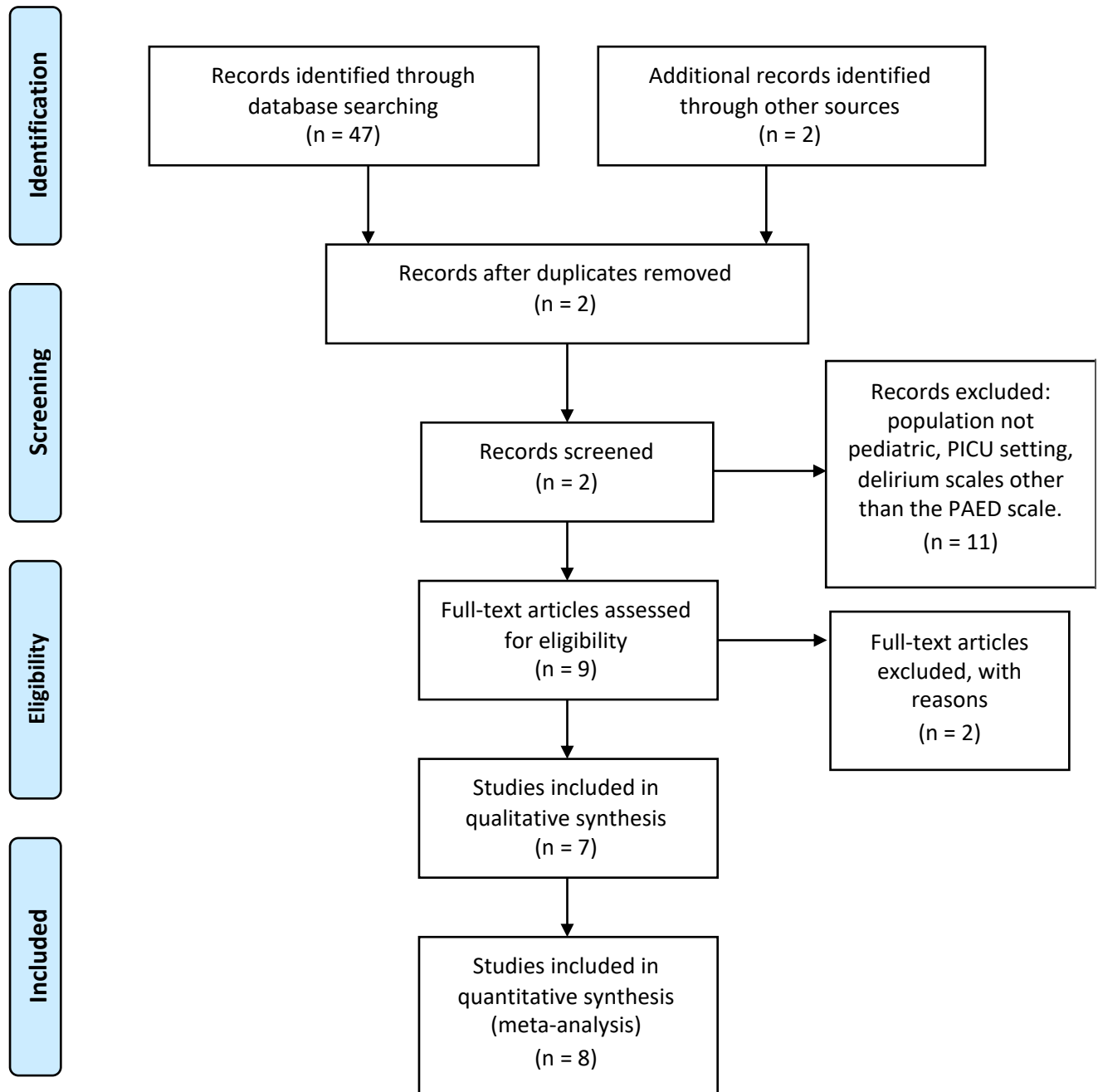


Figure 2. Ottawa Conceptual Model created from Hogan, D. L., & Logan, J. (2004). The Ottawa Model of Research Use. *Clinical Nurse Specialist*, 18(5), 255-261.

doi:10.1097/00002800-200409000-00010

## Appendix D

*Figure 3.* PRISMA Diagram with article breakdown

## Appendix E

Emergence Delirium and Agitation in Children		UpToDate 2019
<p><b>Pre-Op Prevention</b></p> <p><b>Fentanyl Intra-Nasal</b> single dose (0.5-1mcg/kg)</p> <p><b>Midazolam P.O.</b> single dose (0.5 mg/kg)</p> <p><b>Precedex Intra-Nasal</b> 30-60 minutes prior to induction ( 1-2 mcg/kg)</p> <p><b>Intra-Op Prevention</b></p> <p><b>Propofol IV</b> single dose at the end of anesthesia (1mg/kg)</p> <p><b>Fentanyl IV</b> single dose near the end of surgery (1mcg/kg)</p> <p><b>Precedex IV</b> single dose during emergence (0.3 mcg/kg)</p> <p><b>Treatment of Acute Episodes</b></p> <p>Propofol 1mg/kg IV</p> <p>Midazolam 0.1mg/kg IV</p> <p>Fentanyl 1-2 mcg/kg IV or other opioid</p> <p>Parental Presence</p>		<p><b>Differential Diagnosis</b></p> <p>Pain</p> <p>Hypoxia</p> <p>Hypotension</p> <p>Hypocarbica</p> <p>Hypercarbica</p> <p>Hypothermia</p> <p>Hypoglycemia</p> <p>Increased ICP</p>

Emergence Delirium and Agitation in Children		UpToDate 2019
<p><b>Pre-Op Prevention</b></p> <p><b>Fentanyl Intra-Nasal</b> single dose (0.5-1mcg/kg)</p> <p><b>Midazolam P.O.</b> single dose (0.5 mg/kg)</p> <p><b>Precedex Intra-Nasal</b> 30-60 minutes prior to induction ( 1-2 mcg/kg)</p> <p><b>Intra-Op Prevention</b></p> <p><b>Propofol IV</b> single dose at the end of anesthesia (1mg/kg)</p> <p><b>Fentanyl IV</b> single dose near the end of surgery (1mcg/kg)</p> <p><b>Precedex IV</b> single dose during emergence (0.3 mcg/kg)</p> <p><b>Treatment of Acute Episodes</b></p> <p>Propofol 1mg/kg IV</p> <p>Midazolam 0.1mg/kg IV</p> <p>Fentanyl 1-2 mcg/kg IV or other opioid</p> <p>Parental Presence</p>		<p><b>Differential Diagnosis</b></p> <p>Pain</p> <p>Hypoxia</p> <p>Hypotension</p> <p>Hypocarbica</p> <p>Hypercarbica</p> <p>Hypothermia</p> <p>Hypoglycemia</p> <p>Increased ICP</p>

Figure 4. PAED Scale Badge Reference. The original scale appeared in Sikich, N., & Lerman, J. (2004). Development and psychometric evaluation of the pediatric anesthesia emergence delirium scale. *Anesthesiology*, 100(5), 1138-1145.

## Appendix F

Figure 5  
Pre & Post Intervention Survey



Rutgers School of Nursing  
Stanley S. Bergen Building  
Rutgers, The State University of New Jersey  
65 Bergen Street  
Newark, NJ 07101-1700

Pre-Test Intervention

**Application of the Pediatric Anesthesia Emergence Delirium Scale to Enhance Recognition in the PACU**

Please answer the following questions by filling out and/or circling the most appropriate answer

Number of years' experience as a Nurse			
Cohort	D2.	D3	D4
Indicate if you've completed ANST6009 Pediatric Anesthesia	Yes	No	
<p>Which patient is at highest risk for Emergence Delirium?</p> <p>a. 3 y/o female under General Anesthesia with Sevoflurane after MRI</p> <p>b. 4 y/o male under General Anesthesia with Sevoflurane after T &amp; A</p> <p>c. 5 y/o female under General Anesthesia with Total Intravenous Anesthesia after hernia repair</p> <p>d. 12 y/o male under General Anesthesia with Desflurane after elbow ORIF</p>			
<p>Which medication when given in the preoperative setting is most effective for decreasing the incidence of pediatric emergence delirium?</p> <p>a. Midazolam PO 0.5 mg/kg</p> <p>b. Propofol IVP 0.5 mg/kg</p> <p>c. Fentanyl IVP 1 mcg/kg</p> <p>d. Dexmedetomidine Intranasal 1mcg/kg</p>			
<p>A distinction between postoperative pain and emergence delirium is that emergence delirium will exhibit?</p> <p>a. No awareness of surrounding</p> <p>b. Crying</p> <p>c. Facial grimacing</p> <p>d. Marked tachycardia</p>			

## Appendix F

*Figure 5*  
*Pre & Post Intervention Survey*

**I understand the major defining behaviors linked to pediatric emergence delirium**

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
-------------------	----------	---------	-------	----------------

**I feel confident in my clinical ability to assess for pediatric emergence delirium**

Not at all confident	Slightly confident	Moderately confident	Quite confident	Extremely confident
----------------------	--------------------	----------------------	-----------------	---------------------

**I feel confident in my ability to educate parents about pediatric emergence delirium**

Not at all confident	Slightly confident	Moderately confident	Quite confident	Extremely confident
----------------------	--------------------	----------------------	-----------------	---------------------

**I understand how to use the Pediatric Anesthesia Emergence Delirium Scale**

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
-------------------	----------	---------	-------	----------------

**I feel confident in my ability to identify patients at risk for emergence delirium**

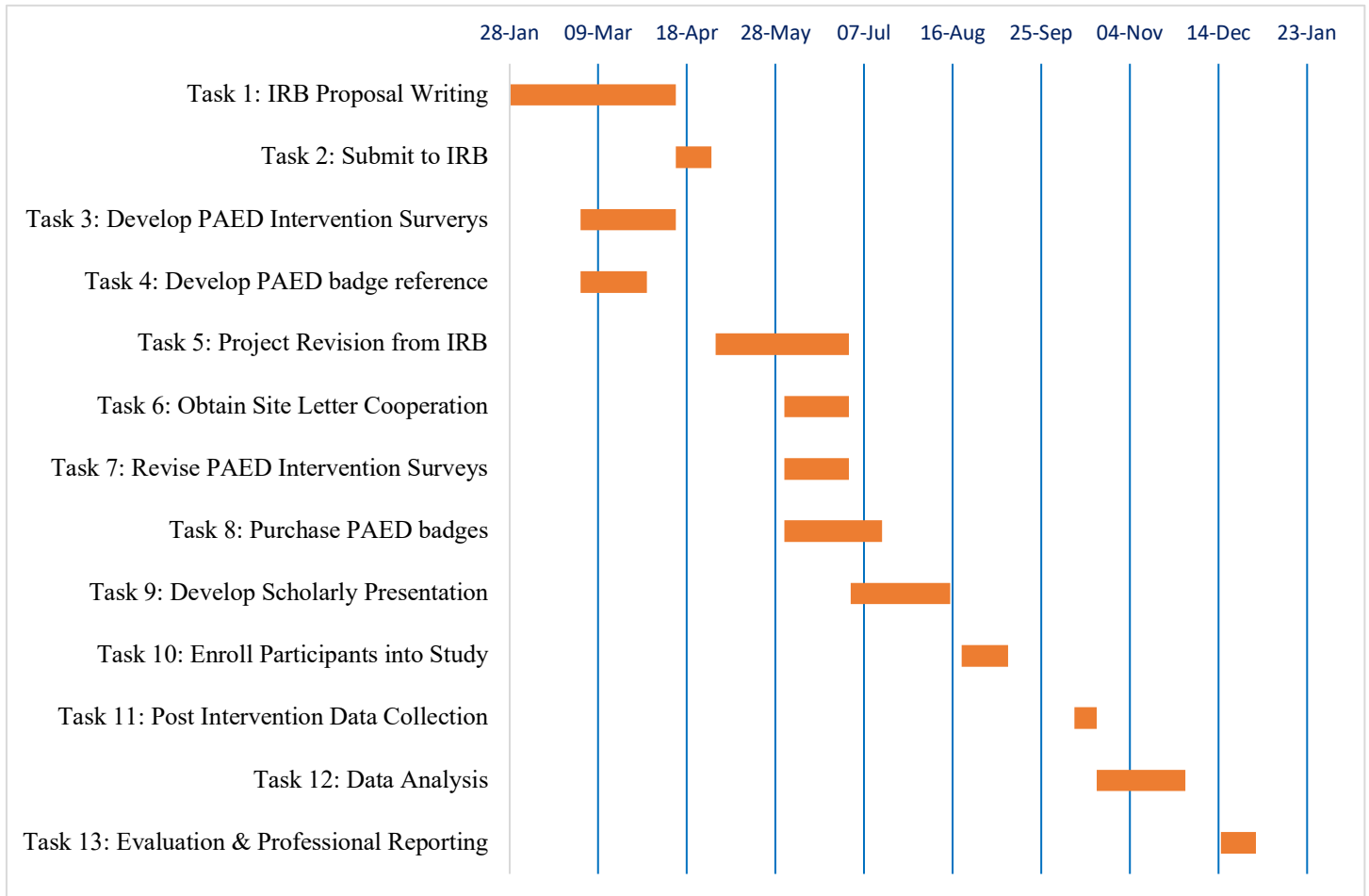
Not at all confident	Slightly confident	Moderately confident	Quite confident	Extremely confident
----------------------	--------------------	----------------------	-----------------	---------------------

**I understand prevention strategies for decrease pediatric emergence delirium**

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
-------------------	----------	---------	-------	----------------


## Appendix G

Table 2

*Project Timeline*

## Appendix H

## Recruitment Flyer




# RUTGERS

School of Nursing

## Improving Recognition and Assessment of Pediatric Emergence Delirium

We Invite You to Participate in Our Voluntary Study Investigating



### Pediatric Emergence Delirium



**Purpose:** Applying the Pediatric Anesthesia Emergence Delirium Scale in Clinical Practice

**Objectives:**

- 1) Expand Pediatric Emergence Delirium Assessment
- 2) Assess Attitudes and Beliefs Towards Emergence Delirium
- 3) Identify Knowledge Gaps About Pediatric Emergence Delirium
- 4) Provide PAED Scale Reference Badge to All Participants



**Where:** [REDACTED]

**Date & Time:** July 12<sup>th</sup>, 2019 at 8am



**Principal Investigators:**

Jedd Dillman  
[REDACTED]  
Matthew DiCioco  
[REDACTED]

Behavior	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
Incomprehensible	0	1	2	3	4

1 – Calm, 2 – Not calm but could be easily soothed, 3 – Moderately agitated or restless and not easily soothed, 4 – combative, excited, thrashing around

Overall Score >12 = Indicative of Pediatric Emergence Delirium

RESERVED FOR IRB APPROVAL STAMP

Version #1    Version Date: 4/1/2019

Rutgers, The State University of New Jersey