ASSOCIATIONS BETWEEN WEIGHT STATUS AND POST-TONSILLECTOMY PAIN EXPERIENCES IN CHILDREN: A RETROSPECTIVE STUDY

by

SHIRLEY SMITH MARTIN

DISSERTATION

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Supervising Committee:

Lauri D. John, Supervising Professor
Daisha J. Cipher
Renee C. B. Manworren

DEDICATION

I am very grateful for the support and encouragement of my family, as I have spent many hours working on graduate school leading up to this research study. Thanks to my parents for always believing the best of me. My husband Wayne has inspired me with countless intellectually challenging conversations. My daughters Emily and Maggie and son-in-law Jason were fellow students as we were all launching onto new pathways. I have enjoyed this shared journey with you. I am thankful for my many family members who valued education and set an example by obtaining graduate degrees. You set the bar high for me.

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Finally, this is dedicated to the children and their parents who trust us to take good care of them during surgery. May we as caregivers be deserving of this honor and may we be ever mindful of the need to find better ways to decrease suffering and promote healing.

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LIST OF FIGURES

Figure		Page
1	PTP factors in OB/OW children……..	8
2	Serial photography of tonsillectomy healing process……..	21
3	Time elapsed until pain controlled……...	56
4	Data collection form……	93-104
5	Wong-Baker FACES® Pain Rating Scale……	106
6	Enrollment and data collection process……...	109

LIST OF TABLES

Table		Page
1	Definitions of OB/OW……..	25
2	Recommended medication dosing for critically ill OB/OW children…….	30
3	Description of entire sample…….	51
4	Description of sample (continuous variables) ……	52
5	Description of sample by weight group …….	53
6	Average Equianalgesic Doses and Weight-controlled doses in OR and PACU……	53
7	Test of predictors of early moderate-to-severe PTP…….	54
8	Mean and median time elapsed until pain controlled……...	55
9	Comparison to similar populations……...	58
10	Comparison of sample to Texas and United States populations…….....	60

LIST OF ABBREVIATIONS

ASA…….	American Society of Anesthesiologists
BMI…….	Body Mass Index
CDC……..	Centers for Disease Control and Prevention
CRP……..	C-reactive protein
FLACC…….	Faces, Legs, Activity, Crying, & Consolability pain scale
IOM……	Institute of Medicine
OB/OW……..	Obese or Overweight
OSA……	Obstructive Sleep Apnea
PTP…….	Post-tonsillectomy pain
TNF-α……	Tumor necrosis factor alpha
VNS……	Verbal numeric pain scale
WBF……	Wong-Baker FACES® pain scale

ABSTRACT

ASSOCIATIONS BETWEEN WEIGHT STATUS AND POST-TONSILLECTOMY PAIN EXPERIENCES IN CHILDREN: A RETROSPECTIVE STUDY

Shirley Smith Martin, Ph.D.

The University of Texas at Arlington, 2016

Supervising Professors: Lauri D. John, Daisha J. Cipher, Renee C. B. Manworren

There has been little research on pain outcomes in obese and overweight (OB/OW) children undergoing surgery. Tonsillectomy or adenotonsillectomy (T&A) is one of the most common painful surgeries performed in children. The estimated number of OB/OW children undergoing T&A each year approaches 200,000. Post-tonsillectomy pain (PTP) management after surgery is complicated by potential for airway obstruction or altered drug metabolism in OB/OW children. The purpose of this study was to examine associations between weight status and PTP outcomes in the PACU. A retrospective correlational cohort design was used. Data were obtained from 180 electronic health records of children who had T&A or tonsillectomy in 2016 at a pediatric medical center in north Texas. Weight status did not significantly increase the odds of experiencing early PTP (adjusted OR = 1.391, $p = 0.369$). OB/OW status was associated with significantly longer episodes of uncontrolled PTP ($r_s(178) = 0.16$, $p = 0.03$). This is the first research report indicating that weight status in children may be associated with increased sustained pain across time. Based on these findings, it is recommended that clinicians

consider greater use of non-opioid medications and soothing factors to lower pain. Education of clinicians should include content about increased risk for uncontrolled PTP, drug metabolism in OB/OW individuals, and alternative methods to reduce pain. Future research is needed to determine if there are other factors such as severity of obstructive sleep apnea or genetic identifiers that could predict risk for uncontrolled PTP. Research-based guidelines for adjusted drug calculations in OB/OW children undergoing T&A are needed. Development of pain assessment tools with increased sensitivity and practical application in the PACU could improve the ability to detect differences in pain outcomes of children. Clinically relevant screening tools could be helpful in assessment of OB/OW children for pain-related risks when undergoing T&A.

TABLE OF CONTENTS

Acknowledgements……. iv

List of Figures……. v

List of Tables…….. vi

List of Abbreviations…….. vii

Abstract…….. viii

Chapters

Chapter 1…… 1

Chapter 2…… 15

Chapter 3…… 33

Chapter 4…… 50

Chapter 5…… 57

Appendices……. 92

References…….. 73

CHAPTER 1

Associations Between Weight Status and Post-Tonsillectomy Pain Experiences in Children: Introduction

The following introduction provides support for a study that examined possible associations between obese and overweight (OB/OW) status and greater post-tonsillectomy pain (PTP) in children. Prevalence of OB/OW in children undergoing tonsillectomy is discussed in the context of the relationship between obesity, obstructive sleep apnea (OSA), and tonsillectomy. Further examination of PTP in OB/OW children, the tonsillectomy procedure, and pain management in children undergoing tonsillectomy helps illuminate the need for research in the area of pain management with OB/OW children. Gaps in knowledge that may influence nurses' practice of pain management in the post anesthesia care unit (PACU) are discussed. A physiological framework is described that depicts factors associated with PTP in OB/OW children. The purpose of doing a study examining OB/OW and PTP in children is identified. Hypotheses and assumptions are detailed.

Background and Significance

Significance

Pediatric tonsillectomy in the United States. Tonsillectomy with or without adenoidectomy is performed on approximately 580,000 children under the age of 15 each year in the United States (Boss, Marsteller, & Simon, 2012). The tonsillectomy procedure, usually performed under general anesthesia, requires excision of the tonsils and control of bleeding in the remaining tissue bed (Baugh et al., 2011; Isaacson, 2014).

As obesity rates have increased in the United States and indications for tonsillectomy have shifted, rates of OB/OW children undergoing tonsillectomy have also increased. The

prevalence of OB/OW children undergoing tonsillectomy was reported in one study as being between 35-38% (Nafiu, Shanks, Abdo, & Tremper, 2013), matching the overall trends for increased OB/OW in children in the United States (Centers for Disease Control and Prevention [CDC], 2015a).

The national prevalence of OB/OW children undergoing tonsillectomy is unknown, and researchers do not always use consistent definitions of OB/OW. Researchers most commonly use a definition of OB/OW that includes body mass index (BMI), gender, and age specific parameters (CDC, 2015b). OW children are those at or above the 85th percentile compared to same gender peers in their age range. Children are considered OB with BMI scores that fall at or above the 95th percentile at the same age and gender. BMI is calculated by dividing weight in kilograms by the square of a person's height in meters (CDC, 2015b; Kuczmarski et al., 2002). BMI calculations can be converted into z-scores for use in research to provide a meaningful score with reference to a same age and gender population (Kuczmarski et al., 2002).

OB/OW children have higher rates of OSA (Bhattacharjee et al., 2010), which places them at increased risk of requiring tonsillectomy. OSA is now the leading reason to perform tonsillectomy. This is a change in practice from the 1970s when most tonsillectomies were performed to treat chronic throat infections (Erickson, Larson, Sauver, Meverden, & Orvidas, 2009; Parker & Walner, 2011). OSA has been defined as upper airway resistance (partial or complete) blocking air exchange during sleep (Bhattacharjee, Kim, Kheirandish-Gozal, & Goza, 2011). Researchers estimate that OSA in the tonsillectomy population ranges from 19.5% (Nafiu, Shanks, et al., 2013) to 61% (Tweedie et al., 2012). Prevalence of OSA in the pediatric tonsillectomy population is highest in children who are OB (Bhattacharjee et al., 2010), likely

due to increased fat accumulation in a parapharyngeal fat pad that can cause obstruction of the airway leading to OSA (Jang et al., 2014).

Researchers have found evidence of a strong relationship between OSA, asthma, obesity, and gastroesophageal reflux because of overlapping physiological processes; this relationship between comorbidities is important to consider in the tonsillectomy population (Bhattacharjee, Choi, Gozal, & Mokhlesi, 2014). Asthma occurs in 8% of children in Texas and 9% of children in the United States (Annie E. Casey Foundation, 2016). Population estimates are not available for prevalence of asthma in the tonsillectomy population, but researchers in one study found that 22.1% of children in the sample (N = 462) had asthma (Nafiu, Shanks, et al., 2013). Prevalence of pediatric gastroesophageal reflux disease in the United States is unknown (El-Serag, Sweet, Winchester, & Dent, 2014), but individual studies have yielded estimates in children ranging from 1.5% (Koebnick et al., 2014) to 7.2% (Nelson, Chen, Syniar, & Christoffel, 2000).

Challenges in PTP management with OB/OW children. OB/OW children experience increased risks associated with pain management for tonsillectomy (Cote, Posner, & Domino, 2014) such as lengthier hospitalizations (Nafiu et al., 2009; Tait, Voepel-Lewis, Burke, Kostrzewa, & Lewis, 2008), higher rates of laryngospasm (Nafiu, Prasad, & Chimbira, 2013), and apnea (Brown & Brouillette, 2014; Cote et al., 2014). These increased PTP management risks are problematic for OB/OW children because tonsillectomy produces moderate-severe pain in at least two-thirds of children (Hadden, Burke, Skotcher, & Voepel-Lewis, 2011). Uncertainty exists about calculation of optimal opioid doses in OB/OW children because clinicians calculate medication dosages using a combination of weight and age parameters, which may result in delivery of adult level dosages to children (Institute of Medicine [IOM], 2011; Ross et al., 2015).

Additional considerations must be made for OB/OW children undergoing tonsillectomy because the amount of body fat present affects metabolism of medications (Ross et al., 2015).

Background

PTP in OB/OW Children. The connection between obesity and higher postoperative pain in adults has been explored extensively, but PTP in OB/OW children has been examined in only two research studies (Nafiu, Shanks, et al., 2013; Scalford et al., 2013). Nafiu, Shanks, et al. (2013) found high BMI to be an independent predictor of early moderate-to-severe PTP in the immediate postoperative period ($p < .001$). In contrast, Scalford et al. (2013) did not find a difference in pain scores by weight in children in the PACU. The relationship between OB/OW and PTP in children is complicated by higher rates of OSA in OB/OW children and the possibility of increased analgesic sensitivity to opiates related to OSA (Brown, Laferrière, Lakheeram, & Moss, 2006).

Mechanisms in PTP. The underlying mechanisms of PTP are poorly understood, but a number of possible factors have been proposed that include physical, cognitive, and emotional triggers for pain. Some of the pain prompts may arise from a trigger of pain fibers during chewing and swallowing (Hanafiah, Potparic, & Fernandez, 2008), release of inflammatory mediators, spasm of pharyngeal muscles (Isaacson, 2014), and neural plasticity (Reichling & Levine, 2009). Previous pain and life experiences may put some children at increased risk for pain (Melzack, 2005). Underlying levels of anxiety also contribute to a child's pain experience (Broekman et al., 2010; Kain, Mayes, Caldwell-Andrews, Karas, & McClain, 2006).

Factors that influence PTP are inter-related. The immune system initiates the healing processes after tonsillectomy, at the same time contributing to pain via localized swelling. Tonsillectomy creates a wound in mucosal tissue that may take up to two weeks to heal

(Isaacson, 2012, 2014; Sutters & Isaacson, 2014). PTP occurs simultaneously with fibrin clot accumulation and inflammation and disappears when complete healing occurs (Isaacson, 2012, 2014). Pressure on nearby pain receptors occurs from swollen tissues in the pharynx. Motion from chewing and swallowing applies extra pressure on swollen areas in the throat (Isaacson, 2014). Pain receptors transmit pain signals to the brain in a process called nociception (Fenton, Shih, & Zolton, 2015; Loeser, 2000). Tonsillectomy pain is believed to be associated with transmission of pain signals via C-fibers (Turhan et al., 2015). C-fibers cause a prolonged burning pain (Fenton et al., 2015). Mucosal healing processes include localized neutrophil infiltration and increases in cytokines, which may contribute to both healing and pain (Clark et al., 2007; Khan, 2008). Neural plasticity plays a role in the amount of pain and the length of the pain experience. Neural plasticity refers to the process where afferent nociceptive nerve fibers, aggravated by acute inflammatory insult (e.g., tonsillectomy), in turn trigger long-lasting hypersensitivity of nociceptors to inflammatory cytokines (Reichling & Levine, 2009).

PTP management. Nurses and physicians manage initial pain of tonsillectomy with intravenous analgesics such as morphine or fentanyl (Hadden et al., 2011) but do not have clinical guidelines for PTP management for OB/OW children. In the PACU, it is possible that OB/OW children could have higher pain initially upon waking, and it is also possible that these children could have pain that is more intractable. Opioid medications may carry extra risks, including death, for certain populations of children due to genetic variations (Isaacson, 2013). OB/OW children have increased risk of experiencing post-tonsillectomy airway obstruction (Nafiu, Prasad, & Chimbira, 2013). PACU nurses who serve at the frontline to prevent and treat PTP (Pop, Manworren, Guzzetta, & Hynan, 2007; Sutters & Isaacson, 2014) may hesitate to treat

pain aggressively due to concerns about respiratory distress in OB/OW children (Nafiu, Shanks, et al., 2013).

Opioid use in OB/OW children. Medication doses in children are primarily determined based on measures of their height and weight, but there still remains a scarcity of evidence to support appropriate dosing of medications in children, particularly in OB/OW children (Ross et al., 2015). Ross and colleagues (2015) identified and evaluated 113 medications that are commonly used in critically ill OB children across the United States. Ross et al. developed a decision support tool to guide medication use in OB children. The decision support tool provides a guide for medication calculations in OB children. This tool has not been studied in OB/OW children undergoing tonsillectomy but could provide a helpful springboard for such research.

Research Problems

There are numerous problems encountered with PTP in OB/OW children, but two unanswered questions formed the basis for inquiry in the proposed study. It is unknown if OB/OW is associated with greater post-tonsillectomy pain in children in the PACU. It is also unknown if OB/OW in childhood is a risk factor for difficult to control PTP in the PACU.

Framework

PTP Framework for OB/OW Children

There are no current pain theories that explain the PTP experience of OB/OW children. Obesity has been associated with uncontrolled acute pain in adults (Liu et al., 2012, Mei et al., 2010, Nunez et al., 2007), but only two studies (Nafiu, Shanks, et al., 2013; Scalford et al., 2013) were found in which researchers explored the relationship between obesity and acute PTP in children.

Framework. This study used a multifactorial physiological model based on a framework by McVinnie (2013) to examine associations between PTP and OB/OW in children. McVinnie created a model to be used to explain the relationship between obesity and chronic pain in adults. According to McVinnie, obesity can cause pain, and multiple factors are involved in a relationship between obesity and pain. Among the contributing factors in the development of chronic pain are the proinflammatory state of obesity, genetics, the sedentary lifestyle, depression, and mechanical stresses. Only the proinflammatory state, genetics, and mechanical stresses from McVinnie's model have application in the examination of relationships between obesity and the relatively short-term experience of PTP in children.

The following pain model (Figure 1) incorporates factors influencing PTP in OB/OW children post-tonsillectomy, mediating factors, and an explanation of how the mediating factors may have an impact on intensity of PTP in OB/OW children. Factors promoting pain in OB/OW children include the pro-inflammatory state of excess body fat, mechanical stressors, and the surgical insult of the tonsillectomy or adenotonsillectomy (T&A). Mediating factors include clinician delivered analgesics, genetic variations in drug metabolism, and soothing factors. This model helps explain how the state of OB/OW in a child could produce greater PTP than would occur in a normal weight peer.

Figure 1. PTP factors in OB/OW children

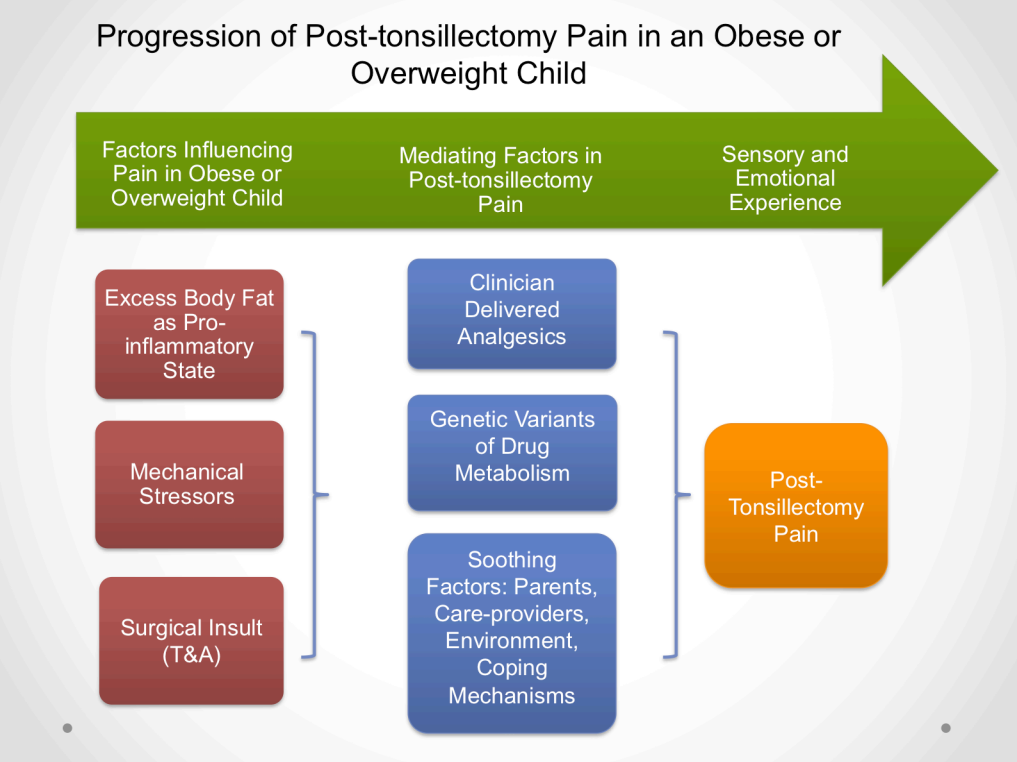


Figure 1. PTP factors in OB/OW children depicts factors that promote pain, factors that mediate pain, and the effect of mediators on pain outcomes.

Factors Influencing PTP in the OB/OW Child. Factors influencing PTP in the OB/OW child include excess body fat as the proinflammatory state, mechanical stressors, and the surgical insult of the T&A. The modifiable factor would be excess body fat. A decrease in excess body fat would decrease the inflammatory state and decrease mechanical stressors. A decrease in excess body fat might also make changes to the mediating factor of genetic variants of drug metabolism.

Excess body fat as a proinflammatory state. Numerous researchers have explored the relationship between inflammatory markers and obesity (Lloret-Linares et al., 2011; McVinnie, 2013; Motaghedi et al., 2013; Okifuji, Bradshaw, & Olson, 2009; Okifuji & Hare, 2015). Pro-inflammatory cytokines have been linked to the hyperalgesic state and increased sensation of

pain (Watkins, Maier, & Goehler, 1995). Currently there are more theories about how inflammatory cytokines promote pain than there is actual evidence that supports this connection between obesity, pain, and cytokines (McVinnie, 2013). As McVinnie (2013) explained, OB patients have higher levels of the inflammatory markers interleukin 6 (IL-6), tumor necrosis factor α (TNF-α), and C-reactive protein (CRP). In conjunction with these higher levels of inflammatory markers, an OB person will have a higher amount of adipocytes than normal or underweight individuals. Adipocytes store energy and also secrete adipocytokines including IL-6, TNF-α, and leptin. IL-6 and other inflammatory cytokines trigger release of CRP in the liver. The adipocytokine monocyte chemoattractant protein 1 (MCP-1) causes monocytes to travel to fat tissue and initiates localized release of other inflammatory cytokines, further increasing IL-6 and TNF-α.

Mechanical Stressors. Increased mechanical stressors in OB individuals have been implicated in risk for increased pain (McVinnie, 2013). Often researchers refer to mechanical stressors on bones and joints, but in children undergoing tonsillectomy, obesity creates a different type of mechanical stressor. According to Jang et al. (2014), OB children may have increased fat accumulation in a parapharyngeal fat pad that can cause obstruction of the airway leading to OSA. This parapharyngeal fat pad may cause mechanical pressure on pain receptors in the swollen pharyngeal tissue after surgery. In addition, more surface area is involved in chewing and swallowing in OB children than normal weight children.

Mediating Factors in PTP in the OB/OW Child. Mediating factors in PTP in OB/OW children include clinician delivered analgesics, genetic variants of drug metabolism, and soothing factors. Many of the mediating factors are difficult to measure or control. It is well known that patients have different sensitivities to pain that may be genetically mediated;

however, tests of genetic variability are not routinely used. Likewise, there are no measurement tools to examine weight-based differences in eating analgesia between OB/OW children and normal weight children. It is likely that the mediating factors in PTP have some interactions. For example, a clinician may deliver an analgesic by titration and decrease the planned amount of medication delivered after seeing a child have a greater response to the medication than anticipated. An increased use of soothing factors in a setting could mean that clinicians would use smaller doses of analgesics.

Clinician delivered analgesics. Nurses and physicians manage initial pain of tonsillectomy with intravenous analgesics such as morphine or fentanyl (Hadden et al., 2011). Medications may be delivered first to the child under anesthesia prior to waking. Nurses in the PACU may continue to manage pain with sliding scale doses based on pain scores (Scalford et al., 2013). Combination analgesic management (e.g., combination of morphine and oxycodone), rather than use of one analgesic alone is commonly used in the PACU to manage PTP as children are transitioned from intravenous pain management to oral pain management (Scalford et al., 2013).

Medication doses in children are primarily determined based on measures of their weight, but there is little evidence to support appropriate dosing of medications in children, particularly in OB/OW children (Ross et al., 2015). There are no clinical guidelines to guide clinician delivery of analgesics to OB/OW children after tonsillectomy. Analgesic dose calculations are more complicated in OB/OW children (Ross et al., 2015). Lacking clear guidelines for proper weight-based dosing in OB/OW children, it is possible that PACU nurses could either under- or overdose OB/OW children in the effort to control pain (Nafiu, Shanks, et al., 2013).

Genetic Variants of Drug Metabolism. Children with unknown genetic background may be susceptible to variations in metabolism of codeine (Isaacson, 2014; Manworren, et al., 2016) and other opioids (e.g., hydrocodone) related to codeine (Isaacson, 2013). Codeine is metabolized by cytochrome P4502D6 into its active metabolite morphine (Isaacson, 2014). There are over 100 known variations of the CYP2D6 gene that are involved in this metabolic process (Baugh et al., 2011; Isaacson, 2013; Khetani et al., 2012; Lauder & Emmott, 2014). Persons with poor metabolism based on genetic variations may get no benefit at all, whereas those with rapid metabolism are at risk of receiving toxic doses of codeine (Isaacson, 2014). The U. S. Food and Drug Administration (FDA) (2013) has issued a black box warning on the use of codeine after tonsillectomy because of deaths reported after use of codeine (Ciszkowski, Madadi, Phillips, Lauwers, & Koren, 2009).

Genetic variations in drug metabolism will influence any child's pain response; some genetic variations may be related to obesity in OB/OW children. Researchers have found a specific polymorphism influencing morphine metabolism that occurs more frequently in OB people than normal-weight people (Lloret-Linares et al., 2011). This polymorphism is associated with a decrease in pain relief from morphine and increased need for morphine and fentanyl for pain relief. Fatty liver disease that can occur with obesity can alter expression of genes, down-regulating certain enzymes and up-regulating other enzymes that are important in the process of drug metabolism (LLoret-Linares, 2013).

Soothing Factors. Soothing factors include those factors that could be used as adjuncts to calm a child's physiological response and reduce pain. Parental presence (Scalford et al., 2013), therapeutic suggestion under anesthesia (Martin, Smith, Newcomb, & Miller, 2014), and music therapy (Klassen, Liang, Tjosvold, Klassen, & Hartling, 2008) have all been used as

adjuncts for successful PTP reduction in children. Likewise, a calm, quiet environment with reduced stimulation could be more calming than a noisy environment (Shertzer & Keck, 2001).

It is likely that soothing factors would operate the same in OB/OW children as in normal weight children, but there may be a physiological difference in children who are accustomed to using food as analgesia. There is a small amount of research on food consumption related to pain reduction in humans (McVinnie, 2013). Researchers have used animal models to study this phenomenon (Foo & Mason 2009). Ingestion of certain foods can produce an analgesic response in animals and humans. It is possible that OB/OW children have used this coping mechanism more frequently than normal weight peers. Post-tonsillectomy ingestion of food to provide analgesia would be difficult during the early recovery period because of postoperative nausea (Baugh, et al., 2011, Isaacson, 2014). Theoretically, this could place OB/OW children at increased risk of greater and more difficult to manage PTP if there were physiological differences in coping styles based on food as analgesia.

Propositions. Several propositions were made based on an understanding of this new model that explains the relationship between OB/OW and PTP in children. The proinflammatory state of excess body fat will increase inflammation during tonsillectomy, leading to increased moderate-to-severe PTP in OB/OW children. The genetic variations associated with obesity, the proinflammatory state, and mechanical stressors will make PTP management more challenging for clinicians. In response, clinicians who fear airway obstruction in an OB/OW child will deliver smaller doses of analgesics to OB/OW children and this in turn will put the OB/OW children at risk of longer periods of uncontrolled PTP.

Conceptual definitions. Two major variables were examined in this study, OB/OW in children undergoing tonsillectomy and PTP in the immediate post-operative period until discharge to home. These variables were conceptually defined as follows:

OB/OW in children. OB/OW in children is a factor influencing pain in which excess body fat produces a pro-inflammatory state and mechanical stressors that combine with the insult of T&A to promote PTP (Nafiu et al., 2009; Nafiu, Prasad, & Chimbira, 2013; Nafiu, Shanks, et al., 2013).

PTP. PTP is an unpleasant, subjective, sensory and emotional experience associated with tissue damage after T&A (Baugh et al., 2011; IOM, 2011; Isaacson, 2014).

Purpose

The primary purpose of this study was to examine associations between OB/OW in children undergoing tonsillectomy and moderate-to-severe PTP in the PACU. The secondary purpose was to examine risk for longer episodes of uncontrolled moderate-to-severe PTP in OB/OW children.

Hypotheses

The following hypotheses were made based on an understanding of the literature:

1. OB/OW status in children would be associated with greater moderate-to-severe early PTP compared to non-OB/OW status in children when controlling for amount of opioid and analgesic received, gender, age, history of OSA, and race.
2. OB/OW status in children would be associated with increased time to pain control in the PACU compared to non-OB/OW status in children undergoing tonsillectomy.

Assumptions

The following assumptions undergirded this study:

1. Children undergoing tonsillectomy are likely to experience moderate-to-severe pain.
2. Nurses and other healthcare providers deliver care to prevent and treat PTP in all children.
3. The electronic medical record is an accurate reflection of care delivered.
4. The effects of eating as analgesia in the immediate post-tonsillectomy period are unknown.
5. Soothing factors are generally the same for OB/OW children as for normal weight children with the exception of eating analgesia.
6. Children in this study receive weight-based doses of dexamethasone and ondansetron prior to arrival in the PACU.

Summary

This chapter included a discussion of current evidence about PTP in OB/OW children to support a study examining possible associations between OB/OW status and greater PTP in children. Prevalence of OB/OW in children undergoing tonsillectomy was discussed in the context of the relationship between obesity, OSA, and tonsillectomy. The tonsillectomy procedure was described in the context of PTP and PTP management, particularly in OB/OW children. Gaps in knowledge that could influence nurses' practice of pain management in the PACU were discussed. A physiological framework was presented to help explain PTP in OB/OW children. The purpose of doing a study examining OB/OW and PTP in children was identified. Hypotheses and assumptions were detailed for clarification.

CHAPTER 2

Associations Between Weight Status and Post-Tonsillectomy Pain Experiences in Children: Review of Literature

The following literature review contains highlights of current knowledge about pain control for OB/OW children undergoing tonsillectomy to provide support for a study that examined possible associations between OB/OW status and higher PTP in children. Prevalence of obesity in children undergoing tonsillectomy is discussed in the context of the relationship between obesity, OSA, and tonsillectomy. Further examination of PTP in OB/OW children, the tonsillectomy procedure, and pain management in children undergoing tonsillectomy helps illuminate the need for research in the area of pain management with OB/OW children. Gaps in knowledge that may influence nurses' practice of pain management in the PACU are discussed.

Significance

Population of interest

Rates of pediatric tonsillectomy in the United States. Tonsillectomy or T&A is performed on approximately 580,000 children under the age of 15 each year in the United States (Boss et al., 2012). This figure represents about 15% of all surgical procedures performed on children each year in the United States (Cullen, Hall, & Golosinskiy, 2009).

Variations occur in the rates of pediatric tonsillectomy by gender, race, and insurance status, as well as by co-morbidity of diseases. Tonsillectomy rates have been reported to be 30% higher in females (Cullen et al., 2009), even though in Texas and across the United States, boys outnumber girls 51% to 49% (Annie E. Casey Foundation, 2016). Accurate estimation of yearly tonsillectomy rates by race or ethnicity in the overall population of the United States has been difficult due to missing data on this demographic (Boss et al., 2012); however, Kum-Nji,

Mangrem, Wells, Klesges, and Herrod (2006) found higher rates in white children than black children in Mississippi. More than half of total tonsillectomy cases were done on children from the southern half of the United States (Boss et al., 2012). Wang, Choe, Meara, and Koempel (2004) reported that physicians were less likely to perform tonsillectomy on children without insurance in California, but Boss et al. (2012) found similar nation-wide rates for tonsillectomy in children with private insurance compared to children with Medicaid.

Current trends in indications for tonsillectomy. Primary indications for tonsillectomy have shifted across time (Erickson et al., 2009). Chronic throat infections and OSA are the two primary reasons to perform tonsillectomy (Baugh et al., 2011; Isaacson, 2014). Hypertrophy of tonsil tissue contributes to OSA, making tonsillectomy a reasonable treatment for OSA (Baugh et al., 2011; Bhattacharjee et al., 2011; Isaacson, 2014). OSA is now the leading reason to perform tonsillectomy, whereas chronic throat infections were the usual motivator in the past (Erickson et al., 2009; Parker & Walner, 2011). Indications for tonsillectomy due to OSA went from 12% in the 1970s to 77% in 2005 in persons from birth to age 29 (Erickson et al., 2009). Parker and Walner (2011) also reported a similar shift based on literature review and chart audit in children up to age 18.

OSA in pediatric tonsillectomy. Only about 2-5.7% of all children in the United States have OSA (Bhattacharjee et al., 2010; Marcus et al., 2012), but researchers have estimated that OSA in the tonsillectomy population ranges from 19.5 % (Nafiu, Shanks, et al., 2013) to 61% (Tweedie et al., 2012). OSA has been defined as upper airway resistance (partial or complete) blocking air exchange during sleep (Bhattacharjee et al., 2011). Snoring, oxyhemoglobin desaturation, and hypercapnia may occur during these airway blockages, causing multiple waking events in children with OSA. OSA differs from habitual snoring, which may occur three

or more nights per week but does not include apnea, abnormalities of gas exchange, or broken sleep (Bhattacharjee et al., 2011). Severity of OSA ranges from mild to severe.

Researchers have found a strong relationship between OSA, asthma, obesity, and gastroesophageal reflux (Bhattacharjee et al., 2014). Asthma occurs in 8% of children in Texas and 9% of children in the United States (Annie E. Casey Foundation, 2016). Population estimates are not available for prevalence of asthma in the tonsillectomy population, but researchers in one study found that 22.1% of the sample (N = 462) had asthma (Nafiu, Shanks, et al., 2013). Prevalence of pediatric gastroesophageal reflux disease in the United States is unknown (El-Serag et al., 2014), but individual studies with children have included estimates ranging from 1.5% (Koebnick et al., 2014) to 7.2% (Nelson et al., 2000).

OSA and OB/OW in pediatric tonsillectomy. There is a connection between the increase in OSA as motivation to perform tonsillectomy and the overall increased nationwide prevalence of OB/OW in children. Obesity is an independent predictor for OSA in children (Marcus et al., 2012; Rudnick, Walsh, Hampton, & Mitchell, 2007). The national prevalence of OB/OW children in the United States who undergo tonsillectomy is unknown. Prevalence of OB/OW in children in the United States has increased dramatically over the past 35 years (CDC, 2015a). For example, the percentage of OB children aged 6-11 has more than doubled from 1980 to 2012, increasing from 7% to 18% (CDC, 2015a). It is expected that a similar increase in OB/OW children undergoing tonsillectomy has occurred to match the general population demographics. The prevalence of OB/OW children undergoing tonsillectomy was reported in one study as being between 35-38% (Nafiu, Shanks, et al., 2013), matching the overall trends for OB/OW in children in the United States.

Prevalence of OSA is highest in children who are OB and undergoing tonsillectomy (Bhattacharjee et al., 2010). Researchers in a multi-center study of four hospitals in the United States and two in the United Kingdom found that over 50% of the children who had T&A to treat OSA met criteria for obesity (Bhattacharjee et al., 2010). Factors associated with OSA in OB children include hypertrophic tonsils, fat distribution, decreased lung volumes, abnormal central nervous system ventilatory responses, decreased opening in the upper airway, and a potential for leptin to interfere with ventilation (Marcus et al., 2012). OB children may have increased fat accumulation in a parapharyngeal fat pad that can cause obstruction of the airway leading to OSA (Jang et al., 2014).

Challenges in PTP management with OB/OW children. OB/OW children experience increased risks associated with pain management for tonsillectomy (Cote et al., 2014). OB/OW children are more likely to be hospitalized overnight or have lengthier hospitalizations post-tonsillectomy (Nafiu et al., 2009; Tait et al., 2008). Higher rates of laryngospasm have been reported for OB/OW children post-tonsillectomy (Nafiu, Prasad, & Chimbira, 2013). The increased occurrence of OSA in OB/OW children makes them at risk for apnea after surgery partly because opioid use for pain management suppresses respiratory drive (Brown & Brouillette, 2014; Cote et al., 2014).

These increased PTP management risks are problematic for OB/OW children because tonsillectomy is associated with some of the highest level and most persistent pediatric pain scores compared to other common pediatric surgeries such as orchidopexy or inguinal hernia repair (Isaacson, 2014; Stewart, Ragg, Sheppard, & Chalkiadis, 2012). PTP is severe in most children in the first few days after surgery and usually decreases linearly during the healing period with severe pain lasting as long as two weeks (Isaacson, 2014). Tonsillectomy produces

moderate-severe pain in at least two-thirds of children during their recovery period (Hadden et al., 2011). Early moderate-to-severe PTP, defined as a pain score of 4 - 5 out of 10 in the first 15 minutes of waking, has been reported to occur in 21 % (Nafiu, Shanks, et al., 2013) to 39% (Scalford et al., 2013) of children.

Uncertainty exists about calculation of optimal opioid doses in OB/OW children because clinicians calculate medication dosages using a combination of weight and age parameters, which may result in delivery of adult level dosages to children (IOM, 2011; Ross et al., 2015). Metabolism of medications may also be affected by the amount of body fat present, so additional considerations must be made for OB/OW children undergoing tonsillectomy (Ross et al., 2015).

PACU nurses serve at the frontline to prevent and treat PTP (Pop et al., 2007) but do not have clinical guidelines for the practice of PTP management for OB/OW children. A search of CINAHL and Medline with the search terms nurse, knowledge, OB, and pain management revealed no articles. In fact, there is a scarcity of research about management of PTP in OB/OW children (Nafiu, Shanks, et al., 2013; Scalford et al., 2013).

Impact of ineffective PTP management in OB/OW children. The problems inherent in PTP management for OB/OW children have a large impact on the children, their families, and the healthcare system. Parents who are already feeling stressed about having a child undergo anesthesia may feel even more stressed as the child experiences PTP or breathing difficulties worsened by medications for pain management (Draskovic, Simin, & Kvyrgic, 2015). Children and their parents who care for them at home after T&A may be exhausted from a taxing visit to the hospital (Sutters et al., 2007). Additional lost workdays may occur for parents in the process of caring for their children during the recovery process. Lengthier hospitalizations for OB/OW children undergoing tonsillectomy (Tweedie et al., 2012) can translate into higher healthcare

costs from additional monitoring and treatment (Isaacson, 2014). Ultimately, this creates higher costs for society.

There could be a long-term impact of ineffective PTP management; OB/OW children may have increased risk compared to non-OB/OW children. There is limited pediatric research that indicates a possible link between obesity and higher PTP in children in the acute recovery period (Nafiu, Shanks, et al., 2013). There are no longitudinal studies in which researchers assessed for potential associations between childhood obesity, PTP, and increased risk for chronic pain (King et al., 2011). Despite the scarcity of pediatric research, researchers have found associations for adults between the rise in adult obesity rates in the United States, poorly controlled post-surgical pain, and development of chronic pain (IOM, 2011). Because of this connection between acute and chronic pain, the IOM blueprint, "Relieving Pain in America" (2011), included a moral imperative to provide effective pain management for all ages of people in the United States.

Background

Tonsillectomy procedure, risks, and indications

Tonsillectomy procedure. The tonsillectomy procedure is usually performed under general anesthesia because the location of the tonsils within the oropharynx would elicit the gag reflex during surgery in a non-anesthetized child (Isaacson, 2014; see Figure 2). The extracapsular tonsillectomy (with or without adenoidectomy) involves removal of the entire tonsil and surrounding tissue with one quick excision. Sometimes a portion of the anterior tonsillar pillar is removed as well. Various methods to remove tonsils can be described as cold or hot techniques. Cold techniques involve use of sharp and dull tools, whereas hot techniques involve use of electrosurgical or thermal instruments. Regardless of technique, tonsillectomy

requires excision of the tonsils and control of bleeding in the remaining tissue bed (Baugh et al., 2011; Isaacson, 2014).

Figure 2. Serial photography of tonsillectomy healing process

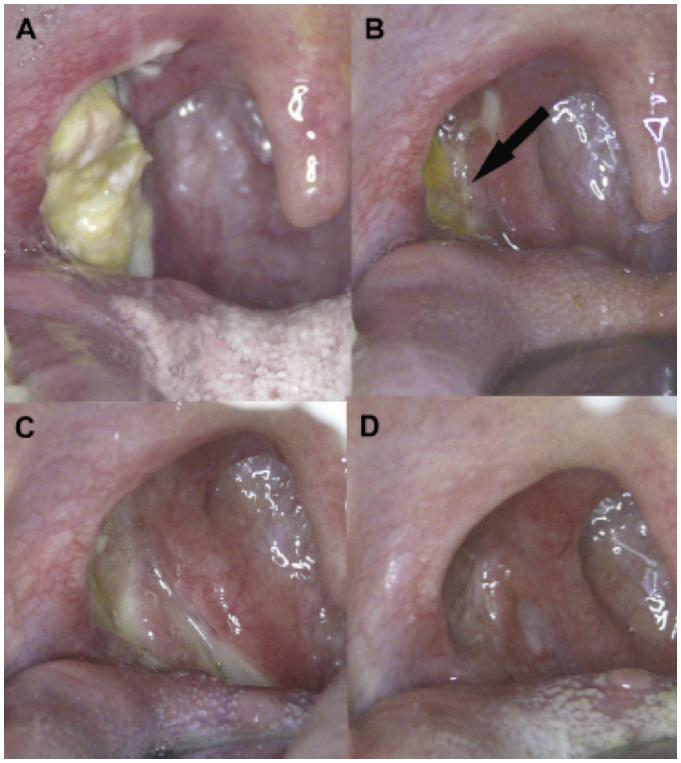


Figure 2. Serial photographs of tonsillectomy healing process depict: A) immediately after tonsillectomy, B) postoperative day 5, C) postoperative day 7, and D) postoperative day 9. Adapted from "Tonsillectomy Healing" by G. Isaacson, 2012, Annals of Otology, Rhinology, and Laryngology, 121(10), p. 647. Copyright 2012 by Annals Publishing Company. Reprinted with permission.

Tonsillectomy risks. Tonsillectomy carries significant risks in addition to the pain of surgery. Post-surgical hemorrhage rates may be as high as 15% in the immediate postoperative period (Sarny, Habermann, Ossimitz, & Stammberger, 2012). Delayed hemorrhage may occur as late as seven to 10 days after surgery (Isaacson, 2014). Other surgical complications that have been reported include trauma to face and oropharyngeal structures, laryngospasm, laryngeal edema, aspiration, respiratory compromise, endotracheal tube ignition, and cardiac arrest (Baugh

et al., 2011). Mortality rate estimates based on data from the 1970s range from 1:16,000 to 1:35,000 (Baugh et al., 2011; Pratt & Gallagher, 1979). OB/OW children undergoing tonsillectomy are at increased risk of complications because of underlying complex health conditions that drive the need for tonsillectomy and make the recovery process more challenging (Gleich et al., 2012, Nafiu et al., 2009, Nafiu, Prasad, & Chimbira, 2013).

Indications for tonsillectomy. Despite the risks, tonsillectomy may improve quality of life in some children when done with careful consideration (Mitchell & Boss, 2009; Venekamp, et al., 2015). Indications for tonsillectomy include OSA and recurrence of severe sore throat measured according to the *Paradise criteria* (Baugh et al., 2011; Isaacson, 2014; Paradise et al., 1984). The *Paradise criteria* contain the following indications for tonsillectomy: seven episodes of severe sore throat in a year, five sore throats in two consecutive years, or three in three consecutive years (Paradise et al., 1984). Other less scientifically supported reasons for tonsillectomy include peritonsillar abscess, pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS) (Alexander, Patel, Southammakosane, & Mortensen, 2011), febrile seizures, dental malocclusion, halitosis, and cryptic tonsils (Isaacson, 2014).

Pain Mechanisms in Tonsillectomy

The underlying mechanisms of PTP are poorly understood, but a number of possible factors have been proposed that include physical, cognitive, and emotional triggers for pain. Some of the pain prompts may arise from a trigger of pain fibers during chewing and swallowing (Hanafiah et al., 2008), release of inflammatory mediators, spasm of pharyngeal muscles (Isaacson, 2014), and neural plasticity (Reichling & Levine, 2009). Previous pain and life experiences may make some children at increased risk for pain (Melzack, 2005). Underlying

levels of anxiety also contribute to a child's pain experience (Broekman et al., 2010; Kain et al., 2006).

Individual pain triggering factors are interrelated. For example, the immune system initiates the healing processes after tonsillectomy, at the same time contributing to pain via localized swelling. Tonsillectomy creates a wound in mucosal tissue that may take up to two weeks to heal (Isaacson, 2014). Pressure on nearby pain receptors occurs from swollen tissues in the pharynx. Motion from chewing and swallowing applies extra pressure on swollen areas in the throat (Isaacson, 2014). Pain receptors transmit pain signals to the brain in a process called nociception (Fenton et al., 2015; Loeser, 2000). Tonsillectomy pain is believed to be associated with transmission of pain signals via C-fibers (Turhan et al., 2016). Activation of C-fibers can cause prolonged burning pain (Fenton et al., 2015). Mucosal healing processes have not been well studied in children, but animal studies provide some background to understand this process (National Research Council, 2009). Incisional pain in mice was strongly associated with neutrophil infiltration and enhanced levels of five cytokines that help regulate the body's response to injury, infection, and inflammation (Clark et al., 2007). The cytokines include interleukin 1B, IL-6, tumor necrosis factor alpha, granulocyte colony stimulating factor, and keratinocyte-derived cytokine (Khan, 2008). PTP occurs simultaneously with fibrin clot accumulation and inflammation and disappears when complete healing occurs (Isaacson, 2014). Neural plasticity plays a role in the amount of pain and the length of the pain experience. Neural plasticity refers to the process where afferent nociceptive nerve fibers may be aggravated by acute inflammatory insult (e.g., tonsillectomy), which in turn trigger long-lasting hypersensitivity of nociceptors to inflammatory cytokines (Reichling & Levine, 2009).

Contributing to the pain experience in children undergoing T&A is the significant risk for nausea and vomiting. Rates of untreated postoperative nausea and vomiting have been reported to be as high as 69% (Stene, Seay, Young, Bohnsack, & Bostrom, 1996). Common treatments used to control nausea and vomiting post-T&A include combination intravenous dexamethasone and ondansetron (Bolton, Myles, Nolan, & Sterne, 2006; Hermans, DePooter, De Groote, De Hert, & Van der Linden, 2012; Steward, Grisel, & Meinzen-Derr, 2011).

Link between OB/OW and Postoperative Pain

Suggestions of a connection between obesity and higher postoperative pain in adults have been explored, but there is limited research that examines OB/OW and increased risk for PTP in children. Researchers have found positive associations between BMI and pain in adults following general surgeries (Mei et al., 2010), knee replacement (Nunez et al., 2007), and hip and knee replacements (Liu et al., 2012). A search of CINAHL, Medline, and PubMed with search terms that included OB, child, BMI, and tonsillectomy produced only two relevant articles (Nafiu, Shanks, et al., 2013; Scalford et al., 2013).

PTP in OB/OW Children

Researchers used BMI, gender, and age specific parameters to examine potential relationships between PTP and pain outcomes in children in two recent studies (Nafiu, Shanks, et al., 2013; Scalford et al., 2013). Nafiu, Shanks, et al. (2013) found high BMI to be an independent predictor of early moderate-to-severe PTP in the immediate postoperative period ($p < .001$). In contrast, Scalford et al. (2013) did not find a difference in pain scores by weight in children in phases I and II of the PACU. It is difficult to compare results between these two studies because BMI was divided into different categories in each study. Scalford et al. grouped children into five BMI categories with cutoffs at 3rd, 10th, 90th, and 97th percentiles. Nafiu,

Shanks, et al. grouped children as normal BMI (5th percentile-84th percentile) or high BMI (greater than or equal to 85th percentile). The BMI group cut-off scores used by Nafiu, Shanks, and colleagues are the same as those recommended by an expert panel at the CDC (CDC, 2015b). See Table 1 for a discussion of BMI estimation and BMI z-scores.

Table 1. Definitions of OB/OW

Concept	**Definition**
OB/OW in children.	Experts reporting at the CDC define OB and OW in children in terms of BMI, gender, and age specific parameters (CDC, 2015b). A child's body composition varies based on age and gender, so use of BMI alone would not help identify OB/OW children. OW children are those at or above the 85th percentile compared to same gender peers in their age range. Children are considered OB with BMI scores that fall at or above the 95th percentile at the same age and gender. BMI is calculated by dividing weight in kilograms by the square of a person's height in meters (CDC, 2015b; Kuczmarski et al., 2002). Researchers may find it helpful to convert BMI scores into z-scores for research purposes. This is a mathematical calculation that derives the amount of deviation of a child's weight from the average value of the reference population (other children of the same age and gender). Z-scores and percentiles have a direct relationship with each other so conversions can be done in either direction using a standard normal distribution table. The z-score provides a continuous weight variable for children, more helpful than BMI for exact calculation and comparison in research (Kuczmarski et al., 2002).

The Nafiu, Shanks, et al. (2013) study may have had a stronger methodology to capture important pain outcomes than the Scalford et al. (2013) study. Scalford et al. reported the first recorded pain score in phase I PACU and the first recorded pain score in phase II PACU for each child, ignoring all other pain scores for comparison. Nafiu et al. compared pain scores, counting any incidence of moderate-to-severe pain in the first 15 minutes of arrival to PACU for comparison. The Nafiu et al. method of obtaining pain scores prevented missing moderate-high pain scores in the first 15 minutes. Pain expression in children could vary in this short period.

Scalford et al. may have missed key information about each child's pain experience by counting only the first pain score. More important than the first pain score on arrival to PACU would be the highest pain score and the length of time required to adequately reduce the pain.

Measures of PTP in the PACU

Measurement of pain in the PACU depends on the child's age, cognitive ability, and level of awareness (Brasher et al., 2014). Self-report of pain is preferable to observational measures (Brasher et al., 2014; Howard et al., 2013). Use of a consistent tool for pain assessment helps provide results with better validity. This is difficult in the PACU because levels of awareness vary with the amount of anesthetic agents and opioids in each child's blood stream. These variations in level of awareness may make accurate determination of pain difficult. In a study by Pop et al. (2007), nurses documented self-report pain scores in less than half of the children in the phase I PACU. Those children who did not have recorded pain scores were either too sleepy or too irritable to provide a self-report pain score (Pop et al., 2007).

Three common pain-scoring tools used in the PACU setting include the Face, Legs, Activity, Cry, Consolability tool (FLACC; Merkel, Voepel-Lewis, Shayevitz, & Malviya, 1997), the Wong-Baker FACES® scale (WBF; Wong & Baker, 1988), and the verbal numeric rating scale (NRS), also known as the verbal numeric scale (VNS; Bailey, Daoust, Doyon-Trottier, Dauphin-Pierre, & Gravel, 2010). The FLACC tool has well-established validity and reliability for use in children ages 1-18 (Howard et al., 2012) and is useful for children in the PACU if they are either too young or too sleepy to provide a pain rating (Merkel, et al., 1997). The WBF and VNS pain scales are helpful for use with children old enough and alert enough to provide self-report of pain (Howard et al., 2012). The WBF scale contains a series of six cartoon faces with increasing pain ratings from 0-5 (or 0-10 at two point increments) (WBF Foundation, 2015).

The WBF scale has established validity and reliability for children ages 3-18 (Keck, Gerkensmeyer, Joyce, & Schade, 1996). The VNS is recommended for children ages eight or older because it requires the cognitive ability to understand a number rating scale. The VNS has established validity and reliability when tested with the well-established visual analogue scale (VAS; Bailey et al., 2010; Ruskin et al., 2014; Voepel-Lewis, Burke, Jeffreys, Malviya, & Tait, 2011). The VNS scores correlate with the VAS measures ($r_{ic} = 0.93$, $p < 0.001$), but the VNS is not interchangeable with the VAS (Bailey et al., 2010). Although the FLACC, WBF scale, and VNS are not equivalent, they are helpful tools to let clinicians know when children have no pain and when they have moderate-to-severe pain. Retrospective research that involved collection of pain scores in the PACU could require collection of pain scores gathered using up to three different measurement tools.

PTP Management

In-hospital medical management of PTP. Nurses and physicians manage initial pain of tonsillectomy with intravenous analgesics such as morphine or fentanyl (Hadden et al., 2011). Medications may be delivered first to the child under anesthesia prior to waking. Nurses in the PACU may continue to manage pain with sliding scale doses based on pain scores (Scalford et al., 2013). Sometimes only one type of analgesic is used to manage pain, but multimodal analgesic management is recommended. Combination analgesic management (e.g., combination of morphine and oxycodone) has been associated with significantly lower pain scores than use of one analgesic alone to manage pain post-tonsillectomy ($p < .045$; Scalford et al., 2013).

In-hospital psychosocial management of PTP. Other non-medical treatments have also been used to lower PTP in children. Parental presence (Scalford et al., 2013), therapeutic suggestion under anesthesia (Martin et al., 2014), and music therapy (Klassen et al., 2008) have

all been used as adjuncts for successful pain reduction in post-tonsillectomy pediatric populations.

Outpatient medication treatment for PTP. Outpatient PTP control is problematic and controversial. Historically, treatment of PTP in children at home has been managed with a combination of acetaminophen with opioids such as codeine, oxycodone, or hydrocodone (Isaacson, 2013). The best combination and timing of medications is unknown (Baugh et al., 2011). There does not appear to be a significant difference between around-the-clock dosing versus as needed dosing for pain control in children, even though studies with adults would lead clinicians to believe otherwise (Hobson, Wiffen, & Conlon, 2015). Opioid medications carry extra risks for certain populations of children.

Researchers have identified variations in the metabolism of codeine to morphine. Codeine is metabolized by cytochrome P4502D6 into its active metabolite morphine (Isaacson, 2014). There are over 100 known variations of the CYP2D6 (P4502D6) gene that are involved in this metabolic process (Baugh et al., 2011; Isaacson, 2013; Khetani et al., 2012; Lauder & Emmott, 2014). Persons may be poor metabolizers, intermediate metabolizers, extensive metabolizers, or ultra-rapid metabolizers of codeine (Dean, 2012/2016). Those with poor metabolism may get no benefit at all, whereas those with ultra-rapid metabolism are at risk of receiving toxic doses of codeine (Isaacson, 2014). In some people, use of codeine has caused death (Ciszkowski et al., 2009). The FDA (2013) has issued a black box warning on the use of codeine after tonsillectomy.

People may be susceptible to variations in metabolism with other opioids related to codeine (e.g., hydrocodone); this places children with unknown genetic background at risk

(Isaacson, 2013). Consequently, some physician groups recommend alternating acetaminophen with ibuprofen on around the clock dosing schedules to control pain (Isaacson, 2014).

Physicians were once hesitant to administer anti-inflammatories such as ibuprofen after T&A due to theoretical risk of bleeding (Baugh et al. 2011). Acetaminophen alone would not provide enough pain control for most children (Sutters & Isaacson, 2014). Fortunately, more recent research supports the safety of ibuprofen use in children post-tonsillectomy (Baugh et al., 2011; Liu & Ulualp, 2015; Yellon, Kenna, Cladis, Mcghee, & Davis, 2014). Liu and Ulualp (2015) found acceptable pain control without increased risks in children post-tonsillectomy by alternating acetaminophen and ibuprofen. Combination acetaminophen and ibuprofen treatment regimens have not been well studied in OB/OW children.

Opioid use in OB children. Medication doses in children are primarily determined based on measures of their height and weight, but there still remains a scarcity of evidence to support appropriate dosing of medications in children, particularly in OB/OW children (Ross et al., 2015). A search of CINAHL, Medline, and PubMed with search terms OB, child, medication, and dosing produced only two articles (Kendrick, Carr, & Ensom, 2010; Ross et al., 2015). In their review of the literature, Kendrick and colleagues (2010) found little data on use of medications in OB children and recommended extrapolation from adult studies with consideration of a child's growth and development. Researchers at Children's Hospital of Colorado (Ross et al., 2015) initiated a collaborative study with 39 other children's hospitals to produce a decision support tool to guide medication administration in critically ill OB children. Ross and colleagues (2015) identified and evaluated 113 medications that are commonly used in OB critically ill children across the United States. There were only 122 citations that supported 66 of these medications. Only 72% of the articles included any guidance about general obesity

dosing and 13% had information about pediatric dosing. The decision support tool to guide medication use in OB children was created by combining knowledge from the limited literature with recommendations from experts.

Lacking other evidence to support practice, the decision support tool by Ross and colleagues (2015) may be generalizable and helpful for those managing pain in OB children undergoing tonsillectomy. Based on this tool, medication calculations would require use of ideal body weight, total body weight, or adjusted body weight. Ideal body weight is calculated as (50% BMI for age) / [height (in meters)]^2. Total body weight is the actual weight of the child. Clinicians calculate adjusted body weight by taking ideal body weight and adding the multiplicand of a specified cofactor times the difference between total (true) body weight and ideal body weight. Specified cofactors are predetermined numbers (such as cofactor of .25) used to adjust for part of the excess body mass in consideration of drug metabolism (Ross et al., 2015). See Table 2 for an example of varied cofactors for medications commonly used after tonsillectomy.

Table 2. Recommended medication dosing for critically ill OB/OW children

Medication	**Recommended Dosing**
Morphine	Ideal body weight (with titration to effect)
Fentanyl	Adjusted body weight (cofactor of .25)
Acetaminophen	Adjusted body weight (cofactor of .25)
Ibuprofen	Adjusted body weight (cofactor .4)
Oxycodone	Adjusted body weight (cofactor .25)

Note. Adapted from "Development of recommendations for dosing of commonly prescribed medications in critically ill OB children," by Ross et al., 2015, *American Journal of Health-System Pharmacy, 72*(7), pp. 548-551. Copyright 2015 by the American Society of Health-System Pharmacists, Inc.

Ross et al. (2015) listed several common opioids that are also used in children post-tonsillectomy. They made recommendations for use of fentanyl, morphine, and oxycodone in OB, critically ill children in the ICU according to the decision support tool. The medications should be delivered based on drug calculations that use either ideal body weight, total body weight, or adjusted body weight. Fentanyl is lipophilic, may build up to toxic levels in obese individuals, and may be dosed in OB children using adjusted body weight with cofactor (0.25), titrating to effect if necessary (Ross et al., 2015). Ross et al. reported that morphine has hydrophilic properties and recommended dosing by ideal body weight with titration to effect. Oxycodone is partially lipophilic. Adjusted body weight with cofactor (0.25) may be used to determine administration of oxycodone according to these guidelines (Ross et al., 2015).

The recommendations by Ross et al. (2015) were made for dosing of these medications in critically ill children, not in children post-tonsillectomy. The underlying science that would guide use of these medications in critically ill children includes some of the same considerations that would be necessary in OB/OW children post-tonsillectomy; however, opioids used in critically ill children are used with the understanding that the child may have an artificial airway. These guidelines for medication use in critically ill OB children have not been studied in OB/OW children undergoing tonsillectomy. A cautious use of these guidelines in pediatric tonsillectomy patients would be encouraged. Research on use of these guidelines in OB/OW children undergoing tonsillectomy could be helpful.

Gaps in the Literature

Based on a thorough examination of the literature, there were a number of unanswered questions about PTP management in OB/OW children. Research results were conflicting about a possible association between BMI and OB/OW in children post-tonsillectomy (Nafiu, Shanks, et al., 2013; Scalford et al., 2013). Also unknown was whether or not OB/OW would be associated

with higher pain when controlling for equianalgesic dosing (Nafiu, Shanks, et al., 2013). There were no studies found in which researchers examined challenges in controlling moderate-severe PTP in OB/OW children compared to normal weight children. There were no clinical guidelines to guide clinician practice of pain management for PTP in OB/OW children. No studies were found in which researchers examined whether PTP management should be based on ideal body weight, actual body weight, or adjusted body weight.

Researchers have also not examined whether or not OB/OW children have increased risk for experiencing longer lengths of time of moderate-to-severe PTP. Lacking guidelines for management of PTP in OB/OW children and fearing airway obstruction, PACU nurses may hesitate to deliver an adequate dose of analgesic in an OB/OW child.

There were numerous problems encountered with PTP in the OB/OW children, but two unanswered questions formed the basis for inquiry in this study. It was unknown if OB/OW is associated with higher PTP in children. It was also unknown if OB/OW in childhood is a risk factor for uncontrolled PTP.

Summary

This chapter included a review of literature about PTP in OB/OW children. Literature to support the significance of the problem of PTP in OB/OW children was presented. This chapter also provided a discussion of the background to support the need for a study about PTP in OB/OW children. A study was recommended based on this literature to examine the association between OB/OW status and moderate-to-severe PTP in OB/OW children who have undergone tonsillectomy.

CHAPTER 3

Associations Between Weight Status and Post-Tonsillectomy Pain Experiences in Children: Methods

This chapter includes a description of the methodology that was used to study the association between OB/OW status and PTP in children. The research design, sample, setting, and measurement methods are discussed. Procedures involved in collecting the sample and protecting human subjects are described and a flow chart is provided. A data analysis plan is included. Delimitations are discussed to help the reader understand application of findings.

Research Design

A retrospective correlational cohort design was used for this study. The purpose of the study was to describe the pain experience of OB/OW children compared to that of normal weight children undergoing tonsillectomy and determine if OB/OW was associated with increased PTP. A correlational design was appropriate for this study because there has been very little research to describe pain management practices in this population or to describe potential associations between OB/OW status and increased PTP. A correlational design allowed for examination of possible relationships between variables (Grove & Cipher, 2017). Description of direction (positive or negative) and strength of the relationship between the variables was possible with this method. Correlational designs are used to support development of descriptions of relationships and do not establish cause and effect relationships between variables (Thomas, Silverman, & Nelson, 2015). An understanding of the relationships between variables is necessary before researchers can test cause and effect in interventional studies.

The retrospective design was selected for three reasons: lack of sufficient evidence about potential relationships between weight status and PTP, feasibility of data collection, and

reduction of potential embarrassment to subjects. Data collection for a prospective study requires more time and resources than a retrospective study. Electronic medical record (EMR) data on children who have experienced tonsillectomy were readily available. Retrospective analysis provided a sample for analysis to establish need for further research. The retrospective design also minimized the potential embarrassment to OB patients and their families that could occur with recruitment to a prospective study based on weight status. Decreasing potential for embarrassment in this population was important because children who are OB often experience obesity-related social stigma (Sutin & Terracciano, 2013).

Sample

The sample included 180 children who had T&A or tonsillectomy alone prior to August 2016 at a large pediatric hospital in north Texas and whose EMRs were accessible for review. Half of the sample was from OB/OW children and the other half from non-OB/OW children, for a total of 90 in each group. Children who met the sample criteria were enrolled starting with children from July 2016 and moving sequentially back in time until the entire sample was obtained.

Sample Criteria

Children between the ages of 4-12 years old who had tonsillectomy or T&A at a large pediatric hospital in north Texas and whose EMRs were accessible for review were eligible for inclusion in the study. Including children ages 4-12 allowed for collection of data from the ages of children most likely to undergo tonsillectomy.

Children were excluded if they had other surgical procedures concurrent with the T&A or tonsillectomy, with the exception of bilateral myringotomy tube placement. This exclusion was necessary because other procedures could have influenced the treatment and recovery process,

particularly the pain experiences of the children, independent of their weight status. Children were also excluded if a BMI score could not be calculated because of data missing from the EMR. Children with a tracheostomy were excluded because an extubation time could not be determined.

Sample Size

The study was powered to answer two research questions. Sample size was determined by power analysis with power set at .80 and two-tailed $\alpha = .05$. If the *p*-value was less than or equal to $\alpha = .05$, then the result was said to be significant. The sample size was calculated using G*Power software (Faul, Erdfelder, Buchner, & Lang, 2009).

Research Question #1

Will OB/OW status in children predict greater early moderate-to-severe PTP when controlling for weight-controlled equianalgesic doses, non-opioid analgesic doses, gender, age, history of OSA, and race?

Power analysis for multiple logistic regression was conducted with G*power to determine a sufficient sample size using an alpha of 0.05, a power of 0.80, a moderate effect size of 2.5, and a two-tailed test. The desired sample size was 162 based on these assumptions. An additional 11% was collected for a total sample size of 180.

Research Question #2

Will OB/OW status in children be associated with increased uncontrolled PTP in the PACU compared to non-OB/OW status in children undergoing tonsillectomy?

Power analysis for a Spearman rank-order correlation was conducted with G*Power to determine a sufficient sample size using an alpha of 0.05, a power of 0.80, a medium effect size ($\rho = 0.3$), and a two-tailed test (Faul et al., 2009). Power was calculated using software for

Pearson product-moment because the Spearman rank-order correlation is computationally identical (Statistics Solutions, 2016b). The desired sample size was 84 based on the assumptions described. An additional 54% was collected for a total sample size of 180. Power was not calculated for Kaplan-Meier Survival Analysis because there was not sufficient literature to make estimations.

Effect sizes for power calculations for each research question were chosen based on previous research or by estimation of clinical relevance. A medium effect size of $r = .30$ was used, based on empirical outcomes seen in the study by Nafiu, Shanks, et al. (2013) in which BMI was associated with early PTP in boys at 15 minutes ($r = .28$) and in girls at 15 minutes ($r = .40$). In addition, high BMI was associated with at least a fourfold higher risk of moderate-to-severe PTP (adjusted OR = 4.24, 95% CI = 2.56 – 7.01, $p < 0.001$; Nafiu, Shanks, et al., 2013).

Setting

The study was conducted at Cook Children's Medical Center and Dodson Surgical Center in Fort Worth, Texas. Cook Children's Medical Center is a 429 bed children's non-profit hospital with an attached Dodson Outpatient Surgery Center. Together, these two centers had over 1,600 children between the ages of 4-12 undergo tonsillectomy or T&A in two recent years.

Measurement Methods

Weight status (OB/OW or non-OB/OW) and pain (PTP) were the research variables of interest in this study. The conceptual definitions, provided in chapter 1, were based on a physiological framework. PTP factors in OB/OW children, the research framework for this study, was developed based on work by McVinnie (2013). The research variables were operationalized as described in this section. Demographic and other descriptive information regarding subjects' age, gender, calculated BMI-z, race, history of OSA and other comorbidities,

opioids received in the OR and PACU, non-opioids in the OR and PACU, and American Society of Anesthesiologists (ASA) status were also collected. The data collection tool is in Appendix A.

Weight Status

Weight status is a factor influencing pain that was operationalized using BMI-z scores as a cut-point. Researchers have demonstrated a high correlation (r = .95) between BMI-z scores and Fat Mass Index in a study of 2554 school children (Freedman et al., 2005). BMI for age had sensitivity to detect overweight ranging from 88%-96% in children aged 2-19 (Mei et al., 2002).

Operational Definition of Weight status. The grouping variable was status of OB/OW or non-OB/OW based on BMI-z scores $\geq 85^{th}$ percentile on the National Center for Health Statistics (NCHS) growth chart for age and gender with non-OB/OW children falling under the 85^{th} percentile (CDC, 2015b). BMI-z scores are calculations of weight and height that have been converted to z-scores derived from the amount of deviation of a child's weight from the average of the reference population (CDC, 2015b; Kuczmarski et al., 2002; Ogden & Flegal, 2010). These calculations were performed as follows. Children had documented height (in centimeters) and weight (in kilograms) in their EMRs. Nurses commonly obtain these measurements at Cook Children's Medical Center and Dodson Surgical Center using a wall stadiometer and digital scale. These measurements were combined with each child's age (in months) and gender to calculate BMI-z scores. To make this determination, first BMI was calculated for each child by dividing weight in kilograms by the square of the height in meters (BMI = kg/m^2). The BMI was then compared to other children of the same age and gender and expressed as a percentile (BMI-z score). Reference growth charts from the NCHS/CDC were used to categorize children into OB/OW or non-OB/OW by gender (CDC, 2015b).

PTP

PTP is an unpleasant, subjective, sensory, and emotional experience that was operationalized as the highest pain score recorded in the first 15 minutes after endotracheal extubation in the PACU. Pain scores every 10 minutes for the remainder of the child's stay in phase I PACU and at 10 - 30 minute intervals while in phase II PACU were also obtained, depending on the availability of pain scores in the EMR. Pain scores were recorded on a 0-10 scale and also labeled as the FLACC scale (Merkel et al., 1997), the WBF scale (Wong & Baker, 1988), or a VNS score. See Appendix B.

Operational definitions of PTP. PTP was operationally defined in four different ways. Early PTP was defined as the highest pain score on a 0-10 scale within the first 15 minutes of extubation. Ongoing PTP scores were the pain scores obtained at 10-minute and 30-minute increments in the PACU. Moderate-to-severe pain was considered pain ≥ 4 on any 0 - 10 - point scale. This definition of moderate-severe pain was consistent with the policy at Cook Children's Medical Center. Uncontrolled PTP was the smallest time frame from the occurrence of a moderate-to-severe pain score until the child sustained low- or no-pain scores for at least 30 minutes.

Nurses used three different pain scales to assess postoperative pain in children, based on age, developmental level, and level of arousal. These pain scales included the FLACC (Merkel et al., 1997), the WBF (Wong & Baker, 1988), and the VNS. The FLACC is an observational scale used with children who are too young to verbalize their pain, and the other two are self-report scales for use with children able to verbalize. Nurses used these pain scales to rate children's pain on 11 point, 0-10 scales, with 0 = "no pain" and 10 = "worst pain." The scales are not equivalent even though the numeric rating system is the same for each (Bailey et al.,

2010; Ruskin et al., 2014). Lack of equivalence between scales is a methodological weakness of this study. The scales are all considered valid and reliable to measure postoperative pain in children (Merkel et al, 1997; von Baeyer et al., 2009; Wong & Baker, 1988).

The following method was used to transform pain scores into a binary variable for comparison between subjects and to control for differences between pain scales. Scores were re-coded to reflect moderate-to-severe pain (score ≥ 4 by FLACC, WBF, or VNS) or absence of moderate-to-severe pain. Pain scores are commonly divided into a clinically meaningful decision point at this cut-off range (Hadden, et al., 2011; Kozlowski et al., 2014; Mei et al., 2010; Nafiu, Shanks, et al., 2013; Tomecka et al., 2012).

Uncontrolled PTP was considered the amount of time it took from the first score of moderate-to-severe pain until the time the child had at least 30 minutes of pain scores ≤ 4 without exacerbation. The soonest time frame that indicated pain was sustained ≤ 4 was considered the end of the moderate-to-severe pain, but this must have been maintained for at least 30 minutes. If there were two or more of these episodes, the longest time frame was used for comparison purposes. A discharge home was considered an end to this time frame. Scores were collected for up to four hours or until the child was discharged home. If a child was admitted as an inpatient, pain scores were collected for up to 4 hours.

FLACC. The FLACC pain scale is an interval-level observational pain scale used by nurses to rate pain in children who are unable to do self-report of pain (Merkel et al., 1997). Children who wake from anesthesia are often sleeping or too drowsy to rate their own pain. The FLACC is frequently used in the PACU to rate pain in children. The FLACC tool has five scalable items (face, legs, activity, crying, and consolability) that are rated 0 - 2. For example, scoring of "consolability" ranges from "content/relaxed" which is recorded as 0 to "reassured by

occasional touching, hugging or being talked to, distractible" which is recorded as 1 to "difficult to console or comfort" which is recorded as 2. Each item score is added for a total pain score that ranges from 0 – 10.

The FLACC is a valid and reliable tool for assessing children's pain in various settings that include the PACU (Manworren & Hynan, 2003; Merkel et al., 1997). In tool development for children ages two months to seven years, the FLACC scores had positive correlations with PACU nurses' global ratings of pain ($r = .41$, $p < .005$; Merkel et al., 1997). Scores from the FLACC and Objective Pain Scale were positively correlated ($r = .80$, $p < .001$) thus demonstrating convergent validity (Merkel et al., 1997). Concurrent validity ($r = 0.59$, $p < 0.05$) between FLACC and the Color Analogue Scale scores was also later demonstrated in children with procedural pain between the ages of 5-16 (Nilsson, Finnström, & Kokinsky, 2008). Construct validity was evaluated by comparison of pre- and post-procedure pain scores when Nilsson et al. (2008) demonstrated that FLACC scores increased to 1 during the procedure but were zero pre- and post-procedure ($p < .001$). Interrater reliability was high ($K = .85$, $p < .001$; Nilsson et al., 2008). The FLACC scores also have had high significant correlations with WBF scores in children ages 5-7 in the postoperative period (r [16] = 0.830; $p < 0.0001$; Willis, Merkel, Voepel-Lewis, & Malviya, 2003) but not in children less than five years of age.

WBF. The WBF scale is a series of circular cartoon faces that range from a smile representing "no hurt" to a grimace with tears indicating "hurts worst" (Wong & Baker, 1988). See Appendix B. WBF was originally scored on a 0 - 5 scale, but now may be scored 0 - 10 (Tomlinson, von Baeyer, Stinson, & Sung, 2010). It should be considered an ordinal scale because children may not consider the intervals between numbers to be equal (Cohen, 2008).

The WBF has had extensive validity and reliability in children ages 3 - 18 (Tomlinson et al., 2010; Wong & Baker, 1988). Tomlinson and colleagues (2010) identified 56 studies in which the WBF was used. The WBF is the scale most preferred by children when compared to other similar valid and reliable faces pain scales ($p < .001$; Tomlinson et al., 2010; Wong & Baker, 1988). No significant difference was found in validity and reliability between the WBF and five other pain scales when tested in children ages 3 - 18 with alpha level set at $p < .05$ (Wong & Baker, 1988). The WBF had good predictive validity ($p < .007$) and high concurrent validity with VNS and VAS in children ages 8 - 12 in the perioperative setting (Jedlinsky, McCarthy, & Michel, 1999). Researchers found that the WBF scale had good discriminant validity between pre-procedure and post-procedure pain scores in children ages 3 - 18 undergoing painful procedures ($p < .001$; Keck et al., 1996).

VNS. The VNS is an 11-point verbal self-report pain intensity rating scale suitable for children approximately eight-years of age and older who have mathematical literacy skills (von Baeyer et al., 2009). The VNS contains numbers 0-10 representing pain ranging from "no pain" to "the worst possible pain" and is considered a ratio level scale (Dijkers, 2010). The VNS does not require the child to see the numbers 0 - 10 because instructions are delivered verbally. Although scores on the VNS have had a high correlation with ratings from the VAS ($r = 0.847$, $p < 0.00$; Paice & Cohen, 1997), children ages 8 - 17 had higher preference for the VNS over the VAS or the 4-point verbal rating scale (VRS; Bailey et al., 2010). Von Baeyer et al. (2009) reported that the VNS, the Faces Pain Scale-Revised (FPS-R) (Hicks, von Baeyer, Spafford, van Korlaar, & Goodenough, 2001), and the VAS are functionally equivalent for ages 7-17 ($r = 0.87$ and 0.89). In contrast, Bailey et al. (2010) found that VNS and VAS were not interchangeable in children ages 8-12 with differences in pain scores that ranged from -1.8 to 2.5. Construct

validity was shown by the reduction in pain scores among those who had treatment for pain and the higher pain scores in children with severe pain than those with mild or moderate pain (Bailey et al., 2010). Bailey and colleagues (2010) also demonstrated concurrent validity with the VNS and VAS for 202 patients (r_{ic} = 0.93 [95% CI 0.91, 0.95], $p < 0.001$). Miró, Castarlenas, and Huguet (2009) reported that in children post-surgery ages 6 – 16, scores from the VNS and FPS-R were highly correlated ($r = 0.93$, $p < 0.001$). Differences between the mean pain scores were not significant (Miró et al., 2009).

More recently, Ruskin et al. (2014) tested the validity of the VNS (here called the NRS) in children with chronic pain ages 8 – 17. Researchers found good convergent validity comparing the VNS with the colored analogue scale (CAS; $r = 0.58$ to 0.68; all $p < 0.001$). The CAS is a colored 11-point ratio scale that has been validated in children with acute and chronic pain (Bulloch, Garcia-Filion, Notricia, Bryson, & McConahay, 2009; Ruskin et al., 2014). The VNS had discriminant validity when compared with affective pain ratings ($Z = 2.84$; $p = 0.005$). Ruskin and colleagues reported that although absolute differences between the two scales were small (range 0.98 ± 1.4 to 1.75 ± 1.9), the scales were not interchangeable.

FLACC, WBF, and VNS Pain scores were recoded into the following categories: 0 = no pain = 0, 1-3 = low pain = 1, 4-10 = moderate-to-severe pain = 2. It was necessary to recode these scores, because although pain scales were not exactly equivalent, they may be used to provide three distinct equivalent categories.

Demographic and Descriptive Information

ASA Status. The ASA recommends classifying risk of undergoing anesthesia according to a physical health classification system (ASA, 2015). ASA classifications range from ASA I to ASA VI, with ASA I representing a completely healthy individual with low risk to ASA VI

representing a brain-dead person undergoing organ harvest. ASA status was recorded on each child as an important demographic characteristic to describe the sample. See the data collection tool (Appendix A).

Opioid doses and analgesics. Total amount of opioid and analgesic medications delivered in the operating room and PACU was obtained from each EMR. The opioids delivered included medications such as fentanyl, morphine, or hydromorphone. Opioid doses were converted to relative potency equianalgesic doses. For example, 1 mg of IV morphine is equivalent to .01mg of IV fentanyl or .15 mg of hydromorphone (Brennan, Fudin, & Perkins, 2016). An online calculator (Brennan et al., 2016) was used to calculate these equivalencies. Analgesics were recorded in milligrams. See the data collection tool in Appendix A.

Weight-controlled equianalgesic dose. A new variable was created to control for weight-based differences in opioid administration. Total equianalgesic dose was calculated and then divided by the weight in kilograms to create a new weight-controlled equianalgesic dose. This calculation was performed for equianalgesic doses in the OR and in the PACU.

Other demographic variables. Information about gender (male or female); age (whole numbers 4 to 12); history of OSA (yes/no); presence of secondary diagnoses such as history of asthma, snoring or OSA; length of stay in PACU; and race was obtained for each child from the EMRs. Race was grouped into White, Hispanic, African American, Asian, and other, because those were the only racial data available in the EMRs.

Procedures

Selection of Subjects

After obtaining approval from the hospital's Institutional Review Board (IRB), a list of potential subjects between the ages of 4-12 years old who underwent tonsillectomy or T&A

during the previous two-year period was generated. Subjects were enrolled from this list until a sample of 180 subjects, including 90 non-OB/OW children and 90 OB/OW children, was obtained. See Appendix C for a detailed flow chart of recruitment activities. A determination of OB/OW status or normal weight status was identified first as data for each potential subject were examined. See Appendix A. After saturation of one weight category was reached, additional subjects were only enrolled to fulfill the remaining number required in the other weight category. A table was maintained linking subjects to hospital identification numbers on a separate spreadsheet. See Appendix A. Tables with hospital identifiers were destroyed after data analysis was completed.

Informed Consent

A waiver of informed consent was requested from and granted by the hospital's IRB according to provisions established in 45CFR 46.117 (c). The research presented minimal risk to subjects and did not involve any additional tests or procedures. The only identified risk was loss of privacy from EMR access during data acquisition.

Data Collection

All data were collected by the principal investigator (PI) and entered into a password-protected database. Data were retrieved from the EMR at Cook Children's Medical Center. Subjects were enrolled in the study after determination of BMI and weight grouping variable. Data were entered into data collection tables in REDCap™ an online data storage and securement system.

Ethical Considerations

Permission to conduct the study was obtained from the IRBs of University of Texas at Arlington and from Cook Children's Medical Center. The risk to children or their families was

minimal because all data were collected from EMRs and de-identified before recording. Subjects selected for the study were not aware that they were in the study and did not participate in any study procedures. Although the study involved children who are considered a vulnerable population, the children did not have any risk of physical or emotional harm because they did not participate in any study procedures and all data collected were pre-existing in the EMRs. An anesthesiologist on staff at Cook Children's served as PI of record for the purposes of adhering to Cook Children's policies.

The IRBs determined that the study should undergo expedited review because the main risk was loss of privacy by examination of the medical record. To protect against loss of privacy, the following procedures were followed. The list of potential subjects was maintained in a separate electronic document with password protection. A single one to three digit number linked data collected during the study to the original list of potential subjects, but the outcomes data did not contain a direct link to the EMR. Refer to Appendix A for an example of how patient identifiers were separate from other collected data.

The PI had documented training in protection of human subjects in research, having completed the required training modules of the human research curriculum from the Collaborative Institutional Training Initiative (CITI) on March 8, 2006. See Appendix D. The PI maintained compliance with required refresher modules since that time. The most recent recertification was received December 22, 2015. The PI passed a basic course for IRB members on June 24, 2014. Additional modules for good clinical practice were completed on September 29, 2011 and December 28, 2015. The PI also had brief service as an IRB member at the institution where the research was conducted. The PI had clearance to conduct research of this type from the Research Authorization Subcommittee at Cook Children's. See Appendix E.

Data Analyses

Data preparation

Data were cleaned prior to statistical analysis. The PI examined the database for any obvious errors in data collection, such as improbable digits or letters. The PI re-checked the EMR when necessary for missing data or improperly coded data prior to destroying the file with medical record numbers. Missing data were handled by the following procedures. If a missing value occurred in an ordinal variable such as a pain score, the decision was made to use the most recent pain score. Nurses in this institution document by exception, meaning a new documented pain score would be expected for a change in status. Missing pain scores were also obtained by assessing the nurse use and timing of opioid administration because hospital policy requires nurses to administer medications for pain scores ≥ 4. The assumption of a pain score of ≥ 4 was made in the case of a missing pain score and the observance of a nurse-administered opioid. After noting Spanish listed as the language of choice in a small number of children with missing racial codes, Hispanic was entered as the race for these children. There were no other missing categorical variables.

Data distribution was evaluated for normality using Shapiro Wilk's W test. It was not necessary to exclude any outliers. Statistical analysis was performed with SPSS, Version 21 (IBM, 2012).

Description of the Sample

Demographic characteristics were reported as frequencies and percentages for categorical variables such as gender, weight status, race, history of receiving non-opioid medications in OR or PACU, episodes of early moderate-severe PTP, history of OSA, and other comorbidities.

Frequency, percent, mode, median, range, mean, and standard deviation were calculated for continuous variables, including age, opioid equivalents for medications give in OR and PACU, calculated uncontrolled PTP, and length of stay in the PACU.

Research Questions

Statistical analysis was performed with SPSS (IBM, 2012) and/or Microsoft Excel (2011)

Research Question #1

Will OB/OW children have greater risk for early PTP when controlling for weight-controlled equianalgesic doses delivered in the OR, non-opioid doses delivered in the OR, gender, age, history of OSA, and race?

Multiple logistic regression analysis was performed to answer the first research question. The following are assumptions of multiple logistic regression: the predictor variables are independent, there is little to no multicollinearity, and there is linearity of predictor variables and log odds (Statistics Solutions, 2016a). Initial data analysis included univariate, bivariate, and multivariate assessment to test for multicollinearity and determine that assumptions were met (Starkweather & Moske, 2011). Model R^2 results were generated to determine the relationships between the variables. Predictors in the equation were OB/OW status, gender, age, history of OSA, race, weight-controlled equianalgesic dose, and non-opioid analgesic use. The criterion variable was the early PTP score. The Hosmer-Lemeshow test was performed to detect goodness of fit between the data and the model (Paul, Pennell, & Lemeshow, 2013). Unadjusted and adjusted odds ratios and 95% confidence intervals were examined to determine the likelihood of greater early PTP based on weight status.

Research Question #2

Will weight status be associated with increased uncontrolled PTP in the PACU in OB/OW children?

The Spearman's rank correlation and Kaplan-Meier survival analysis were performed to answer research question #2. The Spearman's rank correlation tested correlation between weight group and total amount of uncontrolled PTP. The Spearman's rank correlation does not have assumptions about data distribution and is appropriate for at least ordinal data (Grove & Cipher, 2017). The Spearman rank-order correlation does assume that observations are independent (Grove & Cipher, 2017). The Spearman rank-order correlation would be appropriate to use with PTP scores that have been recoded into ordinal level scores. Calculated uncontrolled PTP and the grouping variables OB/OW and non-OB/OW were used for the Kaplan-Meier survival analysis calculations. Kaplan-Meier survival analysis requires that the following assumptions be met: two mutually exclusive states, time to event clearly defined and measured, minimalized left-censoring, independence of censoring and the event, absence of secular trends, similar amounts and patterns of censorship in each group (Laird Statistics, 2013). Assumptions for Kaplan-Meier survival analysis including proportional hazards (Bewick, Cheek, & Ball, 2004) were determined during statistical analysis.

Delimitations

This study was designed to answer questions about pain outcomes in OB/OW children undergoing T&A or tonsillectomy. The population was limited to preschool and school aged children because this is the age range with the highest rates of tonsillectomy. There is also a large difference in cognitive development between infants and adolescents (Piaget, 1950/2001). A study using such narrowed age ranges produced results that may not be generalizable to very young children and teenagers.

The focus of the study was on pain outcomes of the children, not on nurses' or healthcare providers' actions. There was a need to discover if there are weight-based risks for prolonged PTP. There were some assumptions that could be made about PTP in children. The child's pain scores immediately after waking from surgery may partly reflect any measures the anesthesiologist or nurse anesthetist (CRNA) took to lower pain. Pain scores that occurred later in the recovery process may have likewise reflected actions of the PACU nurse to manage pain in the child. Because of this, research question #1 included controls for equianalgesic doses to help establish if pain was associated with OB/OW when opioids were constant. Many other variables could have been involved in the pain experience of the child, such as gender, age, and race. These were considered as possible intervening variables in the pain experience of the child.

The setting of this study may also have limited generalizability of results of this study. Children in this study live in Texas. It was anticipated that a large percentage of the children in this study would be racially white (Martin et al., 2014). Pain outcomes may vary based on genetic differences (James, 2013), so results may not be generalizable to other populations with different racial backgrounds.

Summary

This chapter included a discussion of the methodology proposed to study PTP in OB/OW children. The focus of this methodology was to study PTP outcomes in OB/OW children. The research design, sample, setting, and measurement methods were discussed. The procedures and data analysis plan were included. Delimitations were mentioned to guide application of findings to the broader public.

CHAPTER 4

Associations Between Weight Status and Post-Tonsillectomy Pain Experiences in Children: Results

The results of analysis of retrospective data from 90 OB/OW children and 90 non-OB/OW children who had tonsillectomy between April 2016 and July 2016 are presented in this chapter. These results provide information about whether or not OB/OW status was associated with incidence of early moderate-to-severe PTP and whether or not OB/OW status was associated with longer episodes of uncontrolled moderate-to-severe PTP. Age, gender, race, and opioids delivered in the OR were used in the model as covariates with weight status in testing for occurrence of early PTP.

Study Results

Sample Description

Study participants were selected from a list of potential subjects who had tonsillectomy from April 2016 - July 2016. The sample size was 180 children between the ages of 4 - 12, with half of the children in the OB/OW category and the other half non-OB/OW. Information about gender, race, age, amounts of opioid and non-opioid analgesic medications in the OR and PACU, and pain scores was collected on all subjects, as well as OSA status, other comorbidities, and length of stay in the PACU. There were no missing data in the analysis.

Demographic characteristics for the two groups were as follows. Girls comprised 54% of the sample (Table 3, $p = .77$). OB/OW children had significantly higher ASA scores ($p = .03$). Only 22.2% of the children had OSA (Table 3), including 16.7% of non-OB/OW children and 27.8% of OB/OW children ($p = .07$; Table 5). The average BMI-z score for non-OB/OW children was 49.03 (SD = 24.89) compared to the average BMI-z score for OB/OW children of

Table 3. Description of entire sample

Variable	N (%)
Gender	
Girls	98 (54)
Boys	82 (45.6)
History of OSA	40 (22.2)
History of asthma	33 (18.3)
History of gastro-esophageal reflux	5 (2.8)
History of heart disorder	7 (3.9)
History of developmental delays	28 (1.6)
History of prematurity of infancy less than 36 weeks	9 (5.0)
History of attention deficit disorder	6 (3.3)
History of seizures	6 (3.3)
ASA Status	
1	52 (28.9)
2	124 (68.9)
3	4 (2.2)
Race	
Caucasian/White	147 (81.7)
Black/African American	22 (12.2)
Hispanic	2 (1.1)
Asian	1 (0.6)
Other	7 (3.9)
Unknown	1 (0.6)
Received non-opioids in the OR	53 (29.4)
Received non-opioids in the PACU	14 (7.8)
Early PTP	61 (33.9)

94.96 (SD = 4.25) with an overall mean of 71.99 (SD = 29.10; $p < .0001$ (Table 4). The overall sample was 81.7 % White/Caucasian, and the two weight status groups were not significantly different by race ($p = .57$). Children did not have significantly longer lengths of stay in the PACU based on weight status (Table 4).

All children received opioid pain management in the OR, and 35.6% of children received no additional opioids in the PACU. Average weight-controlled opioid dose in OR was .20 (SD = .05) for non-OB/OW children and .15 (SD = .04) for OB/OW children ($p < .0001$). OB/OW children received an additional 1.2 mg of opioid on average (equianalgesic dose; SD = 1.15), which was significantly higher than non-OB/OW children who received an average of .87 mg

(SD = 1.08; p = .033). Mean weight-controlled opioid doses in the PACU were not significantly different (non-OB/OW: $\bar{x}$ = .03, SD = .04; OB/OW: $\bar{x}$ = .03, SD = .03;. p = .994). Further description of the sample is presented in Tables 3 - 6.

Table 4. Description of sample (continuous variables)

Variable	Non-OB/OW Mean (SD)	OB/OW Mean (SD)	Total Mean (SD)	*P*
Age (years)	7.61 (2.22)	8.13 (2.2)	7.87 (2.23)	.12
Weight (kilograms)	26.24 (8.12)	39.93 (15.80)	33.08 (14.28)	.0001
BMI-z percentile	49.3 (24.89)	94.96 (4.25)	71.99 (29.1)	.0001
Length of stay Phase I PACU (minutes)	46.54 (14.15)	43.54 (17.45)	45.04 (15.91)	.21
Length of stay Phase II PACU (minutes)	94.72 (50.08)	100.78 (34.93)	97.73 (43.20)	.35
Equianalgesic dose for OR (milligrams)	5.01 (1.75)	5.60 (1.89)	5.30 (1.84)	.03
Equianalgesic dose for PACU(milligrams)	.87 (1.08)	1.2 (1.15)	1.05 (1.13)	.03
Weight-controlled opioid dose in OR	.20 (.05)	.15 (.04)	.17 (.05)	.0001
Uncontrolled PTP (minutes)	8.37 (14.49)	16.63 (24.9)	12.50 (20.73)	.21

Table 5. Description of sample by weight group

Variable	Non OB/OW n (%)	OB/OW n (%)	Total n (%)
Early PTP	31 (34)	30 (33)	61 (33.9)
Race			
Caucasian	76 (84.4)	71 (78.9)	147 (81.7)
Hispanic	1 (1.1)	1 (1.1)	2 (1.1)
Black/African American	8 (8.9)	14 (15.6)	22 (12.2)
Asian	0 (0)	1 (1.1)	1 (0.5)
Other	5 (5.6)	2 (2.2)	7 (3.9)
Unknown	0 (0)	1 (1.1)	1 (0.5)
Admitted for overnight stay	3 (3.3)	2 (2.2)	5 (2.8)
ASA classification			
I	31 (34.4)	21 (23.3)	52 (28.9)
II	59 (65.6)	65 (72.2)	124 (0.6)
III	0 (0)	4 (4.4)	4 (2.2)
History of OSA	15 (16.7)	25 (27.8)	40 (22.2)
Received opioid in OR	90 (100)	90 (100)	180 (100)
Received opioid in PACU	52 (57.8)	64 (71.1)	116 (64.4)
Received non-opioid in OR	28 (31.1)	25 (27.8)	53 (28.9)
Received non-opioid in PACU	4 (4.4)	10 (11.1)	14 (7.8)

Table 6. Average Equianalgesic Doses and Weight-controlled doses in OR and PACU

Variable	Mean	SD	*p*
Equianalgesic opioid doses in OR			
Non-OB/OW	5.0	1.75	.03
OB/OW	5.6	1.9	
Equianalgesic opioid doses in PACU			
Non-OB/OW	.87	1.08	.03
OB/OW	1.2	1.15	
Weight-controlled opioid doses in OR			
Non-OB/OW	.2	.05	.000
OB/OW	.15	.04	
Weight-controlled opioid doses in PACU			
Non-OB/OW	.03	.04	.994
OB/OW	.03	.03	

Research Question #1

Will OB/OW status in children predict greater moderate-to-severe PTP compared to non-OB/OW status in children when controlling for weight-controlled opioid doses, non-opioid analgesics received, gender, age, history of OSA, and race?

Multiple logistic regression revealed that OB/OW status did not significantly increase the odds of experiencing early PTP (adjusted OR = 1.391, $p = 0.369$; Table 7) when controlling for age, gender, race, weight-controlled equianalgesic opioid doses in the OR, non-opioid analgesics, and history of OSA. Multicollinearity statistics were within an acceptable range and linearity was noted with visual inspections of scatterplots. Binary logistic regression revealed weight status did not predict early PTP (OR = 1.03, $p = .875$) without covariates in the equation.

Table 7. Test of predictors of early moderate-to-severe PTP

Variable	Adjusted OR (95% CI)	*p*
Race (White)	.644 (.271 - 1.532)	.320
Equianalgesic in OR/weight ratio	.025 (.000 – 31.693)	.312
Age (years)	1.116 (.964 – 1.292)	.171
Non-opioid analgesic use	.838 (.410 – 1.714)	.628
Male	1.385 (.718 – 2.671)	.332
History of OSA	.588 (.278 – 1.243)	.164
OB/OW	1.391 (.678 – 2.854)	.369

Research Question #2

Will OB/OW status in children be associated with increased time to pain control in the PACU compared to non-OB/OW weight status in children undergoing tonsillectomy?

For this analysis, both Spearman's rank correlation and Kaplan-Meier survival analysis were computed to determine if weight status was associated with difficult to control moderate-severe PTP. Spearman's rank correlation was used because the data did not have a normal distribution and violated assumptions for Pearson's correlation. Kaplan-Meier survival analysis calculations were performed to test the time until moderate-to-severe PTP was controlled in each group. Each child in the study showed an improvement in pain scores to either no or low pain prior to discharge from the PACU.

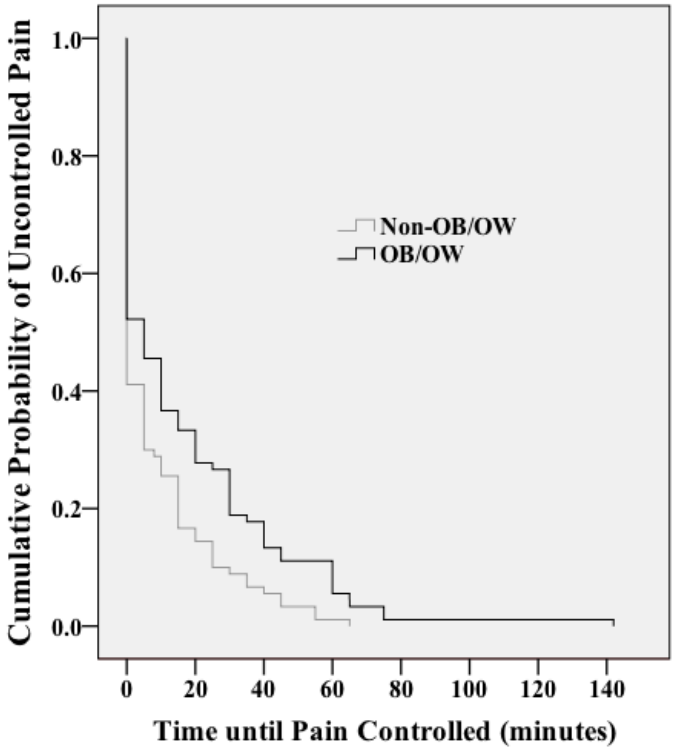
There was a statistically significant correlation between weight status and uncontrolled PTP ($r_s(178) = 0.16$, $p = 0.03$). OB/OW status was associated with longer uncontrolled pain. Weight status explained 2.5% of the variance in the uncontrolled PTP according to these calculations.

Kaplan-Meier survival analysis indicated that median uncontrolled PTP was 5.0 minutes in OB/OW children compared to 0.0 minutes in non-OB/OW children (Table 8). OB/OW children were significantly more likely to have longer episodes of uncontrolled moderate-severe pain in the PACU (χ^2 (1) = 8.353, p = .004; Figure 3).

Table 8. Mean and median time elapsed until pain controlled

Group	Mean	Median
Non-OB/OW children	8.367	.00
OB/OW children	16.633	5.00
All children	12.500	.00

Figure 3. Time elapsed until pain controlled



Summary

This chapter included a description of the analyses used to explore associations between OB/OW status in children and risk for early PTP as well as more difficult to control PTP. The sample included 180 children between the ages of 4 - 12 who had tonsillectomy with or without adenoidectomy between April 2016 and July 2016. Descriptions of the entire sample were provided. Multiple logistic regression was used to answer the first research question. Spearman's rank correlation and Kaplan-Meier survival analysis calculations were used to answer the second research question. Weight status was not a significant predictor of early PTP; however, OB/OW status was associated with longer periods of uncontrolled PTP.

CHAPTER 5

Associations Between Weight Status and Post-Tonsillectomy Pain Experiences in Children: Discussion

The following chapter contains a discussion of the major findings of this study. Results are presented and compared to other studies and the larger population. Links are made to the theoretical framework. Study limitations, conclusions, and implications for nursing practice and education are discussed. In addition, future research is proposed based on these findings.

Interpretation of Major Findings

The findings from this study provide partial confirmation of findings from other research. OB/OW status did not predict higher early PTP, in contrast to outcomes of a study by Nafiu, Shanks, et al. (2013) but matching findings by Scalford et al. (2013). Unlike the results from this study, Nafiu, Shanks, et al. found OB/OW status to be a predictor of early PTP when controlling for age, gender, ASA status, past surgical history, history of asthma, history of OSA, and equianalgesic doses. Only 21% of the entire sample in the study by Nafiu, Shanks, et al. experienced moderate-to-severe PTP compared to 33.9% in this study and 39% in the study by Scalford et al. This finding may be partly due to a difference in methodology. Only about one-third (35.1% in Nafiu, Shanks, et al.; 38 % in Scalford et al.) of the children in their studies were OB/OW whereas the current study had equal numbers of OB/OW and non-OB/OW children due to a different recruitment strategy. Increased risk for longer episodes of moderate-to-severe PTP in OB/OW children was a new finding. Neither Scalford et al. nor Nafiu, Shanks, et al. examined risk for uncontrolled moderate-to-severe pain. Nafiu and colleagues examined early PTP in contrast to Scalford and colleagues, who examined both early PTP and the first pain score in Phase II PACU.

The demographics and inclusion/exclusion criteria varied among these three studies (Table 9). For example, Scalford et al. (2013) included children between the ages of 5 - 10 and excluded children with ASA III or higher and also children with behavioral issues, developmental delays, or those who required admission. In contrast, Nafiu, Shanks, et al. (2013) included all children between the ages of 3 - 17. This study was comprised of children between the ages of 4 - 12, including those with higher acuity similar to those in the Nafiu, Shanks, et al. study.

Table 9. Comparison to similar populations

Variables	Current study %	Nafiu, Shanks, et al. (2013) %	Scalford et al. (2013) %
Gender			
Male	45.6	56.3	52
Female	54.4	43.7	48
Early PTP	33.9	21	39
Race			
White	81.7	*	46
Black	12.2	*	37
Asian	1.1	*	2
Hispanic	0.6	*	*
Other	3.9	*	*
Unknown	0.6	*	*
OSA diagnosis	22.2	19.5	*
History of asthma	18.3	22.1	*
History of gastro-esophageal reflux	2.8	6.9	*

Note. Comparison of demographic information between similar studies.
* Information not provided in article. Adapted from "Association of high body mass index in children with early post-tonsillectomy pain" by Nafiu, Shanks, et al., 2013, *International Journal of Pediatric Otorhinolaryngology, 77*, p. 258. Copyright 2012 by Elsevier. Also adapted from "Pain management of children aged 5 to 10 years after adenotonsillectomy" by Scalford et al., 2013, *Journal of Perianesthesia Nursing, 28*, p. 356. Copyright 2013 by American Society of PeriAnesthesia Nurses.

Nafiu, Shanks and colleagues (2013) found an association between higher ages in children and increased reporting of early PTP, but the children > 12 years were only a small

percentage of the entire sample (14.7%). In addition, older children were more likely to be OB/OW. Including a small group of older children possibly skewed results and makes comparison between samples difficult. The sample sizes were very different for these three studies. Scalford and colleagues (2013) had a sample of 100; Nafiu, Shanks, and colleagues had a sample of 462 children; whereas this study had a sample of 180 children. The average age of the children in the study by Scalford et al. was seven years, as found in this study. The incidence rates of OSA and asthma were comparable between the study by Nafiu et al. and this study, but Nafiu, Shanks, and colleagues found more than twice the gastroesopheal reflux rate as was reported in this study.

Roughly one-third of the children in this study received a dose of non-opioid such as either acetaminophen or ibuprofen. Scalford et al. (2013) also discussed use of non-opioid analgesic medications such as acetaminophen to control pain, but the reported use was small. Only 2% of patients received a dose of acetaminophen in the study by Scalford et al. It is possible that use of non-opioid analgesics could account for the lower rates of early PTP found in this study compared to the study by Scalford et al.

Representativeness of the Sample

The gender and racial demographic distributions in this study were different from the population estimates for Texas and the United States (Table 10). Girls were somewhat overrepresented in this study but to a lesser degree than what was reported by Cullen et al. (2009). Although approximately 58% of the population in Fort Worth is considered Hispanic (U. S. Census Bureau, 2016), the numbers obtained in this study were quite different. Whites were overrepresented and Hispanics were underrepresented as coded. This difference could be due to coding practices at Cook Children's Medical Center

where secretaries in the admissions office code the demographic intake information. Forced choices in the EMR prompt secretaries to code children into the only racial categories available, and there is not a strictly Hispanic category available for them to choose. This may have forced them to code many Hispanic children as White. Comparisons could also be made between this sample and national reports of OSA and asthma (Table 10). OSA occurred in these children at almost 4 times the rate of nationwide estimates. The prevalence of asthma in this study was

Table 10. Comparison of sample to Texas and United States populations

Variables	Current study %	Cullen (2009) %	Texas* %	United States* %
Gender				
Male	45.6	42.6	51	51
Female	54.4	57.4	49	49
Race				
White	81.7		32	52
Black	12.2		12	14
Asian	1.1		4	5
Hispanic	0.6		49	25
Other	3.9		3	4
Unknown	0.6			
OSA diagnosis	22.2			5.7**
History of asthma	18.3		8	9
History of gastroesophageal reflux	2.8			Unknown***

Note. Adapted from "Ambulatory surgery in the U. S., 2006" by Cullen et al. (2009), *National Health Statistics Reports* (No. 11). Hyattsville, MD: National Center for Health Statistics.
*All children under 18. Comparison United States Census population statistics adapted from "KIDS COUNT Data Center" by the Annie E. Casey Foundation, 2016.
** Population-wide statistics for pediatric OSA adapted from "Diagnosis and Management of Childhood Obstructive Sleep Apnea Syndrome" by Marcus et al., 2012, *Pediatrics*, 130, p. e171. Copyright 2012 by the American Academy of Pediatrics.
*** Statistics adapted from "Update on the epidemiology of gastro-oesophageal reflux disease: a systematic review" by El-Serag, H. B., Sweet, S., Winchester, C. C., and Dent, J., 2014, *Gut*, 63, p. 4. Copyright 2013 by El-Serag et al.

twice that of state and national estimates. A higher prevalence of asthma and OSA would be expected in a population of children undergoing tonsillectomy (Nafiu, Shanks, et al., 2013).

Link to Theoretical Framework

Results from this study supported segments of the *PTP Factors in OB/OW Children* framework. For example, each child in the study had some measure of *factors influencing pain in OB/OW child* and all experienced the *surgical insult of a tonsillectomy*. *Mechanical stressors* were indirectly measured by controlling for history of OSA. Clinician delivered analgesics were the only *mediating factors* tested in this model. The finding that weight status had an association with longer episodes of uncontrolled pain in OB/OW children provided support for this model. *Genetic variants of drug metabolism* and *soothing factors* were not measured in this study, so it is unknown how these factors may have affected results.

The *surgical insult of the tonsillectomy* could vary based on surgical technique. This study included patients from multiple physicians, and the study design did not control for technique. Coblation is the most common surgical technique for tonsillectomy used at this facility. Coblation has been associated with lower PTP scores than other techniques such as electrocautery (Jones et al., 2011).

Excess body fat as a pro-inflammatory state was combined with *mechanical stressors* such as excess parapharyngeal tissue and the physiological insult of the surgical wound to promote higher PTP in OB/OW children as mediated by *clinician delivered analgesics*. *Mechanical stressors* in children undergoing tonsillectomy could not be directly measured. Indirectly, history of OSA was a limited measure of how *mechanical stressors* might influence PTP outcomes in OB/OW children. Children with OSA, particularly OB/OW children with OSA, have an airway dynamic that could potentially increase mechanical stressors in the

pharynx after tonsillectomy because of excess parapharyngeal tissue. It is possible to grade severity of OSA with polysomnography, but severity of OSA was not a measured variable in this study. OSA is an inexact measure of *mechanical stressors* due to OB/OW. OSA occurs in both OB/OW children and non-OB/OW children. The OB/OW group had reported rates of OSA that were only 11% higher than the non-OB/OW group. OSA was not a significant predictor of pain outcomes in this model. It is possible that controlling for grades of OSA would make a difference in study outcomes. *Clinician delivered analgesics* would vary based on a child's age and weight and unmeasured individual differences between clinicians. Analgesic doses were converted to equianalgesic doses and combined with weight to create a new variable that controlled for some of these differences. Clinicians may have had internal biases and beliefs about practice that influenced decisions about analgesic dosing. It was impossible to control for this in a retrospective study.

Discussion

The weight-based association of uncontrolled PTP has important clinical significance even though the reported effect was small. Average uncontrolled pain in OB/OW children was twice that of non-OB/OW children, and median uncontrolled PTP was five minutes vs. zero minutes. In the clinical setting, five minutes of suffering in a child is significant to the child, parents, and clinicians. Five to 10 minutes of extra expression of pain and suffering could also create differences in drug administration and lead to an extra dose of opioid. Pain medication titration is often ordered in increments of every 5 - 10 minutes. The factors involved in the relationship between uncontrolled PTP and weight status are yet to be explored.

Uncontrolled PTP in children in the PACU was most likely a reflection of multiple factors in this study. The clinicians in the OR provided pre-emptive pain management for all

patients, including non-opioid analgesics in about one-third of patients. The PACU nurses further influenced the experience of pain by delivering additional analgesics. Equianalgesic doses delivered in the OR and PACU were significantly higher in OB/OW children, but weight adjusted doses must be considered in children to do accurate comparison. OB/OW children received significantly less weight-controlled opioid doses in the OR than non-OB/OW children. OB/OW children did not receive significantly different weight-controlled opioid doses in the PACU. It is possible that uncontrolled PTP in OB/OW children was partly due to the significant difference in weight-controlled equianalgesic doses delivered in the OR. It is unknown if this difference in weight-based dosing occurred because clinicians often switch from weight-based calculation in children to adult recommended dosing when the weight is over 50 kilograms. Adults generally receive standardized dosing of medications at the same milligrams regardless of weight. It could be that OB/OW children had obesity-related increased levels of inflammation contributing to uncontrolled PTP. It is likely that genetic variants in drug metabolism and soothing factors influenced outcomes, but it is unknown how much of an influence this would have had and whether or not this would have been different between groups.

Early PTP scores in this study were at least a partial reflection of how much analgesic was delivered by the clinicians in the OR. Most children experienced low or no pain in the first 15 minutes after extubation. All children received opioid pain management in the OR, but less than one-third received non-opioid analgesics in the OR. It is possible that early PTP would have been higher in certain OB/OW children if further stratification could be done, such as to account for severity of OSA or other currently unknown factors.

Failure to find an association between weight status and early PTP may have been due to variations in pre-emptive pain management in the OR. It is routine practice for clinicians to

deliver intravenous dexamethasone and ondansetron in the OR to reduce incidence of pain and nausea in all children at Cook Children's Medical Center (Hermans et al., 2012; Shakeel, Supriya, Al-Adhami, & Kubba, 2009). It was assumed but not verified that all children received weight-based dosing of dexamethasone and ondansetron in the OR. In addition, clinicians administered opioid analgesic medications to reduce pain in all children in the OR, but how much opioid analgesic medications were adjusted for higher weights in OB/OW children is unclear. Less than one-third of the children received non-opioid analgesics such as ibuprofen or acetaminophen in the OR. It is worth noting CRNAs provided pain management in the OR whereas PACU nurses provided pain management in the PACU. CRNAs deliver medications to children who are intubated, but PACU nurses are deciding about medication administration with children who are extubated. Both sets of nurses are probably estimating future pain responses of the child, but PACU nurses are possibly able to titrate opioid medications to effect with better accuracy because the children are awake.

About one-third of children experienced early moderate-to-severe PTP. This early PTP rate fell in-between reported rates (23.6% vs. 39%) by Nafiu, Shanks, et al. (2013) and Scalford et al. (2013). The rate of early PTP (39%) in the study by Scalford and colleagues might have been slightly higher if the studies had used the same methodology. Scalford and colleagues used ≥ 5 as the cut-off for moderate-to-severe PTP as opposed to the cut-off score of ≥ 4 used in both the study by Nafiu, Shanks, et al. and this study. Nafiu, Shanks, and colleagues found that OB/OW children were more likely to experience early PTP despite their overall low rate (21%) of early PTP for the entire sample. This could be due to differences in clinical practice based on clinician beliefs and biases about the pain experience and about best pain management practices; however, Nafiu, Shanks, and colleagues used a population that included older children and still

found increased age associated with increased early PTP. It is unknown which practices in that institution led to a much lower early PTP rate than in this study. Practices may vary at different institutions. There is no research that examines clinician beliefs and biases in treating PTP in OB/OW children.

The pain tools used in this study may not have been sensitive enough to detect all of the differences in pain expression among individuals. It is unknown if more sensitive pain scoring tools would change results in an analysis of weight-based risk for early PTP.

Use of three different, non-equivalent pain-scoring tools was problematic. Self-report tools are considered the most accurate but cannot be used in a child too drowsy to provide a response. The PACU is a fast-paced environment. Nurses do not have time in the clinical setting to administer extensive and time-intensive pain assessment tools. Nurses may be using intuition, relying on parent concern or parent report, or paying attention to other factors when making a judgment call about how much pain a child is experiencing. These factors influence the nurse's decision to treat for pain currently expressed or even anticipated pain. FLACC was most commonly used in the first 15 minutes after extubation, but as the children became more alert, some nurses switched to documenting WBF or VNS scores in children. A study design with binary pain outcomes was chosen because of non-equivalency in pain scoring tools. Scalford and colleagues (2013) also reported on outcomes of three different pain tools in their study.

Underlying differences in levels of inflammation between OB/OW children and non-OB/OW children were unknown. Higher levels of pre-surgery inflammation might influence a child's healing process and experience of pain. The influence of increased baseline inflammation on PTP in OB/OW children is unknown; however, it is known that pain decreases

as inflammation decreases and healing occurs. It was assumed that all children received dexamethasone to lower inflammation, nausea, and vomiting. Less than one-third received non-opioid analgesic medications; ibuprofen was an unmeasured fraction of these medications in the PACU. The only non-opioid analgesic delivered in the OR was intravenous acetaminophen.

Variations in drug metabolism may have increased sedation effects or provided increased pain relief in some children or no pain relief in other children. Genetic testing related to drug metabolism is not routinely performed in children. In addition, children with fatty liver disease could be experiencing alterations in gene expression that would influence drug metabolism by the up-regulation and down-regulation of enzymes involved in drug metabolism. How this influences PTP in OB/OW children is unknown.

Soothing factors such as how much comfort was provided by a parent or nurse, the level of noise in the environment, or a measure of eating as analgesia were not examined. Valid and reliable tests to measure eating as analgesia have not been developed. Nurses measure fluid intake in the PACU, but this would be an imprecise measure of eating as analgesia, complicated by differences in levels of nausea, levels of awareness, amounts of prophylactic medications received, and unknown parental and clinician influences.

Presence of hypercarbia in a child with history of severe OSA could have created a situation where the child had lower pain scores than would be otherwise expected (Brown et al., 2006). Monitoring of carbon dioxide levels to detect hypercarbia is commonly performed in the OR but less frequently in the PACU. It is possible that some PACU nurses hesitated to deliver analgesics if a child was very drowsy as a result of unmeasured hypercarbia or increased sensitivity to previously delivered analgesics. These children may have presented as pain-free only to wake up with severe pain as anesthetic agents were metabolized. OB/OW children were

at particular risk of experiencing longer episodes of PTP. Variations in grades of OSA may have influenced the outcomes of this study, but these were not measured.

Researchers have proposed that children with significant ongoing history of severe hypoxemia at home may have heightened analgesic sensitivity to opiates (Brown et al., 2006). It is possible that some of the children in this study experienced low early PTP because of this heightened sensitivity. OSA had a significant modest effect on risk for early PTP in the study by Nafiu, Shanks, et al. (2013), but the effect was evident in a sample size of 462 compared to this study of 180 children. Perhaps an association between PTP and OB/OW status would have been observed if there had been a larger sample size with children grouped by severity of OSA. The sample size for this study was calculated based on the effect size reported by Nafiu, Shanks, et al. (2013), and that study revealed a significant effect without stratifying severity of OSA.

Study Limitations

There were a number of limitations in this study. It was impossible to control for certain types of error in measurement due to the retrospective methodology. Although all instruments used to measure pain in the clinical setting of this study have well-documented validity and reliability, reliability testing of the pain scoring tools could not be performed in this retrospective study. Clinical use of three different pain-scoring tools further limited the statistical analysis of pain scores. Failure to track OSA severity may have also influenced study results.

The sample reflected the pertinent populations necessary for generalizations. The data collected were from a short time period; this strengthened the study by reducing confounding variables. Major practice and clinician changes were avoided in this sample because of the narrow time frame. There were slightly more girls than boys in the sample which meant girls were over-represented compared to state and national population statistics. The OSA and asthma

rates were very similar to what has been reported in similar studies but different from the general pediatric population in the United States. This finding was not surprising because OSA is a primary indicator to perform tonsillectomy in children. Asthma does not have a direct link to PTP, but the presence of an acute asthma flare may affect a child's ability to breath. A clinician making decisions about the preemptive use of opioid analgesics might withhold medication or give smaller doses of opioid medications when anticipating possible breathing difficulties. This could indirectly influence a child's risk for increased pain during recovery.

Conclusions

OB/OW children in this study were at risk of longer episodes of uncontrolled PTP than other children. OB/OW status in children was not associated with higher early PTP scores, even when controlling for other variables such as age, gender, race, history of OSA, and amount of opioid administered. Pain can be better quantified by capturing severity and length of time as opposed to a single highest pain score. Risk for uncontrolled PTP episodes has greater clinical significance than risk for higher early PTP scores because uncontrolled PTP episodes are indicative of prolonged suffering for the child.

Implications for Nursing

There are a number of implications for nursing based on the results of this study. Nurses have a moral imperative to assess, treat, and prevent pain if possible. CRNAs can make changes based on these outcomes to better control pain in OB/OW children. PACU nurses are also in a position to implement practice changes that can alter the way children recover from tonsillectomy. Knowing that OB/OW children are at risk of uncontrolled PTP, nurses can maximize use of soothing factors to increase comfort and reduce pain. Soothing factors such as parental presence (Scalford et al., 2013), music therapy (Klassen et al., 2008), or therapeutic

suggestion under anesthesia (Martin et al., 2014) could be promoted with this population to reduce the risk of prolonged PTP.

The majority of children had early PTP well controlled in this study, but improvements could be made. For example, less than one-third of children received non-opioid analgesics in the OR. It could become standard practice to use non-opioid analgesics in the OR on all children. This might lower risk for PTP in OB/OW children as well. Nurses and other clinicians could consider use of non-steroidal anti-inflammatory medications to lower inflammation in children, particularly in OB/OW children known to be at risk for higher baseline levels of inflammation.

Nurse educators can use the results of this study to help clinicians understand risks for uncontrolled PTP and ways to safely manage pain in OB/OW children. A reminder that uncontrolled acute pain is a risk factor for development of chronic pain later in life (IOM, 2011) could be a powerful motivator to improve practice. Professionals may have knowledge of various soothing factors to use with children, but they may not have developed skill sets to implement these in practice. Nurse educators may design practice sessions to train clinicians about how to incorporate soothing factors in clinical practice. Clinicians need comprehensive education about pharmaceutical use in OB/OW children. For example, a nurse or physician may choose fentanyl over morphine as a shorter acting drug, thinking the child can be monitored carefully for a shorter amount of time. Fentanyl has lipophilic properties (Ross et al., 2015) and may be metabolized differently in OB/OW children than in normal weight children. It is possible that morphine could be a more reliable choice for PTP in OB/OW children. Education about maximizing use of non-opioid analgesics in this population is also important. Pre-emptive

pain management is a practice that can be encouraged with all children undergoing painful surgeries.

Future Research

Research is needed to support PTP management guidelines in OB/OW children. Secondary analysis of this study and other studies of weight-associated PTP outcomes could be performed to obtain baseline knowledge of the current opioid dosing practices in OB/OW children undergoing tonsillectomy. The recommendations by Ross et al. (2015) about medication management in critically ill OB/OW children could be applied and studied in children post-tonsillectomy to test for generalizability. Other novel treatments to lower PTP in this population could also be studied.

Pain research is limited by the sensitivity and variety of the measurement tools used to measure pain outcomes. Pain scales are problematic in pediatric research because of the need to use multiple scales in the clinical setting. Better measures of pain would provide more accurate research results. Future research could incorporate measures of cytokines as a way to more objectively measure pain-related outcomes; however, there is no single biomarker for pain or pain intensity.

There are no studies that support weight-based differences in cytokine levels in children undergoing tonsillectomy. Study results in adult populations support the idea that there are weight-based differences in cytokine levels. Research linking cytokines and PTP outcomes in children could provide further support for the model proposed in this study. This is complicated by lack of understanding of how cytokines interact with medications during surgery. For example, certain individuals have a polymorphism of IL-6 that is associated with higher opioid requirements unrelated to pain (Bialecka et al., 2016).

A means to identify and manage pain in the children at highest risk is necessary. There were individual OB/OW and non-OB/OW children who experienced prolonged uncontrolled PTP. It is possible that some of the risks were related to genetic variants of drug metabolism. It is also possible that there were underlying psychological differences in children that influenced risk for PTP. Laboratory testing has been developed to identify certain at-risk genetic backgrounds, but there may be other genetic variations that could predict risk for increased PTP. Modified prescribing regimens could be developed for children with ultra-rapid metabolization of opioids. A better understanding of how genetic backgrounds may influence the pain experience and drug metabolism could guide future research and practice. It is still unknown how children could be screened for underlying psychological risk factors in a clinically feasible manner.

In this study it was not possible to control for severity of OSA. It is still unknown if OB/OW is a risk factor for uncontrolled early PTP when controlling for severity of OSA. Researchers and clinicians may collaborate on better identification of OSA severity in children prior to tonsillectomy and then examine for risk of severe PTP, both early and prolonged.

An accurate measurement tool for eating as analgesia could be developed and tested. Such a tool would be helpful in research with OB/OW children undergoing painful surgeries. The tool would need to incorporate measures of nausea and vomiting and medications delivered that targeted nausea and vomiting. Valid and reliable ways to measure nausea and vomiting in children would also be needed.

A better understanding of clinician beliefs and biases would also be helpful in the design of studies examining potential PTP treatment options in OB/OW children. Each clinician has internal beliefs and biases about pain management in the OR and PACU. These internally held

beliefs and biases possibly influenced decisions for how to manage pain in each child. It is unknown how much the clinicians in the OR and PACU were influenced by apprehension of potential airway obstruction and how the clinicians responded to concerns during medication administration. It has yet to be determined what clinicians think about the timing, dosing, and choices of analgesics best suited for OB/OW children post-tonsillectomy.

Summary

This chapter included a discussion of major findings. Comparisons were made between this study and other similar research studies. The population of this study was compared to the state and national population demographics to determine generalizability. The study findings were linked to the theoretical framework. Implications for nursing practice and education were discussed. Future research was proposed based on the findings of this study.

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Appendix A

Data Collection

Figure 4. Data collection form

Study Number and Hospital Identifier

Study ID _____

Hospital V Number _____

Confidential

Demographics

Group	◯ OB/OW
First Name	_____
Last Name	_____
Date of birth	_____
Age (months)	_____
Race	◯ Caucasian ◯ Hispanic ◯ African American ◯ Asian ◯ Other ◯ More Than One Race ◯ Unknown / Not Reported
Gender	◯ Female ◯ Male
Height (cm)	_____
Weight (kilograms)	_____
BMI	_____
BMI-z	_____
BMI-Z PERCENTILE	_____
ASA	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ other
Comments	_____
History of OSA	◯ yes
Other Comorbidities	☐ asthma ☐ other lung ☐ reflux ☐ other GI ☐ heart disorder ☐ liver disorder ☐ developmental delays ☐ other
Other comorbidities comment	_____

Data Collection Tool

Data Collection Tool

Time into Phase I _____

Arrival to Phase II _____

Calculated Length of Stay Phase I _____

Calculated length of stay Phase II _____

Morphine in OR _____

Morphine in Pacu _____

Fentanyl in OR _____

Fentanyl in pacu _____

Other opioid in OR

_____

Other opioid in pacu

_____

Calculated equianalgesic dose for pacu _____

Calculated equianalgesic dose for OR _____

other non opoid in OR

_____

other non opoid in pacu

_____

Pain Outcomes Data Collection

Pain Outcomes Data

Highest pain score _____

Pain Score at 20
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 20
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 20
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 30
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 30
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 30
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 40
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 40
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 40
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 50
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 50
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 50
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 60
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 60
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 60
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 70
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 70
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 70
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 80
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 80
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 80
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 90
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 90
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 90
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 100
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 100
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 100
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 110
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 110
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 110
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 120
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 120
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 120
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 130
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 130
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 130
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 140
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 140
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 140
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 150
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 150
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 150
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 160
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 160
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 160
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 170
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 170
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 170
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 180
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 180
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 180
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 190
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 190
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 190
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 200
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 200
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 200
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 210
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 210
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 210
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 220
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 220
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Confidential

Recode Pain Score at 220
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 230
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 230
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 230
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Pain Score at 240
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7
- ◯ 8
- ◯ 9
- ◯ 10

Pain Type at 240
- ◯ FLACC
- ◯ WBF
- ◯ VNS
- ◯ Unkown

Recode Pain Score at 240
- ◯ 0
- ◯ 1
- ◯ 2
- ◯ unknown

Calculated time to control pain _____

General Comments

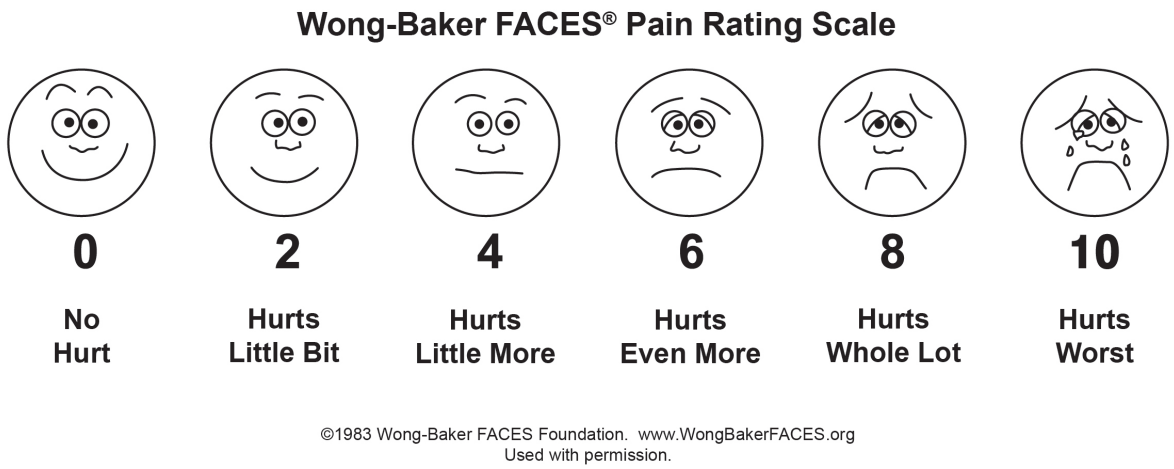
Comments

_____

Appendix B

Wong-Baker FACES® Pain Rating Scale

Figure 5. Wong-Baker FACES® Pain Rating Scale



February 23, 2016

Dear Shirley,

Thank you for contacting our foundation and completing the web form.

You have permission to use our scale in your research, without a licensing requirement or fee.

Please follow these four conditions:
- The information below is for your use only. We ask that you not share it with other unlicensed organizations.
- Use the authorized image of the scale provided below.
- Use the scale as the instructions indicate, without modifications.
- Do not use the scale for profit.

Here is the JPEG of the scale in English for your use: Wong-Baker FACES® Pain Rating Scale.

Instructions for the use of the scale

Frequently Asked Questions

Please let me know if you need anything else, including language translations of the scale. We would love to hear about the results of your research.

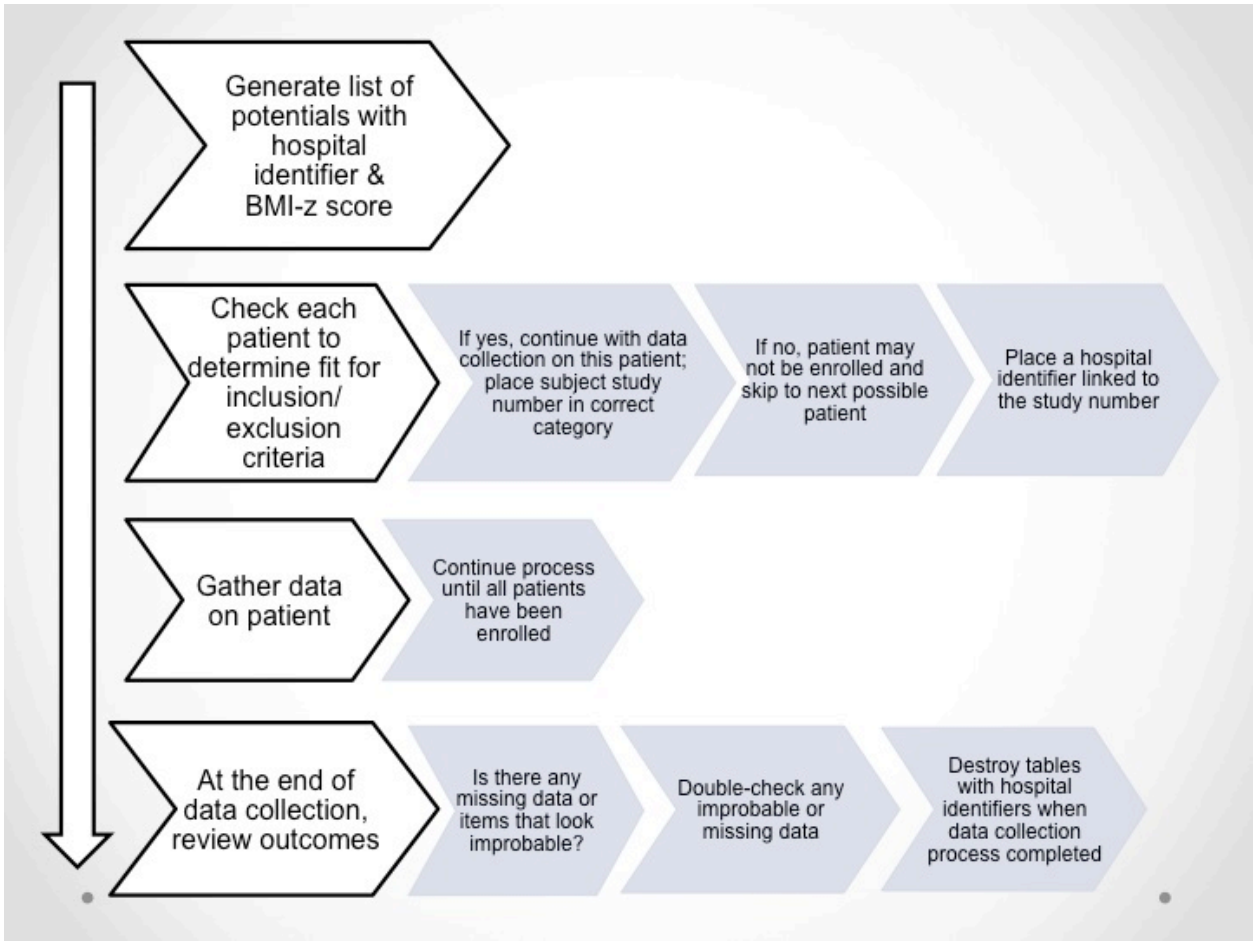
Kind regards,

Nick Nick Baker
Licensing Department
Wong-Baker FACES Foundation

Appendix C

Enrollment and Data Collection

Figure 6. Enrollment and data collection process



Appendix D

Human Subjects Training

COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE (CITI PROGRAM)

COURSEWORK REQUIREMENTS REPORT*

- NOTE: Scores on this Requirements Report reflect quiz completions at the time all requirements for the course were met. See list below for details.
  See separate Transcript Report for more recent quiz scores, including those on optional (supplemental) course elements.
- **Name:** shirley martin (ID: 273870)
- **Institution Affiliation:** Cook Children's Health Care System (ID: 493)
- **Institution Unit:** PACU
- **Phone:** 682-885-4050

- **Curriculum Group:** Human Research
- **Course Learner Group:** Biomedical Research Investigators
- **Stage:** Stage 2 - Refresher 2 Course
- **Description:**
  Choose this group to satisfy CITI training requirements for Investigators and staff involved primarily in biomedical research with human subjects.
- **Report ID:** 17934195
- **Completion Date:** 12/22/2015
- **Expiration Date:** 12/21/2016
- **Minimum Passing:** 80
- **Reported Score*:** 97

REQUIRED AND ELECTIVE MODULES ONLY DATE COMPLETED SCORE

Biomed Refresher 2 - Instructions (ID: 764) 12/22/15 No Quiz Biomed Refresher 2 – History and Ethical Principles (ID: 511) 12/22/15 3/3 (100%) Biomed Refresher 2 – Regulations and Process (ID: 512) 12/22/15 2/2 (100%) Biomed Refresher 2 – Informed Consent (ID: 514) 12/22/15 3/3 (100%) Biomed Refresher 2 – SBR Methodologies in Biomedical Research (ID: 515) 12/22/15 4/4 (100%) Biomed Refresher 2 – Genetics Research (ID: 518) 12/22/15 2/2 (100%) Biomed Refresher 2 – Records-Based Research (ID: 516) 12/22/15 3/3 (100%) Biomed Refresher 2 - Populations in Research Requiring Additional Considerations and/or Protections (ID: 519) 12/22/15 1/1 (100%) Biomed Refresher 2 – Vulnerable Subjects – Children (ID: 521) 12/22/15 3/3 (100%) Biomed Refresher 2 – FDA-Regulated Research (ID: 524) 12/22/15 3/3 (100%) Biomed Refresher 2 – HIPAA and Human Subjects Research (ID: 526) 12/22/15 5/5 (100%) Biomed Refresher 2 – Conflicts of Interest in Research Involving Human Subjects (ID: 681) 12/22/15 2/3 (67%) How to Complete the CITI Refresher Course and Receive a Completion Report (ID: 922) 12/22/15 No Quiz Cook Children's Health Care System (ID: 774) 12/22/15 No Quiz

For this Report to be valid, the learner identified above must have had a valid affiliation with the CITI Program subscribing institutionidentified above or have been a paid Independent Learner.

CITI Program

Email:citisupport@miami.edu Phone: 305-243-7970 Web: https://www.citiprogram.org

Appendix E

Investigator Approval

CookChildren's

February 3, 2016

Shirley Martin, RN, BSN, PhD(Candidate)
Cook Children's
801 7th Avenue
Fort Worth, TX 76104

Dear Shirley,

The CCHCS Research Development Council Research Authorization Subcommittee met and made the following decision regarding your application:

Approved, Level – Non-Interventional, Investigator-Initiated Human Research, Active Principal Investigator

Your application will be filed in the Research Administration Office and released and/or utilized according to policy. Of course, you may review the present application at any time, and apply for Research Authorization at a higher level as necessitated by your planned research participation.

Contact me with any questions.

Sincerely,

James D. Marshall, MD
Chair, Research Development Council
Research Authorization Subcommittee

801 Seventh Avenue
Fort Worth, TX 76104-2796
682-885-4000
www.cookchildrens.org

CookChildren's.

NURSING ADMINISTRATION

ADMINISTRATIVE APPROVAL FOR NEW RESEARCH PROJECTS

Project Name: Management of Post-tonsillectomy Pain in Obese and Overweight Children		
Principal Investigator: Dr. Bryan Harris	**Phone:** 682-885-4054	**Department: Anesthesia**
Sub-Investigator(s): Shirley Martin, Tim Muirheid		
Sponsoring Organization (if other than CCMC): **no sponsors; unfunded study done as PhD candidate at University of Texas at Arlington**		
Anticipated Project Dates: July 2016-November 2016	**Start** July 2016	**Stop** November 2016
Describe proposed project: This is a retrospective descriptive cohort study to examine post-tonsillectomy pain outcomes in obese and overweight children compared to normal weight children. There is limited literature on this topic. Cook Children's performed over 1600 tonsillectomies in a recent two year period. Approximately 1/3 of these children were likely overweight or obese. There are no clinical guidelines to guide pain management practice with this population and there are theoretical reasons to believe these children are at risk. This study will contribute to the body of science that can help us know how to better care for this population.		
Human subjects involved: ☒Yes ☐ ☐No ☐		
Describe the sample and its size: 180 children will be enrolled. The sample will be obtained by retrospective chart review, with 90 children in the obese/overweight group and 90 children in the normal/underweight group. Children between the ages of 4-12 will be enrolled if they had tonsillectomy or tonsillectomy & adenoidectomy. Children will be excluded if they had other surgical procedures concurrently, with the exception of bilateral myringotomy tube placement.		
Describe briefly the financial costs: *(And attach a copy of the study budget.)* No costs to Cook Children's. The Sub- Investigator will be collecting data to fulfill requirements for PhD dissertation.		
Applying for Grant Funding: ☐Yes ☐ ☐No ☒	**If yes, funding source: Amount:** $	

Describe staff required and time requirements for this project:

We will request Tim Muirheid to collect a list of children who had tonsillectomy & adenoidectomy. If possible, we will sort children into two groups by BMI-z scores for random assignment. His time will take an estimated 2 hours or less.

Shirley Martin will be doing data collection and analysis during non-work/non-paid time.

Submitted By: Shirley Martin **Signature-** Shirley Martin	**Date** 7-8-16
Manager Signature *(if applicable)*: Terri Bears	**Date** 7-11-16
Department Director Signature: Karen Rumbelow	**Date** 07-12-16
Submit this form with signatures and copy of budget to: Dr. Mary Cazzell, Director of Nursing Research, 901 7th Ave, Office 4108. Phone: 682-885-3383	
For Nursing Admin Office Use Only	
Director, Nursing Research Signature Mary Cazzell	**Date** 7-19-2016
Will CCMC resource utilization be within acceptable limits? ☒ Yes ☐ No	
Does this project align with CCMC mission and values? ☒ Yes ☐ No	
Senior VP / CNO Approval: **Signature** Cheryl Pitcher	**Date** 7/21/16

Appendix F

IRB Approval

UNIVERSITY OF TEXAS ARLINGTON | OFFICE OF RESEARCH ADMINISTRATION
REGULATORY SERVICES

Institutional Review Board
Acknowledgment of Approved Research Activity

August 30, 2016

Shirley Smith Martin
Dr. Lauri D. John
College of Nursing
The University of Texas at Arlington
Box 19407

UTA Protocol No.: 2016-0195
Protocol Title: *Management of Post-tonsillectomy Pain in Obese and Overweight Children*

The UT Arlington Office of Research Administration - Regulatory Services and Institutional Review Board (IRB) are pleased to acknowledge your engagement in this research protocol involving human subjects which has been approved by the IRB at Cook Children's Health Care System (CCHCS). The CCHCS IRB is noted as the "IRB of record" for this protocol. An IRB of record assumes IRB responsibilities for another institution as specified in each institution's Federalwide Assurance (FWA), and has an agreement of reliability on file. Having met the conditions for approval set forth by the IRB at CCHCS, and in compliance with applicable regulations, acknowledgment of such approval has been granted by the UTA IRB or designee.

CCHCS IRB No: 2016-054
Review Level: Expedited
Approval Date: August 16, 2016

Please note that you are responsible for providing UT Arlington's IRB with a copies of official notifications or approvals from the IRB of record, including but not limited to: approval letters for continuing reviews, approval letters for protocol modifications, incident or adverse event reports, audit or monitoring reports, or study closures.

The UT Arlington IRB and the Office of Research Administration - Regulatory Services appreciate your continuing commitment to the protection of human subjects engaged in research and wish you all the best in your research endeavors. Should you have questions or require further assistance, please contact Regulatory Services at regulatoryservices@uta.edu or 817-272-2105.

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Cook Children's Health Care System Institutional Review Board
Initial, New Research IRB Approval

Principal Investigator: Bryan Harris
Title of Research Study: Management of Post-tonsillectomy Pain in Obese and Overweight Children
IRB Number: 2016-054
Study Number: OB2016
Submission Date: 08/10/2016 07:44:23 AM CDT
iMedRIS Submission Reference Number: 030461
Today's Date: August 17, 2016

Dear Bryan Harris:

The above entitled research study was approved by the Cook Children's Health Care System Institutional Review Board (CCHCS IRB) Chairperson on 08/16/2016. This research study has been approved for the following time period:

Initial Approval Period: 08/16/2016 - 08/15/2017

Please note that this final approval letter includes approval of the following: Protocol, Version 1.2, dated 08/07/2016, as well as a Waiver of Informed Consent and HIPAA Authorization Waiver

The research may not continue beyond the end of the approval period, as indicated by the expiration date above. In order for the research to continue beyond that date, the IRB must first conduct continuing review and designate a new approval period.

The IRB will send you a continuing review notice 120, 90, 60 and 45 days via the iMedRIS system before the expiration date listed above. If the continuing review information is not submitted, completely filled out, received, reviewed and approved by the IRB before the end of the expiration date above, enrollment of new subjects in the research must cease until IRB approval can be obtained. Continued involvement in the research of previously enrolled subjects may not continue unless explicitly approved by the IRB to prevent harm to subjects.

The research was approved by the following method:

Expedited Review; this study meets expedited category 5a which is defined as: "Research involving materials (data, documents, records, or specimens) that have already been collected for some other purpose", in

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the expedited review section of the Federal regulations as well as the CCHCS IRB Policy and Procedure Manual.

The research may be conducted at the following research sites:

Cook Children's Health Care System

Enrollment of the following number and type of research subjects may commence:

Number of Subjects Approved: 180
Authorized Types of Subjects: Children ages 4-12 years of age who underwent tonsillectomy or adenotonsillectomy with or without bilateral myringotomy tube placement surgery July 2016 and prior at Cook Children's

Informed consent is required as follows:

Not applicable as a Waiver of Informed Consent and HIPAA Authorization Waiver has been granted.

The IRB emphasizes the following requirements in granting approval for this research project:

1) Any changes, modifications, or amendments to any facet of the research must be reviewed and approved by the IRB before these changes may be initiated.
2) All unanticipated problems involving risks to subjects or others must be reported to the IRB according to CCHCS IRB policy requirements (please consult the CCHCS IRB Policy and Procedure Manual for specific definitions and reporting time-frames and requirements).
3) All research-related records and documentation may be inspected by the IRB and/or Compliance office for the purposes of ensuring compliance with CCHCS IRB policies and procedures and Federal regulations governing the protection of human subjects. The IRB has the right and authority to suspend or terminate its approval if CCHCS and Federal requirements are not strictly adhered to by all study personnel.
4) All consent forms and records related to this research should be kept for a period of three years following completion of the study.
5) Copies of consent forms containing genetic testing information can be scanned into the subject's electronic medical record. However, research consent and authorization forms containing references to genetic testing are not considered to be part of the designated record set and <u>should not be released under any circumstances</u>.

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6) Investigators should keep the original, executed copy of the consent and/or assent forms for this study. These documents should be filed with the research records associated with this study.
7) A copy of the consent and/or assent form should be given to each participant in this study.

If you have any questions or concerns about these requirements or this letter, please contact the IRB Office at 682-885-5990 or andrea.keane@cookchildrens.org. The IRB thanks you for your continued commitment to the protection of human subjects in Cook Children's research.

Signature, IRB Staff Member: Lori A. Lomax
Signature applied by Lori Lomax on 08/17/2016 07:47:13 AM CDT