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

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Abstract

Pediatric emergence delirium is a prevalent, distinctive postoperative phenomenon following general anesthesia in infants and children. Due to its unpredictability and distressing presentation, pediatric emergence delirium requires prompt recognition and accurate identification. The Pediatric Anesthesia Emergence Delirium (PAED) scale is a validated assessment tool with high sensitivity and specificity. Unfortunately, the PAED scale is under-utilized and current literature shows that pediatric emergence delirium assessment is not consistently performed by anesthesia providers and PACU nurses. Using principles of the Ottawa model of research, the aim of this quality improvement project was to improve pediatric emergence delirium assessment among interprofessional healthcare providers. This multiple cohort project incorporated a scholarly presentation, pretest, posttest, and post-posttest intervention survey to evaluate the clinicians understanding of emergence delirium and assess self-reported competency of the PAED assessment scale in the clinical setting. All survey responses for second year RRNA and third year [redacted] Resident Nurse Anesthetists showed statistical improvements for understanding signs and symptoms ($m=2.82$, $m=4.43$, $p<0.01$), use of the PAED scale ($m=2.23$, $m=4.42$, $p<0.01$), and confidence with assessment skills ($m=1.21$, $m=4.08$, $p<0.01$).

Keywords: emergence delirium, emergence agitation, pediatric emergence delirium, pediatric anesthesia emergence delirium, pediatric emergence delirium assessment

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 19th 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. The objectives and aims for this quality improvement projective were based on the criteria listed below:

- 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 59 results; however, only 39 articles met the inclusion criteria. Please refer to Appendix D for the Prisma Review of Literature Table.

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 Remifentanil 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 deliriogenic 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 than12; 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. Please refer to Appendix C for the depiction of the Ottawa Concept Model.

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 at a large tertiary academic hospital in northern New Jersey. 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] campus 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. A power analysis based on the review of literature and pilot studies conducted on the PAED scale indicated sufficient validity with n>50 project participants. The total project participants was n=62.

Subject Recruitment

A PAED recruitment flyer was developed and distributed to all anesthesia cohorts via [redacted] email with assistance from the program assistant. Additionally, the recruitment flyer was distributed to all potential 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 I 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. Please refer to Appendix F for the pre and post intervention survey. 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 on third year and second year RRNA to capture data on the PAED assessment scale. The PAED assessment badge reference is attached in Appendix E.

Outcomes 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 Appendix F. 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 29th, 2019. IRB project submission occurred on May 21st, 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 total cost for the project was $230.

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. All project surveys are stored in a locked filing cabinet in room 1104 on the 11th floor of the [redacted] Building.

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 third year (n=21) and second year (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. Mean demographics for years of experience among project participants include third year RRNA (n= 21,7 years), second RRNA (n=22, 6 years), CRNA (n=9, 7 years), MDA (n=5, 12 years), and PACU nurses (n= 4, 10 years).

Third year 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=≤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=≤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=≤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=≤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=≤0.01 respectively.

Second Year 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=≤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=≤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=≤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=≤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. The project intervention was completed over the span of 60 days to include the implementation and collection of data. Project participant and increased result variability would've improved by performing the intervention on multiple consecutive days; however this did not happen.

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.

Discussion

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.

Implications for Clinical Practice

Our project results are supported by literature to justify the application of the PAED scale into hospital policy for pediatric patients. Increased clinical competency amongst a population that requires unique assessment skills improves overall care. This quality improvement project is feasible, easily re-created and warranted by countless studies. The PAED scale allows users to recognize signs and symptoms of post-operative delirium faster with a higher degree clinical certainty.

Implications for Education

Emergence delirium continues to be ever evolving with updates in current evidenced-based practice. This project's foundation is based upon the most current interventions and assessments; despite there not being a standardized practice to prevent pediatric emergence delirium. Above all else, this quality improvement project was effective in increasing participants overall knowledge of pediatric emergence delirium. This project has potential to not only benefit the [redacted] Nurse Anesthesia Program, but also the profession of nurse anesthetists as a whole.

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 the RRNA cohorts with a follow-up survey 30 days from the pre-test intervention. This quality improvement project serves a benchmark intervention for future doctoral nurse anesthesia residents. The concepts and principles of this project can be reconstructed to further advance pediatric anesthesia services.

Plans for Future Scholarship

The plans for dissemination of the DNP project include poster board presentations through the Rutgers University Anesthesia program and at the state level including New Jersey Association of Nurse Anesthetists annual conference meeting. 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 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, CINHAL, 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. *Paediatric Anaesthesia*, *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 PACU, time to hospital discharge	-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 ant other painful procedure -Utilized LMA and all patients received oral Versed 0.5mg/kg preoperatively

					-Incidence of ED was lower with Propofol in both assessment scale groups PAED (29% vs. 7%, P<0.001) Watcha (39% v. 15%, P<0.001)	-Propofol started prior to completion of procedure could reduce time spent in PACU -Study needs to be replicated in surgical setting to compare/contrast results
3	FitzSimons, J., Bonanno, L. S., Pierce, S., & 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.	Quantitative Level III/B Systematic Review	- Determine the effectiveness of preoperative intranasal Precedex compared to oral Versed for the prevention of pediatric ED general anesthesia	74 articles identified 0 articles eligible for critical appraisal Keywords: Dexmedetomidine, Emergence delirium, intranasal midazolam, pediatric	-PAED is the only validated scale used specific to the pediatric population -Highest level of sensitivity and specificity for detecting ED is a score >10 Measured ED as a primary outcome with specific ED assessment scales and revealed a lack of existing literature -Wide range of interventions, administrations routes, and timing of drug administrations presented a challenge for the reviews specific question	- Included reference appendix for excluded studies with a rationale for exclusion -Two independent research reviewers verified search strategy and results -No conclusions can be made comparing Precedex to Versed for pediatric ED prevention due to a lack of evidence -Data extraction and synthesis could not be completed -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
4	Hudek, K. (2009). Emergence delirium: a nursing perspective. *Aorn j, 89*(3), 509-520. doi:10.1016/j.aorn.2008.12.026	Qualitative Level V/B Case Report and Clinical Experience	-Author conveyed the challenges and issues with nursing care for patients experiencing emergence delirium -Discussed perioperative risk factors, pathogenesis, incidence, and treatment of ED		-Addressed the importance of documenting the presence of ED and the value of including this assessment as a vital sign metric -Highlighted the significance of collaborative assessment efforts among nurses, physicians, and anesthesia providers -Stressed the importance of patient education and having ED talks be included in the patients plan of care	-Authors assessment of agitation was not specific to anesthesia emergence delirium -Provided a comprehensive nursing care plan for patients at risk for ED -The case presentation for pediatric emergence delirium was described/diagnoses as “adverse reaction to anesthesia” and was not related to ED
5	Jang, O. (2017). *Efficacy of Two*	Quantitative	-Objective of this study was to	N= 60 children	-Secondary outcome assessments were	-ED was diagnosed with PAED score >10

	Screen-Based Approaches to Relieving Preoperative Anxiety in Young Children: Preliminary Data. (M.S.), Boston University, Ann Arbor. Retrieved from: ProQuest Dissertations & Theses Global database. (10265539)	Level II/C Randomized Intervention Trial	determine whether the Bedside Entertainment Theater (BERT) decreased pediatric anxiety prior to general anesthesia more than standard hand-held screens	Ages 4-10 ASA I & II Non-Emergent Outpatient Surgery	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	-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. *Journal of PeriAnesthesia Nursing*. 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 sever 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

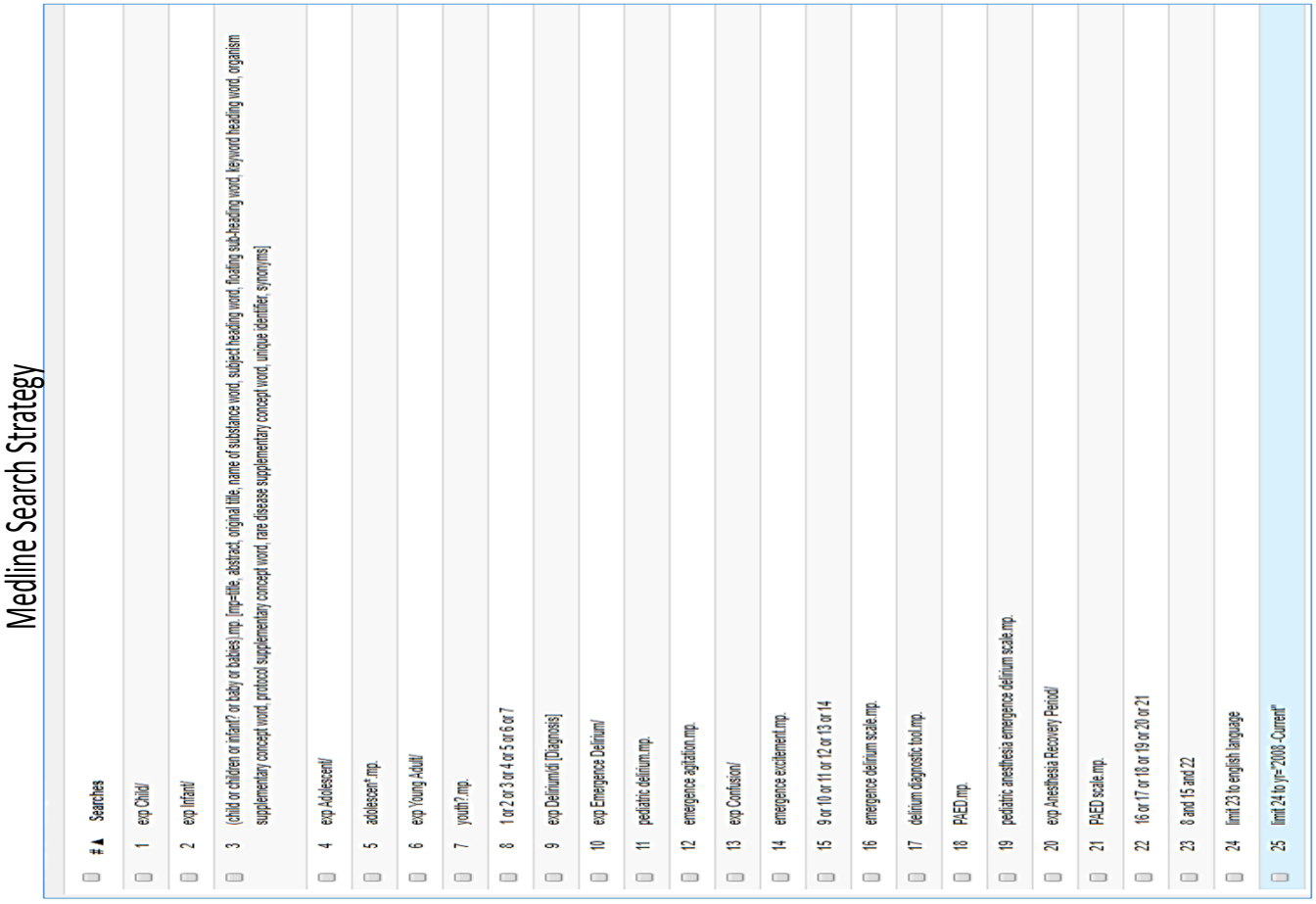
						interventions for pediatric ED
7	Makkar, J. K., Bhatia, N., Bala, I., Dwivedi, D., & Singh, P. M. (2016). A comparison of single dose dexmedetomidine with Propofol for the prevention of emergence delirium after desflurane anesthesia in children. *Anaesthesia, 71*(1), 50-57. doi:10.1111/anae.13230	Quantitative 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. *British Journal of Anaesthesia, 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. *BJA Education, 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/England	-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. *Paediatric Anaesthesia, 28*(4), 332-337. doi:https://dx.doi.org/10.1111/pan.13348	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.

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, *38(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., *26(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, *100(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	Somaini, M., Engelhardt, T., Fumagalli, R., & Ingelmo, P. M. (2016). Emergence delirium or pain after anaesthesia--how to distinguish between the two in young children: a retrospective analysis of	Quantitative Level III/B Retrospective Chart Review	-Identification of individual observation domains of several scales including PAED, FLACC, CHIPP, and CHEOPS, and deciphering between ED and pain.	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 during the first 15 min after awakening.	-This study being a retrospective analysis of 3 different prospective observational studies. -Risk factors of ED were not described efficiently.

	observational studies. *British Journal of Anaesthesia, 116*(3), 377-383. doi:10.1093/bja/aev552					
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. *Aorn j, 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.	

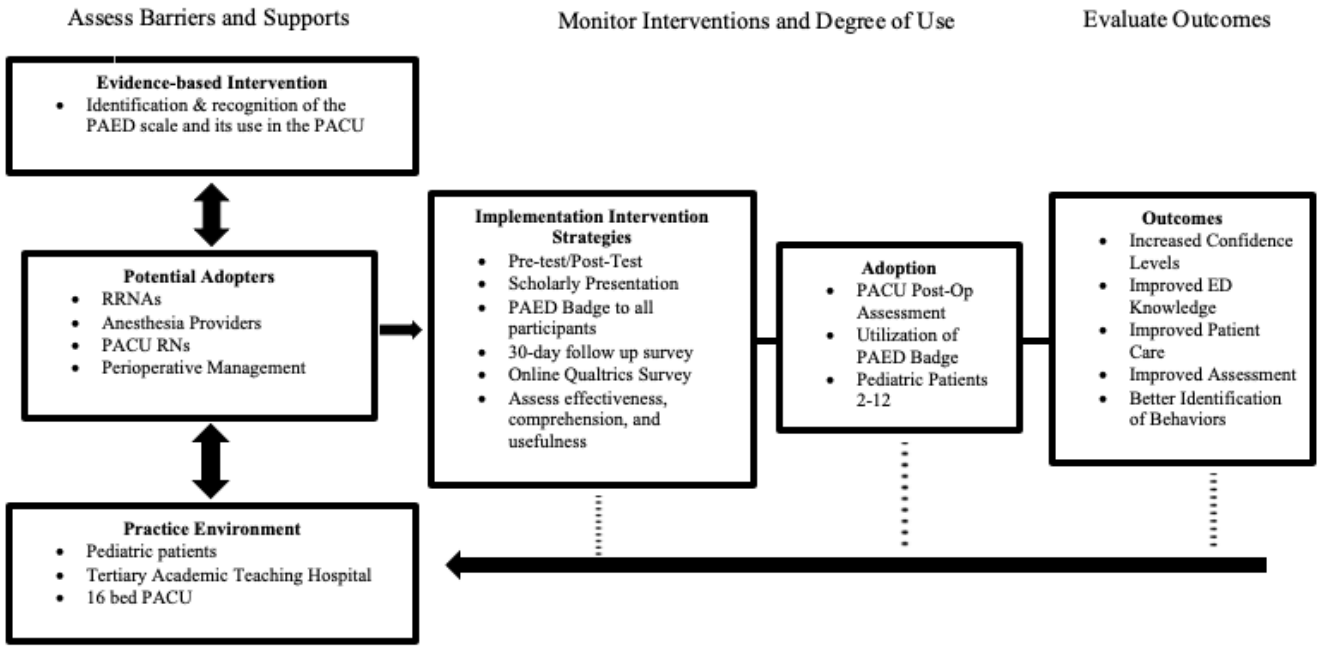
Appendix B

Medline Search Strategy



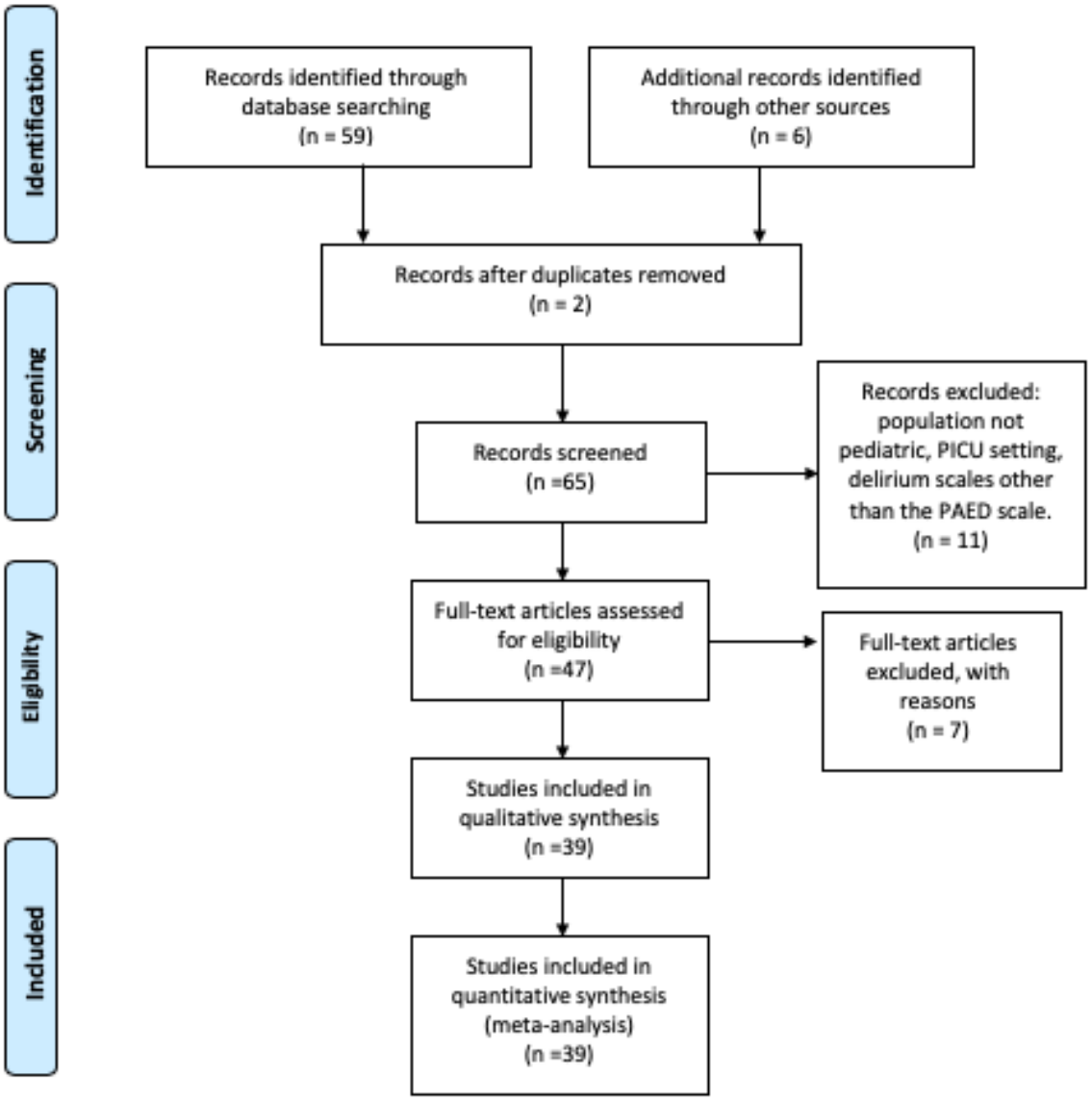
Appendix C

Ottawa Concept Model



Appendix D

Prisma Table for Review of Literature



Appendix E

PAED Scale Badge Reference.

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

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

[redacted]

Appendix F

Pre & Post Intervention Survey

RUTGERS

Rutgers School of Nursing
Stanley S. Bergen Building
Rutgers, The State University of New Jersey
65 Bergen Street
Newark, NJ 07101-1709

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**

Which patient is at highest risk for Emergence Delirium?

a. 3 y/o female under General Anesthesia with Sevoflurane after MRI
b. 4 y/o male under General Anesthesia with Sevoflurane after T & A
c. 5 y/o female under General Anesthesia with Total Intravenous Anesthesia after hernia repair
d. 12 y/o male under General Anesthesia with Desflurane after elbow ORIF

Which medication when given in the preoperative setting is most effective for decreasing the incidence of pediatric emergence delirium?

a. Midazolam PO 0.5 mg/kg
b. Propofol IVP 0.5 mg/kg
c. Fentanyl IVP 1 mcg/kg
d. Dexmedetomidine Intranasal 1mcg/kg

A distinction between postoperative pain and emergence delirium is that emergence delirium will exhibit?

a. No awareness of surrounding
b. Crying
c. Facial grimacing
d. Marked tachycardia

[redacted]

Appendix F

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

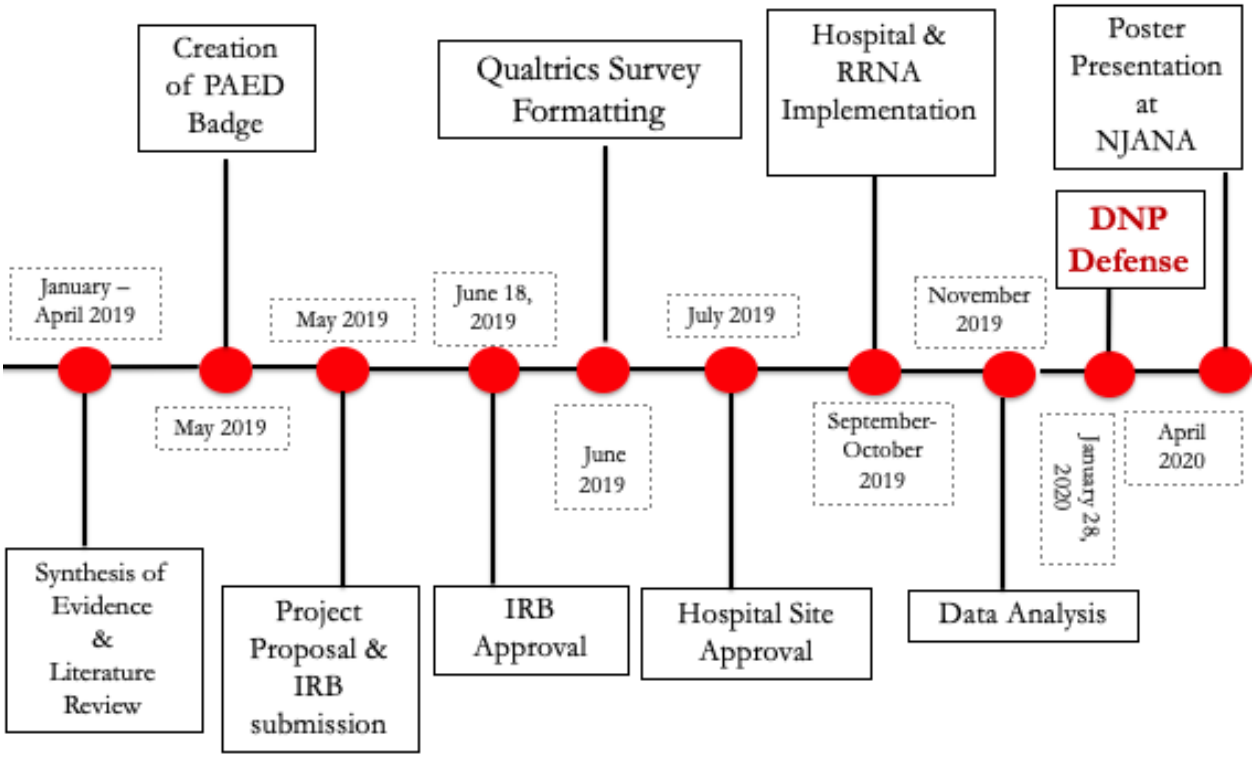
I understand prevention strategies for decrease pediatric emergence delirium

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

[redacted]

Appendix G

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 12th, 2019 at 8am

Pediatric Anesthesia Emergence Delirium Scale *Lerman et. al. (2006)*

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 surrounding	4	3	2	1	0
Restless	0	1	2	3	4
Inconsolable	0	1	2	3	4

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

Overall Score >12 = Indicative of Pediatric Emergence Delirium

Principal Investigators:

Jedd Dillman [redacted]
Matthew DiCicco [redacted]

Version #1 Version Date: 4/1/2019

RESERVED FOR IRB APPROVAL STAMP [redacted]

Rutgers, The State University of New Jersey

Appendix I

Consent

TITLE OF STUDY: Application of the Pediatric Anesthesia Emergence Delirium Scale to Enhance Recognition in the PACU

Time and Location:
Monday, September 9th (D3 and D4 Cohort)
[redacted]

Study Investigators:
Jedd Dillman
[redacted]
Matthew DiCicco
[redacted]

This consent form is part of an informed consent process for a research study and it will provide information that will help you decide whether you want to take part in this study. It is your choice to take part or not. If you take part in the research, you will be asked to fill out a pre-education survey and then listen to a 15-minute PowerPoint presentation. Your time in the study will take no more than 20 minutes. There are no legal, physical, social risks or any burdens by agreeing to be apart in the study. Your alternative to taking part in the research study is not to answer the questions and not to take part in the survey responses. You are not giving up any of your legal rights by agreeing to take part in this research or by signing this consent form.

Who is conducting this research study?
Jedd Dillman and Matthew DiCicco are the Principal Investigators of this research study. A Principal Investigator has the overall responsibility for the conduct of the research. The purpose of this study is to determine whether the application of the PAED scale enhances interobserver reliability within the PACU among healthcare providers.

Why have I been asked to take part in this study?
You are invited to participate in this study because of your clinical experience with anesthesia and postoperative care of pediatric patients.

How long will the study take and how many subjects will take part?
The number of participants will account for [redacted] nurse anesthesia residents, CRNAs, MDAs, and PACU RNs. The duration of time is approximately 20 minutes for the participants. A 30 day follow up post education survey will be asked to be filled out by participants which should only take 3 minutes. The overall length of time of the study is approximately 2 months.

What will I be asked to do if I take part in this study?
Take a pre-education survey on pediatric emergence delirium, then patiently listen to a 15-minute presentation on pediatric emergence delirium. A 30 day follow up post-education survey will be filled out

assessing the clinical competence of the clinicians. The PAED scale badge reference will be issued to all study participants.

What are the risks and/or discomforts I might experience if I take part in this study?
Breach of confidentiality is a risk of harm but a data security plan is in place to mitigate this risk. There are no physical, economic or social harms/risks, no collection of sensitive data or use of personal identifiers, and no costs or legal risks related to this study. A potential psychological risk exists with the PAED assessment scale. Performing pediatric emergence delirium assessments may place the study participant at heightened risk for clinical stress and assessment anxiety.

Are there any benefits to me if I choose to take part in this study?
You will be contributing to knowledge about pediatric anesthesia; however, it is possible that you may not receive any direct benefit from taking part in this study.

What are my alternatives if I do not want to take part in this study?
There are no alternative treatments available. Your alternative is not to take part in this study.

Will there be any cost to me to take part in this study?
There are no costs associated with this study.

Will I be paid to take part in this study?
You will not be paid to take part in this study.

How will information about me be kept private or confidential?
All efforts will be made to keep your personal information in your research record confidential, but total confidentiality cannot be guaranteed. There are no personal identifiers or collection of sensitive data in this study. Only the chief investigating authors and project chair will have access the survey outcomes. Data analysis will be performed on password protected computers. Only the authors of the study will have access to the data analysis results. The surveys and consents are de-identified and do not include any protected health information. Responses may be converted to paper copies and stored in a locked cabinet in the office of our faculty advisor, Dr. McLaughlin ([redacted]). All survey responses and consents will be destroyed after data analysis and professional reporting is underway.

What will happen to my information collected for this research after the study is over?
Responses may be used or distributed to investigators for other research without obtaining additional informed consent from you.

What will happen if I do not wish to take part in the study or if I later decide not to stay in the study?
It is your choice whether to take part in the research. You may choose to take part, not to take part or you may change your mind and withdraw from the study at any time. If you do not want to enter the study or decide to stop taking part, your relationship with the study staff will not change, and you may do so without penalty and without loss of benefits to which you are otherwise entitled

Who may use, share or receive my information?
The research team may use or share your information collected or created for this study with the following people and institutions:

· [redacted] Investigators involved in the study
· [redacted] personnel to communicate information necessary for health care operations.
· The Rutgers University Institutional Review Board and Compliance Boards

Who can I contact if I have questions?
If you have questions about taking part in this study, you can contact the investigators listed at the top of page. You can also contact our faculty advisor, Dr. Michael McLaughlin DNP, CRNA/APN at [redacted] or via email at [redacted]

If you have questions about your rights as a research subject, you can call the Newark Health Sciences IRB Director at 973-972-3608 or the Rutgers Human Subjects Protection Program at 973-972-1149

How long will my permission last?
Your permission for the use and sharing of your information will last until May 2020.
A copy of this consent can be made available upon request

By beginning this research, you acknowledge that you have read the information and agree to take part in the research, with the knowledge that you are free to withdraw your participation without penalty.