Reducing Anesthesia Use for Pediatric Magnetic Resonance Imaging: The Effects of a Patient- and Family-Centered Intervention on Image Quality, Health-care Costs, and Operational Efficiency

Kari A. Mastro, PhD, RN, NEA-BC
Vice President & Chief Nursing Officer

Linda Flynn PhD, RN, FAAN; Toni F. Millar MS, CCLS;
Tina M. DiMartino, MS, MBA, CCLS; Sarah M. Ryan, MS; Mark H. Stein, MD
(Research Team)
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Presentation Outline

1. Background & Significance
2. The Problem & Gap
3. Literature Review & Conceptual Framework
4. Operational Definitions & Research Questions
5. Methods & Sample
6. Results of Research Question Testing
7. Policy & Practice Implication
Pediatric Population Statistics

- National statistics indicate that there are 73.6 million children in the U.S. of which 9.6 million of those children between the ages of 5-17 years are reported to have activity limitations related to one or more health conditions.

Radiological Imaging Advancement

- Diagnostic imaging technology has advanced over the past 15 years with MRI as a preferred diagnostic modality for children.
  - Benefits – reduced exposure to radiation.
  - Cons – Children must stay still for long periods of time as such, anesthesia is used.
- It is estimated that the growth of anesthesia use for children requiring MRI in the U.S. is 7-8%/year.
Risks & Side Effects of Anesthesia

- There are physiological and biological risks & side effects of anesthesia associated with the pharmacological agents.
- Most concerning is the effect of anesthesia on the developing brain.
- Animal studies exploring the effects of anesthesia on the developing brain have shown dramatic negative effects on the neurodevelopment early in life and subsequent learning performance issues.
- There have been a few retrospective studies using large data sets of children, which have retrospectively explored associations between exposure to anesthetics for surgical intervention, academic aptitude scores and other bio-behavioral challenges such as attention disorders.
Patient- and Family Centered Care (PFCC)

- It is believed that partnering with the patient and family leads to better patient outcomes.
- Nationally, there is significant interest and funding for patient-centered research.
- While strategies to reduce or minimize the side effects associated with anesthesia in MRI are robust in the empirical literature, research evaluating the effectiveness of strategies in reducing the need for anesthesia in children requiring MRI and associated outcomes are limited.
The Problem

- It is believed that a child must be sedated in order to remain still so as to obtain a magnetic resonance image that is deemed good enough to interpret.

- The emerging literature provides evidence that caution must be taken when deciding whether or not to use an anesthetic agent in children whose brains are still developing.
The Gap

- Despite an emphasis to implement PFCC across all areas of pediatric care, at the time of this study there was no published research in the U.S. that explored the use of a comprehensive multimodal PFCC approach to reducing anesthesia use during pediatric magnetic resonance imaging procedures (MRI).
Conceptual Framework

Mastro, et al. (2014) synthesized the existing Patient- and Family Centered Care literature and developed a parsimonious theoretical model of PFCC. The model proposes sequenced phases of partnership development in PFCC, as well as propositional statements regarding the associations between PFCC and outcomes.

The Problem Statement

What are the effects of a Patient-and Family-Centered Non-Anesthesia Preparation (PFC-NP) Intervention for pediatric MRI on the magnetic resonance image quality, healthcare costs and operational efficiencies such as procedural time?
Operational Definitions

Patient- and Family-Centered Non-Anesthesia Preparation Intervention

- Three Main Activities

  1. **PFCC approach** in that caregiver consultation conducted by a CCLS with the parent (or parent & child) prior to or on the day of a visit to determine their interest in pursuing a non-anesthesia alternative.

  2. **Pre-MRI preparation session** for the PFC-NP Intervention child. (iPad, medical play, mock MRI, MRI goggles, parent presence)

  3. **Personalized interventions** and support during the MRI procedure.
Operational Definitions

**Magnetic Resonance Image Quality**
- 5-point Likert-type rating scale
  1. excellent quality & no motion artifact
  2. good quality & little motion artifact
  3. acceptable quality & moderate motion artifact
  4. poor quality & excessive motion artifact
  5. The child was unable to complete the MRI

**Hospital Costs**
- Medication charge + facility charge

**Procedural Time**
- When the patient entered the MRI room to when the patient exited the MRI room.
Research Questions

1. For patients who received the Patient- and Family-Centered Non-Anesthesia Preparation (PFC-NP) intervention, what percentage of patients have magnetic resonance images that are of acceptable to excellent quality?

2. Is there a difference in quality of magnetic resonance images between children who received the PFC-NP Intervention compared to those who received (a) Standard Care Anesthesia, (b) CCLS Preparation for Anesthesia, (c) No Preparation & No Anesthesia?
Research Questions

3. Does the PFC-NP intervention for MRI reduce **hospital costs** as compared to those who patients received:
   - (a) Standard Care Anesthesia,
   - (b) CCLS Preparation for Anesthesia,
   - (c) No Preparation & No Anesthesia?

4. Does the PFC-NP intervention reduce **procedural turn around time** as compared to patients who received:
   - (a) Standard Care Anesthesia,
   - (b) CCLS Preparation for Anesthesia,
   - (c) No Preparation & No Anesthesia?
Methods

Setting
A major metropolitan quaternary pediatric hospital located within an academic medical center in the northeast region of the U.S.

Sampling Method
This quasi-experimental designed study exploring retrospective data from all children chronologically ages 3 through 17 who underwent MRI from January 2015 through September 2016.

Power Analysis
Six Predictor Model-moderate effect size of $R^2 = 0.15$, desired statistical power level of 0.8, probability level of $\alpha=0.05$, which indicated a sample size of 84 for each group. **Final Sample: 125 encounters/group (500 total encounters)**

Exclusion Criteria
Non-English speaking children
Children under age 3 and older than age 17
Any hospitalized patient receiving a MRI
Sample Characteristics

- Nearest-neighbor matching, with logistic regression distance, was performed using the “MatchIt” R package v3.0.1. to create equal-size, covariate-balanced between groups, according to age, gender, ethnicity, prior MRI experience, and type of body part scanned.

- Age = Mean 10.67 (SD 4.08)
- Gender (Female) = 41.9%
- No prior experience with MRI = 82.8%
- 1 MRI per encounter = 74.7%
- Body Area (head) = 50.2%
Adjusted Models

Adjusted Model

- **Quality of MRI** - The 6 variables were found to have statistically significantly low to moderate correlation. (age, gender, diagnosis, body area of MRI, number of magnetic resonance images per encounter, & prior experience)

- **Healthcare Cost** - The 6 variables were found to have statistically significantly low to moderate correlation. (age, gender, diagnosis, body area of MRI, number of magnetic resonance images per encounter, & prior experience)

- **Procedural Time** - The 5 variables were found to have statistically significantly low to moderate correlation. (age, gender, diagnosis, body area of MRI, & number of magnetic resonance images per encounter)
Results of Research Question Testing

Research Question #1:

96.8% of the children in the intervention group had adequate-excellent scan quality.
Results of Research Question Testing

Research Question #2:

PFC-NP Intervention group as compared to Standard Care & Anesthesia group

- Statistically lower quality of magnetic resonance images with a 0.418/unit decrease ($\beta = 0.118$, $p = .0005$)
- Statistically lower healthcare costs by $1,848.90$ per encounter ($\beta = -.304$, $p = .0005$)
- Statistically shorter procedural times by 35.81 minutes (95% CI: 26.06 to 45.50 minutes) ($p < .001$)
Research Question #3:

PFC-NP Intervention as compared to CCLS preparation for Anesthesia group

- Statistically lower quality of magnetic resonance images with a 0.492/unit decrease ($\beta = 0.139, p = .0005$)
- Statistically lower healthcare cost by $1663.03$ per encounter ($\beta = -0.274, p = .0005$)
- Statistically shorter procedural times by 23.61 minutes (95% CI: 13.67 to 33.53 minutes) ($p < .001$)
Results of Research Question Testing

Research Question #4:

PFC-NP Intervention as compared to No Preparation & No Anesthesia group

- No statistical difference in quality of scan ($p = 0.123$); healthcare costs ($p = .055$); procedural time ($p = .467$).

- While the PFC-NP costs slightly more than no preparation at all, the results suggest that the PFC-NP Intervention is an alternative option to Anesthesia for MRI.
Policy & Practice Implications

• The historical reason for the practice of using anesthesia was to ensure the child remain still in order to obtain a MRI with high enough quality for interpretation however, the results of this study brings this standard practice under scrutiny.

• This study supports that healthcare providers should no longer assume that young patients need anesthesia to remain still enough to obtain a high quality magnetic resonance image.

• The results suggest that the PFC-NP Intervention should be considered as an acceptable option in practice for parents, radiologists and other providers when determining the safest, most cost effective and efficient method in obtaining a MRI.

• Most importantly, the quality of an overwhelming number of the magnetic resonance images for those children who received the intervention were found to have acceptable to excellent image quality.

• Findings from this study support the Conceptual Model of PFCC
THANK YOU!