A Description of Health Services Research Variables and Moderate Sedation in Interventional Radiology

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DEDICATION

This dissertation is dedicated to my children; Molly and Logan. You are both very good with highlighters.

To my husband Justin for inspiring me to be better.

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Chapter One

Introduction

This dissertation details three health services research variables that relate to patients receiving moderate sedation in interventional radiology (IR). In order to direct the future study of outcomes for this population, there must first be an understanding of the variables that may influence these outcomes. Using the Minnick & Roberts Outcomes Production Framework this study follows the first step of the research continuum (describing, relating, and then determining cause) to describe the variables, organizational facets, employment terms, and labor (quality and quantity), as they exist for a sample of 82 hospitals offering IR services (A. F. Minnick, Roberts, Young, Kleinpell, & Marcantonio, 1997). This dissertation represents the first time this framework has been applied to the field of IR.

1.1 Statement of the Problem

Understanding the specific impact of health services research variables on outcomes for patients receiving moderate sedation is particularly important in the current healthcare market because the number of patients receiving anesthesia and sedation outside of the operating room increases each year (Nagrebetsky, Gabriel, Dutton, & Urman, 2017). Coupled with the shift in healthcare from inpatient to outpatient services, there is a need for alternative care models that move beyond treatment of patients in the traditional hospital structure. Procedures requiring moderate sedation that may once have been completed within the conventional operating room system with full anesthesia teams are now commonly done in hybrid inpatient/outpatient procedural areas, outpatient care facilities, surgical centers, and doctor's offices with registered

nurses, nurse practitioners, or other sedation providers as support (Tuite & Rosenberg, 2005). Yet, we have little information on the safety, quality, and the patient outcomes of sedation provided in these locations.

Assessing the overall state of the literature regarding patients receiving moderate sedation is challenging due to a lack of consistent variables and outcome definitions, small sample sizes, potentially biased data collection methods, and limited internal and external validity. The literature specific to outcomes for patients in IR is overwhelmingly focused on clinical results like tumor size, blood loss, or infectious complications. There is very limited information on the study of health services research outcomes like cost effectiveness, patient satisfaction, mortality, or failure to rescue, and less information on the impact and role of the nurse during these procedures or on moderate sedation outcomes (Werthman, 2018). In addition to the limited number of studies, there are no universally accepted quality measures for reporting, tracking, or evaluating sedation use or complications. This makes it difficult to understand the true rate of complications within the population of patients receiving moderate sedation. However, moderate sedation complications do occur and include respiratory or cardiovascular compromise, the need for reversal medications like naloxone or flumazenil, agitation, longer recovery times, respiratory depression, cardiac or respiratory arrest, and incomplete procedures (Olsen, Barger, & Doshi, 2013). These complications adversely affect patients and drastically increase the burden on hospitals challenged with managing costs and increasing efficiencies (Arepally, Oechsle, Kirkwood, & Savader, 2001; Martin & Lennox, 2003).

Health services research conducted during the past few decades has significantly improved the understanding of the role of nursing, education, training, and staffing and their impact on patient outcomes (L. H. Aiken et al., 2011; Kendall-Gallagher, Aiken, Sloane, &

Cimiotti, 2011; J. Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). However, the majority of these studies were completed at the hospital level within acute care settings, making their application to specialized procedural areas challenging. Units providing interventional methods of treatment require specific attention due to the specialized nursing roles, team makeup, acuity of patients, and the complexity of the interventional procedural suites. Studying health services research variables as they specifically relate to interventional procedural areas will allow for an increased understanding of the influence of the specialized labor, education, workforce policies, and organizational structure on patient outcomes for this population. This dissertation is a first step as it begins to outline the essential variables influencing outcomes for patients receiving moderate sedation. This is being done through the use of an organized approach using the research continuum, a conceptual framework, and a conceptually tested and reviewed research tool to describe the variables, organizational facets, employment terms, and labor (quality and quantity).

1.2 Purpose of the Study

As described by the Minnick & Roberts Outcomes Production Framework there are many variables that have the potential to impact patient outcomes (Appendix B - Figure B 1). These include capital inputs, employment terms, organizational facets, labor quality and labor quantity, employee attitudes, employee behavior, patient characteristics, and the patient experience. It is not feasible to study all variables from this conceptual model within a single dissertational study. Therefore, the scope must be limited to focus on only a few of these variables. Employment terms, organizational facets, and characteristics of labor (quality and quantity), have emerged from the literature as being essential to the study of nursing.

This study describes employment terms, organizational facets, and characteristics of labor (quality and quantity), as they exist within IR (Appendix B - Figure B 2). This study also addresses significant gaps in the literature through the first step of the research continuum. It provides high-quality descriptive survey research related to these variables, guided by the Minnick & Roberts Outcomes Production Framework. Information gained from this study will help to inform future studies relating these variables to patient outcomes within this population.

1.3 Research Questions or Hypotheses

This dissertation outlines three specific health services research variables as described by the Minnick & Roberts Outcomes Production Framework. These include employment terms, organizational facets, and characteristics of labor. The specific aims of this study are as follows:

Specific Aim 1: To describe employment terms within IR departments.

Specific Aim 1a: To describe workload requirements within IR departments.

Specific Aim 1b: To describe temporal conditions (shift length, hours of work) within IR departments.

Specific Aim 2: To describe the organizational facets within IR departments.

Specific Aim 2a: To describe the work environment within IR departments.

Specific Aim 2b: To describe organizational structures (policies and procedures) within IR departments.

Specific Aim 3: To describe the characteristics of labor (quality and quantity) within IR departments.

Specific Aim 3a: To describe the quality (competence and training, certification, degree, and level of experience) of labor within IR departments.

Specific Aim 3b: To describe the quantity (total providers and full-time equivalents [FTEs]) of labor within IR departments.

1.4 Significance of the Issue and the Study

Significance to Society – Interventional Radiology

Interventional radiology is an example of a complex hybrid inpatient/outpatient area providing care for patients with multiple disease processes and comorbidities. Through advances in technology, progressive procedure, and clinical treatments are offered as minimally invasive therapies. The primary and complementary procedures in IR expand treatment options to many patients who may have previously been considered non-operative due to complex diseases and varying comorbidities. They offer alternatives to conventional "open" surgeries, allowing lower risk and shorter recovery time (Lessne, Holly, Huang, & Kim, 2015). Traditionally, patients undergoing procedures in IR receive moderate sedation administered by registered nurses to manage pain and anxiety during their treatment (Mueller, Wittenberg, Kaufman, & Lee, 1997).

The comprehensive practice of radiology encompasses a large set of imaging procedures and techniques. A survey conducted by the Association for Radiologic and Imaging Nursing (ARIN), the professional society representing radiology nurses, identified two major radiologic modalities: imaging and therapeutic. Within these groups are 16 different practice areas including:

- General diagnostic imaging
- Computed tomography (CT)

- Magnetic resonance imaging (MRI)
- IR
- Nuclear medicine
- Neuro-IR
- Cardiac catheterization
- Breast health/women's health
- Ultrasound
- Radiation therapy
- Information technology
- Positron emission tomography (PET)/PET-CT
- Vascular ultrasound
- Cardiac stress testing
- Vascular access
- Other ("Practice Analysis of Radiology Nursing," 2010)

IR is a part of the therapeutic modality, combining imaging and invasive procedural techniques to provide targeted care for multiple disease processes.

Dr. Charles Dotter performed the first angioplasty in 1964 to open a blocked femoral artery for a patient with a gangrenous foot ("The History of Interventional Radiology," 2016). This single procedure served as the foundation for non-surgical interventions. The current definition for IR is a "…clinical subspecialty of radiology focused on minimally invasive, image-guided therapy for numerous diseases ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014)." This service offers these least invasive treatment options for almost every organ system, covering a vast array of patients and

diseases. These include treatments for the vascular, neurovascular, musculoskeletal, hepatobiliary, pulmonary, and gastrointestinal systems ("What is Vascular and Interventional Radiology," 2016). Procedures include, but are not limited to, angiography, biopsies, coil, catheter or chemotherapy embolization, vascular filters, ablations, drainage tube, and central line placements ("Professions in Interventional Radiology," 2015). Complications that occur are primarily related to the particular type of procedure completed. Internal blood vessel injury, a common complication of IR procedures, has a range of effects from manageable to complex (Lessne et al., 2015). Other complications include bleeding, puncture site difficulties, incorrect catheter placement, infection, neurologic deficits like stroke, problems resulting from incomplete or inappropriate universal protection protocol or moderate sedation administration, and death (Arepally et al., 2001; Clark, 2006; Halpenny & Torreggiani, 2011; Kumar, 2014).

Interventional radiologists are board certified physicians specializing in this area of care. They are experts in imaging techniques like x-rays, ultrasounds, CTs, and MRIs that are used to diagnose and treat disease ("Professions in Interventional Radiology," 2015). The American College of Radiology (ACR) and the Society of Interventional Radiology (SIR) are nonprofit professional societies that serve as the primary organizations representing radiologists, radiation oncologists, and medical physicists in the United States and interventional radiologists, respectively. ("About Us," 2016; "Vision to Heal," 2016). The ACR and the SIR provide recommendations and guidelines of practice for interventional radiologists and procedural teams. However, specific team composition may differ significantly among states and hospitals based on those individual state and hospital requirements as well as provider preferences.

In addition to the proceduralists, other members of the team may include physician assistants (PAs), nurse practitioners (NPs), registered nurses (RNs), registered radiologist

assistants (RAs), radiologic technologists (RTs), certified medical assistants (MAs), certified registered nurse anesthetists (CRNAs), and anesthesiologists ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014). Each of these team members has a specialized skill set that helps a radiologic suite operate safely and effectively, managing both patient care and the complex imaging equipment utilized in this environment (Table 1).

Table 1: Clinical Team

Interventional Radiologist	Team leader, responsible for clinical management and performance of interventional procedures
Non-Physician Practitioner	Can refer to physician assistants (PAs), nurse practitioners (NPs), or radiologic assistants (RAs). Participate in the treatment and plan of care, perform minor interventional procedures, increasing the efficiency of practice. NPs and PAs may bill for services, depending on state regulations.
Nursing	Responsible for clinical services including nurse coordination activities (lab values, medication lists, etc.).
Registered Radiology Assistant	Advanced level radiographers, registered by the American Registry of Radiologic Technologists (ARRT), who participate in patient assessment and treatment under the supervision of a radiologist. This does not include diagnostic interpretations.
Radiologic Technologist	Certified by the ARRT and may have additional certification in radiography (RT or CV), cardiac-interventional (CI), or vascular-interventional (VI), depending on specific field. Specialized providers skilled in the use, management, and care of imaging equipment.
Certified Medical Assistant	Aid in efficiency of a busy practice by drawing blood, obtaining vital signs, and bringing patients to different locations in the hospital or clinic.

("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014).

Registered nurses (RNs) in particular, have important responsibilities in the interventional suite. Their clinical service activities include patient assessment and history, vital signs, blood drawing, patient monitoring, education, patient screening, follow-up, promoting the health, wellness, comfort, and safety of the patient during procedures, patient positioning, and medication administration, including the administration of moderate sedation ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014; Goodhart & Page, 2007; *Scope and Standards of Practice: Radiologic and Imaging Nursing*, 2013). Although a registered nurse is able to provide sedation to patients in IR, there are specific limits to the types of sedation they are licensed to administer. Patients requiring advanced sedation care or patients with complex disease processes and comorbidities necessitate management by an advanced provider like a CRNA or anesthesiologist.

Medical imaging was a focus of discussions related to cost and utilization as a result of its rapid growth through the early 21st century (Smith-Bindman, Miglioretti, & Larson, 2008). Imaging services experienced the fastest growth of any Medicare expenditure until its peak in 2006 (Lee, Duszak, & Hughes, 2013a). In 2003, this represented a cost of $294 per Medicare enrollee, but almost doubled to $418 in 2006 (Dodoo, Duszak, & Hughes, 2013). Bhargavan & Sunshine (2001) reviewed utilization of radiologic resources through aggregated claims data from Medicare enrollees and the Medical Expenditure Panel Survey (MEPS), reporting a 10% increase in the use of IR services between 1992 and 2001, or 215 interventional procedures per 1000 Medicare non-managed care enrollees (Bhargavan & Sunshine, 2005). Iglehart (2009) reported an increase in diagnostic imaging services from $3.6 billion in 2000 to $7.6 billion in 2006, faster than any other billable physician service (Iglehart, 2009). Concerted efforts were

therefore made to control the soaring costs of medical imaging as a result of these growth patterns.

An overall decline in cost and utilization began in 2008, due in part to the Deficit Reduction Act (DFA) and other legislation, representing a $2.8 billion decrease in Medicare reimbursement for imaging services over five years. Additional reductions were also due to public health concerns about radiation exposure, increased use of decision support services to determine need for imaging, expansion of bundled payment codes, and the economic recession (Lee, Duszak, & Hughes, 2013b; Rosenkrantz, Hughes, & Duszak, 2015). Between 2006 and 2010, Medicare Part B expenditures declined by approximately 21% (Report, 2012). The most recent data from the Medicare Payment Advisory Commission (MedPAC) indicates a $663 billion dollar total Medicare spend for 2016 of which outpatient imaging represented $6 billion of that total (~1%) (Commission, 2018a). Other data sets support this decline in the use of radiologic services. The Harvey L. Neiman Health Policy Institute studies value of radiology services and offers insight into current utilization using aggregated claims data from the Center for Medicare and Medicaid Services (CMS). According to these analyses, there were approximately 163.36 IR procedures per 1000 beneficiaries in 2016, down from 332.43 in 2006. This represents a cost of $21,324.20 per 1000 beneficiaries in 2006 and $12,644.52 in 2016 ("Medicare Part B Interventional Radiology Procedures per 1000 Beneficiaries," 2016).

Controlling costs of imaging services remains a focus of CMS given the rapid growth seen in the early 2000s, a recent increase in use, and a concern for low value care (Commission, 2018a; Rosenkrantz et al., 2015). A 1.4 % increase in imaging services per Medicare beneficiary was reported in 2016 and imaging services and cancer screening represented 60% of the total volume of low value care per 100 Medicare beneficiaries (Commission, 2018a). Low value

measures are defined as “either a service that has little or no clinical benefit, or care in which the risk of harm from the service outweighs its potential benefit (Commission, 2018b, p. 116).” The current health care spending for the United States represents 17.9% ($3.3 trillion or $10,348 per person) of the Gross Domestic Product (GDP) and is estimated to grow to an approximately 20% in the next few years. It is therefore expected that radiology imaging will continue to be a focus of efforts to determine appropriate use of services ("Centers for Medicare & Medicard Services, Historical ", 2018).

Significance to Society – Moderate Sedation

Moderate sedation medications are used to manage pain and anxiety during medical procedures in both inpatient and outpatient procedural practice settings (Gan, 2006). Areas that use sedation include intensive care units, interventional or diagnostic cardiology and radiology, dentistry, and the emergency department (Gan, 2006). Much like anesthesia in the operating room, sedation plays a large part within IR and is an important factor during invasive radiologic procedures. The use of sedation outside of the operating room has increased to address demand for procedures that require these medications. Multiple studies have discussed the increased use of sedation outside of the operating room, administered by non-anesthesia personnel (Arepally et al., 2001; N. Crego, 2014; N. Crego, 2015; Karian, Burrows, Zurakowski, Connor, & Mason, 1999; Korzewski, Raingruber, & Van Leuven, 2016; Metzner & Domino, 2010; Mueller et al., 1997; Patatas & Koukkoulli, 2009). A 1997 survey of radiologic practices queried the 1,713 members of the Society of Cardiovascular and Interventional Radiology, now known as the SIR. Of the 634 respondents (37% response rate), 90% of therapeutic procedures used a “drowsy/arousable” level of sedation (Mueller et al., 1997). A similar 2006 study of the 5,000 physician members of the American College of Gastroenterology (ACG) reported some type of

sedation in 98% of cases (N=1,353 surveys returned, 27.1% response rate), 79% of which was administered by nursing under the supervision of a gastroenterologist (Cohen et al., 2006).

The overall goal of sedation during procedures is, "to provide diminished awareness, memory, and discomfort through the use and titration of sedative and analgesic medicines, while safeguarding spontaneous respiration and protective reflexes, so that unpleasant diagnostic or therapeutic procedures can be performed safely and effectively (Hall, 2005, p. 63)." Moderate sedation is administered by anesthesia providers, like anesthesiologists and CRNAs, or non-anesthesia providers like gastroenterologists, emergency room physicians, or registered nurses trained in sedation administration (Metzner & Domino, 2010). Many radiology departments have nursing teams who are responsible for the administration of moderate sedation medications and patient monitoring during procedures. In these scenarios, moderate sedation is directed by the interventional radiologist and administered by the registered nurse.

Multiple medications are used to achieve the desired sedative effect. Common sedation medications utilized in procedural area include opioids like fentanyl and morphine combined with benzodiazepines like midazolam (Tuite & Rosenberg, 2005). Propofol is a type of sedative-hypnotic that is gaining popularity in procedural sedation due to its rapid onset and recovery. However, controversy exists with regard to its management by non-anesthesia practitioners due to its significant respiratory and myocardial depressive effects and the rapid level of deep sedation achieved with this medication (Tuite & Rosenberg, 2005).

Sedation ranges across a continuum from minimal to general anesthesia. The necessary level of sedation required for a procedure is dependent on a number of factors, including patient status and procedure type. Each level of sedation has implications for recovery time and

location, necessary equipment, and personnel. The American Society of Anesthesiologists (ASA) defines types of sedation as follows:

- Minimal sedation - A normal response to verbal stimuli with no effect to the patient's airway, spontaneous ventilation, or cardiovascular function.
- Moderate sedation (formerly termed procedural or conscious sedation) - A drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation. No interventions are required to maintain a patent airway, spontaneous ventilation is adequate and cardiovascular function is usually maintained.
- Deep sedation - Involves a "purposeful" patient response after painful stimuli. While cardiovascular function is typically maintained, intervention might be necessary to preserve the patient's airway and ventilation.
- General anesthesia – General anesthesia is the highest level of sedation that renders the patient completely unresponsive, requiring the anesthesia provider to maintain the patient's responsiveness, airway, ventilation, and cardiovascular function ("Practice Guidelines for Moderate Procedural Sedation and Analgesia," 2018).

Recognizing the use of sedation by non-anesthesia personnel, the ACR in conjunction with the SIR, published guidelines and parameters in 2015 for patients receiving sedation during radiology procedures. These guidelines focused on sedation administration outside of the operating room for interventional, diagnostic, or radiation oncology procedures in order to decrease pain or discomfort, or to relieve anxiety and increase patient cooperation (Radiology, 2015). The ACR noted that their guidelines address moderate sedation administration only, as deep sedation requires "…a greater level of skill and experience and more intensive monitoring

than is described here (Radiology, 2015)." These guidelines detail the selection of patients appropriate to receive sedation or anesthesia based on the ASA Physical Status Classification:

- Class I: A normal healthy patient
- Class II: A patient with mild systemic disease
- Class III: A patient with severe systemic disease
- Class IV: A patient with severe systemic disease that is a constant threat to life
- Class V: A moribund patient who is not expected to survive without the operation
- Class VI: A declared brain-dead patient whose organs are being removed for donor purposes (Radiology, 2015)

According to the ACR guidelines, patients meeting Class I or Class II qualify for sedation outside of the operating room. Additional consideration should be given to Class III or Class IV level patients, but any patient meeting Class V criteria is inappropriate for sedation by non-anesthesia personnel (Radiology, 2015).

A recent set of guidelines published by the ASA in 2018 replaced a previously published version from 2002, and was the work of a multidisciplinary task force including the ACR and SIR. These guidelines were published with a focus on addressing, "…procedural sedation provided by any medical specialty in any location ("Practice Guidelines for Moderate Procedural Sedation and Analgesia," 2018). The guidelines discuss other practice recommendations for sedation including hemodynamic monitoring recommendations, pre-procedure preparation like fasting practices, use of supplemental oxygen, capnography, the availability of emergency equipment and the development of patient safety and quality improvement processes as examples. They also note the inherent risk associated with sedation, like cardiac or respiratory depression, unintended deep sedation, undersedation, neurologic injury, pulmonary aspiration,

unplanned hospital admissions, or death. ("Practice Guidelines for Moderate Procedural Sedation and Analgesia," 2018)."

Many studies reviewing sedation outcomes note that moderate sedation is "safe," however, these studies report patient level data, using institution-specific protocols, on small sample sizes within single locations, on primarily pediatric populations (Mason et al., 2002). Very few studies address the safety of sedation in adults (Karamnov, Sarkisian, Grammer, Gross, & Urman, 2014). Crego (2015) reports that morbidity and mortality related to moderate sedation is virtually unknown (N. Crego, 2015) There is, however, varied information on morbidity and mortality rates for anesthetic complications overall. While not specific to moderate sedation or radiology, it provides insight into potential rates of complications as a result of the use of moderate sedation.

A 1954 study by Beecher & Todd represented the first study to review anesthesia-related mortality, noting specific concern for a gross variation in practice stating, "…there is an extraordinary amount of turmoil present, rapid adoption of new techniques, equally swift abandonment of the old (Beecher & Todd, 1954, p. 26)." The authors discuss that the lack of stability in a field that has existed for over a hundred years was surprising, and estimated a mortality rate of 3.29 deaths associated with anesthesia per 100,000 population (Beecher & Todd, 1954). This statistic was compared to poliomyelitis, a significant health threat at the time of the study, noting the incidence of death as 1.38 per 100,000 population. This illustrated the fact that death from anesthesia-related complications was 2.4 times that of poliomyelitis during the five years (1948-1952) that the authors collected data, sufficiently identifying anesthesia-related mortality as a public health problem and leading the way for marked improvement in anesthesia practices (Beecher & Todd, 1954).

There were a number of changes to anesthesia care over the following decades, including advancements in medications and monitoring equipment that dramatically increased the safety of anesthesia ("Foundation History," 2015). A 2009 study by Li, Warner, Lang, Huang, & Sun on the epidemiology of anesthesia-related mortality in the United States noted a significant decline in mortality from 1 in 1,000 in the 1940s to 1 in 100,000 in the 1990s and early 2000s (Li, Warner, Lang, Huang, & Sun, 2009). These authors compared data from the 10th Revision of the International Classification of Diseases (ICD-10) for the years 1999-2005 and mortality data from the National Vital Statistics System. They reported 2,211 anesthetic related deaths between 1999-2005, or approximately 315 per year, a population-based death rate of 1.1 per million population per year. Of these, 46.6% were attributable to overdose of anesthetics, 42.5% to adverse effects of anesthetics, 3.6% to complications during pregnancy and the stages of labor, and 7.3% to other complications (Li et al., 2009).

Compared to heart disease, which accounts for 193.3 deaths per 100,000 population, the numbers of anesthesia-related deaths seem small ("National Center for Health Statistics," 2016). However, Li et al. (2009) noted that studies of anesthesia-related mortality in the United States remain limited due in part to the lack of a national surveillance system and the rapid expansion of multiple anesthesia types throughout new practice areas, both of which make event reporting and data collection challenging (Li et al., 2009). These factors create a situation in which the rate of sedation-related complications in adult IR is not well understood (Patatas & Koukkoulli, 2009). Crego (2015) hypothesized that based on the data from Li et al. (2009) and the assumed lower risk of moderate sedation, population-based sedation-related mortality should be less than the anesthesia-reported mortality, however, this claim is untested. Lack of consistent outcome definitions, small sample sizes, single sample sites, limited internal and external validity, and

opportunities for bias in data collection limit the number of high-quality studies. Overall, there is little standardization within the realm of moderate sedation. There is currently no recognized official definition for adverse sedation events and no quality measures or accepted standards for reporting, tracking, and evaluating the use of sedation (Leffler et al., 2015).

Significance to Healthcare

There are various implied expenditures related to moderate sedation at the hospital level but limited literature that attempts to understand the true cost. For IR, the risks of an invasive procedure are compounded by the risks of the use of moderate sedation. The diffuse use, as well as noted issues with reporting and data collection, makes understanding costs to the hospital as they relate to financial, quality, and safety goals difficult. Studies completed at the hospital level typically compare different medication types (i.e. midazolam vs. propofol) and seek to determine workforce costs like total monitoring times between two patient groups. As an example, Holger et al. (2005) studied sedation in the emergency department by randomizing patients to receive either midazolam or propofol. Among these patients, the group receiving propofol had significantly shorter total RN monitoring times (median 36 vs. 52 minutes p</= .007) and less time to sedation (4 vs. 12 minutes p</= .013) (Holger, Satterlee, & Haugen, 2005). Limitations as noted by the authors include a small sample size and the non-blinding of drug groups to the nurses and physicians responsible for administering the medications and recovering the patients.

Examples of other studies reviewing sedation practices and resource utilization include those completed by Ostermann, Keenan, Seiferling, & Sibbald (2000) as well as Jackson, Proudfoot, Cann, & Walsh (2010). Both studies sought information on sedation practices for critically ill individuals in the intensive care unit (ICU) and any "optimal" practices found in the literature that may be linked to outcomes, like length of stay and cost (Jackson, Proudfoot, Cann,

& Walsh, 2010; Ostermann, Keenan, Seiferling, & Sibbald, 2000). Ostermann et al. (2000) additionally compared propofol vs. midazolam, reporting a faster time to extubation with propofol for ICU patients. Jackson et al. (2010) saw better patient outcomes with improved sedation practices like instituting standardized protocols and increasing interruption of sedation. Interestingly, both report a lack of high-quality studies for sedation practices despite the widespread use of sedation in the intensive care setting.

One noted challenge of moderate sedation within the United States is the lack of specificity and uniformity of standards for administration of these medications. The Joint Commission (TJC), various state practice acts, and professional societies, administer guidelines that establish a set of minimum standards for moderate sedation care, however, there is no universally accepted set of moderate sedation regulations. Thus, the bulk of current responsibility for regulating sedation falls to the hospitals. While this allows for flexibility for individual facilities to develop their own guidelines and credentialing around sedation administration, it is a complex responsibility.

Of immediate significance are the reports of practice variability within the radiologic environment. Several studies support variation of sedation practice within IR (Arepally et al., 2001; Conway, Page, Rolley, & Worrall-Carter, 2011; Mueller et al., 1997; Olsen et al., 2013). Identified variability includes the types of sedation medications used, differences in training for the physicians and nurses involved in the sedation procedures, and nurse availability for sedation administration. Conway, Page, Rolly, & Worrall-Carter (2011) reported a gap in the study of sedation medications as well as limited information on clinical guidelines used to guide the practice of moderate sedation administered by non-anesthesia providers, despite an increase in non-operating room anesthesia (Conway et al., 2011). Metzner and Domino (2010) cited a lack

of high-quality studies of anesthesia practices outside of the operating room and no studies that reviewed practices by specialty or practitioner (Metzner & Domino, 2010).

Arepally, Oechsle, Kirkwood, & Savader (2001) additionally discussed variability in practice in their article *Safety of Conscious Sedation in Interventional Radiology.* The authors discussed two surveys describing practice patterns during IR procedures that use moderate sedation. The first, completed by McDermott, Chapman, & Gillespie (1993) surveyed British and Irish interventional radiologists about sedation and monitoring of patients during IR procedures. The authors reported significant variability in practice of patient monitoring (nursing monitored vital signs in only 49% of cases), pulse oximetry, supplemental oxygen use, and recovery area staffing (McDermott, Chapman, & Gillespie, 1993). The second, completed by Mueller, Wittenberg, Kaufman, & Lee (1997) discussed similar trends in nurse staffing (87% reported the assistance of a full time radiology nurse), and monitoring (70% reported patient monitoring during procedures), as well as significant variation during "off hour," night and weekend care (30% reported nursing coverage only during business hours) (Mueller et al., 1997).

Although the studies by McDermott et al. (1993) and Mueller et al. (1997) are older (>10 years), there is little indication that variability in practice patterns has been adequately addressed. A recent study by Natcheva et al. (2014) queried 2,284 members of the SIR about their staffing patterns. At least one nurse was reported per IR room in 90% of daytime cases and 93.6% of cases during off hours while 10% and 15% of respondents (N=777) reported staffing as inadequate during regular business hours and off hours, respectively (Natcheva et al., 2014). A second survey completed by Korzewski, Raingruber & Van Leuvan (2016) discussed the specifics of sedation during neuro-interventional procedures. In this case, 36.19% of the respondents (n = 109) reported that anesthesia was responsible for sedation during endovascular

revascularization procedures (Korzewski et al., 2016). The studies by Natcheva et al. (2014) and Korzewski et al. (2016) specifically discussed methods of standardization for IR. Natcheva et al. (2014) advocated for the potential need for general standardized staffing guidelines for radiology procedures while Korzewski et al. (2016) specified the need for standardization of the role of individual providers during neuro-intervascular therapies.

A third study by Cohen et al. (2006) queried 5,000 members of the ACG on the specifics of endoscopic sedation practice. The authors noted a wide variation of sedation practices by geographic region for these procedures. Anesthesiologists were reported to administer sedation by 6-7% of respondents in the Midwest, Southwest, and Northeast as compared with 17.4% in the South and 36.6% in the Mid-Atlantic (Cohen et al., 2006). This study reported registered nurses as part of the sedation team in most cases (89.5%) (McDermott et al., 1993). While not specific to IR, this study of sedation practices in endoscopic procedures is important as it highlights the lack of standards related to sedation medication administration. In the article *Procedural Sedation Practice: A Review of Current Nursing Standards,* Crego (2015) clearly states, " …there is no single consensus statement on RN sedation core competencies or a consistent way in which RN sedation practice is regulated in the United States (N. Crego, 2015, p. 50)." This author notes that the Joint Commission and the ASA have published sedation standards and guidelines that include the administration of sedation by non-anesthesia personnel. However, these standards are not comprehensive as to the role of nursing, ultimately leaving state boards of nursing and specialty societies to publish their own position statements to address these gaps (N. Crego, 2014).

Without consistent recommendations or clear guidelines from the state boards, the resulting consequence is conflicting statements between societies or state regulations and

confusion as to the nurses' role. This can result in "scope creep" as described in a case study in California that resulted in nurses administering etomidate in the emergency room and in the intensive care unit (Davidson, Bloomberg, & Burnell, 2007). In their review of standards, Davidson et al. (2007) reported that the Emergency Nurses Association (ENA), the American Association of Critical Care Nurses (AACN), the American College of Emergency Physicians (ACEP), and the ASA all had sedation-related guidelines. Both the ENA and the ACEP allow registered nurses to administer deep sedation under the supervision of a physician according to their society guidelines. The AACN and the ASA do not. As the state of California offered no specific guidance on the use of this medication, it was left to the hospital to decide the course of care. This case resulted in the approval of administration of this medication by registered nurses for procedural sedation in the emergency department on a pilot trial basis. The authors make note, however, that this case raised new questions related to the management of propofol by registered nurses (Davidson et al., 2007).

Once the sole realm of anesthesia, more specialties are pushing for nurse administered propofol sedation. The study by Cohen et al. (2006) reported that 68% of endoscopy respondents were interested in utilizing propofol in their practice (Cohen et al., 2006). A few studies have discussed the safety and effectiveness of nurse administered propofol sedation and specific societies have lobbied for it use (Bosslet, DeVito, Lahm, Sheski, & Mathur, 2010; Dumonceau et al., 2010; Lin & Weigel, 2018; Sato et al.; Weaver, 2006). Unclear guidelines of care and conflicting standards lead to differences in sedation practices and standards of care that vary from state to state, hospital to hospital, or even unit to unit within the same facility. As a result of these differences, providers can be guarded about their own sedation techniques if they are operating outside of their own licensure or as a result of differences between hospital and

professional society guidelines (Krauss & Green, 2006). In addition to these challenges, pressures to practice outside of scope (i.e. practicing deep sedation and calling it moderate) can lead to contentious relationships among providers of various specialties and clear patient safety issues, including under reporting of adverse events or other sedation-related complications. This only increases gaps in available information related to outcomes for patients receiving moderate sedation medications, including patients in IR.

There is very limited information on major health services research outcomes and significant gaps in the study of sedation practices, staffing mix, training of providers, equipment availability and use (i.e. capnography for moderate sedation), and the different medications used in IR. The lack of literature related to the study of outcomes significantly impacts hospitals as there is subsequently little information regarding the safety, quality, and costs of care for patients receiving moderate sedation for IR procedures. Patients who suffer complications like oxygen desaturation, hypoventilation, hypotension, unresponsiveness, or cardiac arrest as a result of moderate sedation may require the use of narcotic reversal medication, oral airway placement or intubation, or even CPR, each of which can result in increased monitoring and recovery times, longer hospital stays, and unplanned admissions (Arepally et al., 2001; Martin & Lennox, 2003). This places greater pressure on hospitals already trying to maximize quality and efficiency amidst increasingly strained resources. Many articles that address the safety of sedation in procedural settings do so with the caveat that there are providers available who have the appropriate training, education, and support to manage complications or adverse events, yet there is a gross lack of literature studying the providers or their relation to these outcomes (Brown, Lovato, & Parker, 2005; Conway et al., 2011; Hall, 2005; Patatas & Koukkoulli, 2009). While there is limited literature that describes patient outcomes after moderate sedation in IR, sedation

is a part of many invasive procedures and plays an important role in the management of pain and anxiety for patients.

Significance to Nursing

The overall use of moderate sedation outside of the operating room administered by non-anesthesia personnel has increased to address the greater demand for procedures that require these medications (N. Crego, 2014; Korzewski et al., 2016; Metzner & Domino, 2010; Mueller et al., 1997). The SIR and the ACG report the use of moderate sedation in approximately 90% and 98% of procedures, respectively (Cohen et al., 2006; Mueller et al., 1997). Nurse administered moderate sedation is the preferred method of sedation administration within the current radiologic environment, including for procedures completed within IR (N. Crego, 2014; Korzewski et al., 2016; Metzner & Domino, 2010; Mueller et al., 1997). Studies indicate that nurses participate in the majority of therapeutic procedures completed in IR, often with moderate sedation administration and monitoring as their primary role (Goodhart & Page, 2007; Mueller et al., 1997; Natcheva et al., 2014).

The current "radiologic and imaging nurse generalist" is defined by the ARIN in *Scope and Standards of Practice: Radiologic and Imaging Nursing* as a "licensed registered nurse who demonstrates clinical skills and knowledge in radiologic and imaging nursing and technologies (*Scope and Standards of Practice: Radiologic and Imaging Nursing*, 2013). Nurses have multiple responsibilities within IR. These include promoting health, comfort, and safety during imaging procedures, patient assessment, education, monitoring of vital signs, patient positioning, and medication administration, including the administration of moderate sedation (Goodhart & Page, 2007; *Scope and Standards of Practice: Radiologic and Imaging Nursing*, 2013). Nursing plays a particularly important role in IR with regard to moderate sedation. The SIR position

statement, *Staffing Guidelines for the Interventional Radiology Suite,* specifically identifies the essential position of nurses in the care of critically ill patients and sedation administration, recommending that a nurse dedicated to moderate sedation be a part of each IR team (Baerlocher et al., 2016).

A few societies provide recommendations for nurses and their role in moderate sedation. According to the American Association of Nurse Anesthetists (AANA), moderate sedation is well within the scope of a registered nurse as they state that nurses trained in sedation may assist with its administration ("Concious Sedation: What Patients Should Expect," n.d.). The ARIN additionally provides nursing-specific guidelines for sedation administration by nurses in radiology. In their *Scope and Standards of Practice* document, the ARIN notes that moderate sedation is within the scope of a radiologic nurse's responsibility. As stated by Goodhart & Page (2007), "The radiology nurses become the patients' voice when the patients cannot speak for themselves (Goodhart & Page, 2007)." Therefore, nursing has the potential to make a significant impact on outcomes for patients who receive moderate sedation (Goodhart & Page, 2007).

The past few decades have seen a fluctuation in the numbers of registered nurses. There are various reports in the literature that attempt to explain this phenomenon, including an aging workforce and significant challenges with both recruitment and retention of nurses (Hassmiller & Cozine, 2006). The workforce shortages of the early 2000s demonstrated a need to prove the value of nurses within their respective care areas. Reports from the Institute of Medicine like *Keeping Patients Safe: Transforming the Work Environment of Nurses* published in 2003, and *The Future of Nursing: Leading Change, Advancing Health* published in 2010 identified appropriate nurse staffing as an essential priority. Studies completed during this time gathered extensive evidence linking nurse staffing to quality patient outcomes and demonstrated that as

the largest labor group providing direct patient care, nurses have the potential to make a significant impact on the quality and safety of our nation's hospitals.

Multiple studies outside of the radiologic literature have examined characteristics of nursing that relate to patient outcomes. These studies primarily focused on aspects of workforce labor quantity (defined as total providers, full- time equivalents, or hours per patient day) and quality (defined as competence, certification, training, degree, or level of experience) (L. H. Aiken et al., 2011; L. H. Aiken, Shang, Xue, & Sloane, 2013; Bluemke & Breiter, 2000; Couloures, Beach, Cravero, Monroe, & Hertzog, 2011; Fatima et al., 2008; R. L. Kane, Shamliyan, Mueller, Duval, & Wilt, 2007; Kendall-Gallagher et al., 2011; McHugh, Berez, & Small, 2013; J. Needleman et al., 2002; J. Needleman et al., 2011). Examples of studies of labor quantity include those examining the association between higher total nurse hours and improved outcomes, with examples including rates of urinary tract infections and cardiopulmonary shock in medical patients, or registered nurse staffing levels and hospital performance in the Hospital Readmissions Reduction Program from the Centers for Medicare and Medicaid Services (McHugh et al., 2013; J. Needleman et al., 2002). Examples of labor quality include the association between higher levels of nursing education (associate degree in nursing vs. bachelor of science in nursing) or the presence of a specialty certification and decreased rates of outcomes like 30-day inpatient mortality and failure to rescue (L. H. Aiken et al., 2011; Kendall-Gallagher et al., 2011).

The majority of research studying nursing's impact on patient outcomes focuses on their role within inpatient care settings (Doran, 2011). Interestingly, the current literature for radiology nursing is primarily descriptive with no information on the value of their care and limited information describing their practice, resulting in a huge gap in the knowledge of nursing

in IR (Werthman, 2018). Studies must be completed within these specialized care areas in a similar fashion to the workforce studies completed in the early 2000s. Studies focusing on the radiologic environment will complement the known aspects of nursing value and characterize the value of nursing in procedure areas. Currently, a major obstacle to understanding the role of radiology nursing is an overall lack of high-quality studies that examine the impact of nurses on patient outcomes for patients receiving moderate sedation.

Issues and Challenges

Studying moderate sedation is challenging as obtaining total numbers of patients receiving moderate sedation in the United States is almost impossible. Patients volumes can be inferred via total procedures completed for specialties outside of the operating room that typically utilize sedation, however, individual counts of sedation administration are not necessarily recorded in way that can be easily accessed. (Bhargavan & Sunshine, 2005). Moderate sedation is seen in inpatient and outpatient hospital specialties like radiology, cardiology, endoscopy, maxillofacial surgery, dentistry, and cosmetic surgery as examples. Patients in intensive care units may also receive sedation for various painful procedures, or simply for comfort (Jackson et al., 2010). Similarly, adverse sedation events related to quality and safety are often recorded in internal hospital reports that are not made public. Studying complications as they relate to moderate sedation requires the researcher to review studies that report quality metrics from individual hospitals or those completed with help of secondary data from national registries that currently report sedation adverse events (Arepally et al., 2001; Bluemke & Breiter, 2000; Couloures et al., 2011; N. Crego, 2014). These studies and reports are limited in their scope, however, due to a lack of generalizability with single facility sites and

registries, with the Pediatric Sedation Research Consortium database that focuses on a single population (pediatrics), serving as a representative example.

Despite the limits of current literature and challenges in estimating complications, multiple recent media reports have highlighted the need for better oversight and regulation in moderate sedation practice. Two such reports involving complications and tragic outcomes related to sedation were observed in dental care and endoscopy screening (Carroll, 2017; Jewett & Alesia, 2018). These included a four-year-old child from Massachusetts who became hypoxic and passed away after receiving sedation for a routine dental procedure and an 83-year-old man from Arkansas who stopped breathing after receiving sedation for a colonoscopy at a surgical center. Both cases raise questions about pre-procedure screening, medication administration, and appropriate post-procedure recovery of these patients. Published in *Today, Health* and *USA Today,* respectively, these cases piggyback previous descriptions of the complications and untimely deaths of high profile media figures like Michael Jackson and Joan Rivers that were also related to sedation medications (Duke, 2013; Engel, 2014). Although outside of the field of IR, a single death related to moderate sedation, regardless of the field, is one too many.

These publicly reported events call attention to the need to establish widely accepted quality and safety guidelines for moderate sedation administration. Including specialties like dentistry, endoscopy, or the ICU in the discussion of sedation outcomes demonstrates the prevalence of the use of these sedative medications in many areas of medicine. It amplifies a major threat to patient safety given the wide use of sedation medications, ultimate variations in practice due to a lack of standards and guidelines, and limited reporting for adverse events. Goals for the study of moderate sedation over the next few decades should include a collaborative effort from many individual societies to create a set of agreed upon guidelines for

the use and administration of sedation as well as a formalized and structured methodology for reporting and collecting data for sedation outcomes. Such efforts will aid in the study of sedation outcomes and prioritize patient safety.

Chapter Two

2.1 Theoretical Framework

There are no conceptual or theoretical frameworks in the literature that have specifically studied patient outcomes in IR during cases of moderate sedation. The majority of studies completed in IR are clinical research studies. An in-depth review of theoretical and conceptual frameworks determined that there are a few essential theories and models that can help guide the study of outcomes in this area (Appendix A - Table A 1). These frameworks provide context to understand the different structures and processes that lead to outcomes for patients in IR. In order from least to most applicable, they include:

- General Systems Theory by Ludwig von Bertalanffy (1968)
- The Outcomes Equation by Kane & Radosevich's (2011)
- A Framework of Structure, Process, and Outcomes by Donabedian (2005)
- The Quality Health Outcomes Model by Mitchell et al. (1998)
- The Conceptual Framework for the International Classification for Patient Safety (2009)
- The Minnick & Roberts Outcomes Production Framework (Bertalanffy, 1968; *Conceptual Framework for the International Classification for Patient Safety*, 2009; Donabedian, 2005; R. L. Kane & Radosevich, 2011; A. F. Minnick et al., 1997; Mitchell, Ferketich, & Jennings, 1998).

The Minnick & Roberts Outcomes Production Framework is the most applicable and was used to guide this study (Appendix B – Figure B 1).

There are multiple important concepts within the framework including capital inputs, employment terms, organizational facets, labor inputs (including both quality and quantity), employee behavior, employee attitudes, patient experience, and patient characteristics. Outcomes are a result of the interaction and influence of all of these variables. While it has not been specifically utilized in studies of procedural areas, the Minnick & Roberts Outcomes Production Framework is well tested and has been utilized in multiple publications and various dissertations (Barnett, 2012; Maxwell, 2012; A. F. Minnick, Fogg, Mion, Catrambone, & Johnson, 2007; A. F. Minnick et al., 1997; Oberlies, 2016).

Many of the concepts identified in this framework have been examined in prior studies (L. H. Aiken et al., 2011; L. H. Aiken et al., 2013; Encinosa & Bernard, 2005; Kendall-Gallagher et al., 2011; McHugh et al., 2013; A. F. Minnick et al., 1997; J. Needleman et al., 2002; Olds & Clarke, 2010; Rogers, Hwang, Scott, Aiken, & Dinges, 2004). This framework recognizes that several variables are universal to health care and influence health outcomes. The model additionally suggests that a solution to improved outcomes involves influencing change on larger system variables and specifically distinguishes between these variables and those that cannot be altered, like patient characteristics (A. F. Minnick et al., 1997). However, a limitation of this model is the complexity of the interactions among factors that influence outcomes. It is challenging to measure all factors in the model within a single study. Therefore, specific variables within the framework were identified that were considered to be more applicable to the study of this phenomenon of interest than others. Variables including employment terms, organizational facets, and characteristics of labor (quantity and quality) stand out as potentially being impactful in this population, based in part on a detailed literature search and the calculation of effect sizes of these variables from the identified studies.

2.2 Literature Review

Interventional radiology officially evolved as a formal specialty from diagnostic angiography in the 1960s (Rosch, Keller, & Kaufman, 2003). Dr. Alexander Margulis, a gastrointestinal radiologist, coined the term IR in 1967 (Rosch et al., 2003). Like Dr. Dotter before him, Dr. Margulis recognized that the developing field was separate and distinct from other radiologic and surgical specialties. Conducting the minimally invasive, image-guided therapies required specialized staff, skills, and equipment. These hallmarks of IR help to frame key concepts and variables.

An initial search of the literature was completed to understand the study of the health services research variables defined by Minnick et al (2013) within IR. The search strategy was not limited to any specific variable, or radiologic modality. Similar procedural areas like interventional cardiology, gastroenterology, or procedures completed in the intensive care unit were included. The goal was to determine how the concepts were studied and defined, and to determine any relationships to patient outcomes. A total of seven studies were identified that addressed any of the health services research variables outlined by the framework. They included capital equipment (1), labor quality (3), and patient characteristics (4) (Applegate et al., 2016; Arepally et al., 2001; Bluemke & Breiter, 2000; Couloures et al., 2011; Fatima et al., 2008; Karamnov et al., 2014; Karian et al., 2002). Effect sizes were calculated for six of these articles in order to determine whether any of these variables had practical significance, particularly as it pertains to patient outcomes (Appendix A - Table A 2). In one article, effect sizes could not be calculated due to the limited statistical information provided by the authors (Arepally et al., 2001). However, this paper was still examined given the applicability to the phenomenon of interest (Appendix A – Table A 3).

Of the seven studies that met criteria, six papers utilized descriptive designs (Arepally et al., 2001; Bluemke & Breiter, 2000; Couloures et al., 2011; Fatima et al., 2008; Karamnov et al., 2014; Karian et al., 1999). One study utilized a two group quasi-experimental design (Applegate et al., 2016). All studies utilized quantitative methods. Two studies utilized prospective data collection (Applegate et al., 2016; Arepally et al., 2001). Five studies utilized a retrospective approach, reviewing the details of medical records (Bluemke & Breiter, 2000; Couloures et al., 2011; Fatima et al., 2008; Karamnov et al., 2014; Karian et al., 1999; Karian et al., 2002). All papers used convenience sampling of patient populations at single sites. Studies included a combination of both adult and pediatric patient populations.

Applegate et al. (2016), Arepally et al. (2001), Fatima et al. (2008), and Karamnov et al. (2014) focused on adults while Karian et al. (1999) and Couloures et al. (2002) studied pediatric patients. The study by Bluemke & Breiter (2000) included a combination of both adults and pediatric patients (Bluemke & Breiter, 2000). Given that inclusion criteria did not limit studies to IR, there were a range of study locations. Arepally et al. (2001) exclusively studied adult IR (Arepally et al., 2001). The rest of the studies reviewed populations of patients receiving testing and procedures in gastroenterology, diagnostic radiology, and cardiology (Applegate et al., 2016; Bluemke & Breiter, 2000; Couloures et al., 2011; Fatima et al., 2008; Karamnov et al., 2014; Karian et al., 1999). Sample sizes for the studies varied with the largest study completed by Couloures et al. (2011) as a retrospective review of the Pediatric Research Sedation Consortium (PRSC) (n = 131,751) (Couloures et al., 2011).

Outcomes examined in each study generally focused on adverse events associated with sedation overall, although definitions of adverse events differed among studies. As an example, Applegate (2016) defined their primary outcome as the intergroup difference in total alarm

events during procedural related sedation (PRS). In this study, alarm events were defined as an SpO2 </=92% (desaturation event); RR</=8 BPM (respiratory depression); PSI </=50 (deeper than intended sedation)(Applegate et al., 2016). Intra-procedure data was collected by advanced monitoring equipment, which transmitted the study data to research computers for analysis. Arepally et al. (2001) studied three types of outcomes: respiratory (oral airway, jaw thrust, ambu-bag), sedation (change in clinical status due to sedation, use of reversal agents, unresponsiveness, or agitation), and major (hypotension, CPR, cardiac or respiratory arrest) (Arepally et al., 2001). Data was collected on these events using a single page form completed by the procedure nurses. These differences limit the comparison of outcomes among study results.

The results of this search confirmed that the primary focus of IR research has been clinical outcomes like peritonitis following gastrostomy tube placement in children or creatinine function after percutaneous nephrostomy (Dookhoo et al., 2016; Patel, Jeon, & Kumar, 2015). Health services variables like employment terms, organizational facets, labor quantity and their relationship to patient outcomes have not been studied within the radiology literature. Due to the limitations in the radiology literature additional searches were completed to better understand the conceptual definitions and effect sizes as they exist outside of this field (Appendix A - Table A 4) (L. H. Aiken et al., 2011; L. H. Aiken et al., 2013; Encinosa & Bernard, 2005; Kendall-Gallagher et al., 2011; McHugh et al., 2013; A. F. Minnick et al., 1997; J. Needleman et al., 2002; Olds & Clarke, 2010; Rogers et al., 2004).

2.3 Critical Review of the Literature

This dissertation details organizational facets, employment terms, and aspects of labor (quality and quantity) as they exist for patients receiving moderate sedation in IR. It addresses the known gaps in the literature and works to understand variables that influence outcomes within the procedural space. There is substantial evidence from the literature to support a dissertational study of these variables. Other issues of importance with respect to this phenomenon that emerged in the literature search include the role of nursing, definition of moderate sedation, and the definition of moderate sedation outcomes within this population.

Employment Terms

Employment terms was studied by Olds & Clarke (2010) through a review of extended work duration and adverse events and errors, including needlestick injuries, work-related injuries, patient falls with injury, nosocomial infections, and medication errors. The authors described an increase in adverse events related to working more than 40 hours per week (worked over 40 hours: wrong medication or dose, OR 1.28, $p<0.01$, CI 1.10-1.49, $r = 0.0679$; falls with injury, OR 1.17, $p<0.05$, CI 1.02-1.36, $r = 0.0432$; nosocomial infections, OR 1.14, $p<0.05$, CI 1.02-1.28, $r = 0.0361$; work injuries, OR 1.25, $p<0.001$, CI, 1.11-1.40, $r = 0.0614$; any needlestick injuries in the last year, OR 1.28, $p<0.01$, CI 1.08-1.52, $r = 0.0679$). Rogers, Hwang, Scott, Aiken, & Dinges (2004) also studied work hours and their effect on self-reported and near miss events related to shift length. This study reported a significant increase in errors as work hours increased (work duration and one or more errors: 8.5 hours, OR 1.00, $r = 0$; 8.5-12.5 hours, OR 1.85, $p = 0.06$, $r = 0.16$; >/=12.5 hours, OR 3.29, $p = 0.001$, $r = 0.3119$; work duration with one or more near miss events: 8.5 hours, OR 1.00, $r = 0$; 8.5-12.5 hours, OR 1.44, $p = 0.18$, $r = 0.1$; >/= 12.5 hours, OR 1.80, $p = 0.04$, $r = 0.1599$) (Rogers et al., 2004).

Organizational Facets

Aiken et al. (2011) studied the work environment as it related to mortality and failure to rescue. In this example, the authors demonstrated that a better work environment decreased the odds of adverse outcomes (environment and mortality, OR 0.926, CI 0.898-0.955, $p<0.0001$, effect size $r = 0.0212$; environment and FTR, OR 0.925, CI 0.897-0.954, $p<0.0001$, effect size $r = 0.0215$) (L. H. Aiken et al., 2011).

Labor Quantity

Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky (2002) reviewed the impact of nurse staffing on a variety of patient outcomes with the greatest impact seen in total nurse hours and urinary tract infections (RN hours, OR 0.48, CI 0.38 to 0.61, $p<0.001$, $r = 0.1983$), and nurse hours and shock (RN hours, OR 0.48, CI 0.27 to 0.81, $p = 0.007$, $r = 0.1983$) in medical patients (J. Needleman et al., 2002). McHugh, Berez, & Small (2013) examined the relationship between registered nurse staffing levels and hospital performance in the Hospital Readmissions Reduction Program (HRRP), by looking at staffing (hours per adjusted patient day) and readmissions for which hospitals would be penalized. The authors reported a relationship between higher levels of staffing and lower hospital penalties (higher nurse staffing, OR 0.75, 95% CI: 0.64-0.89, $r = 0.0791$) (McHugh et al., 2013).

Labor Quality

Bluemke & Breiter (2000) studied labor quality, defined as staff experience administering sedation and total sedation time for patients receiving medications for magnetic resonance (MR) imaging among different groups of nurses. When comparing the specialized MR nurse to general radiology nurses, there was an effect size of $r = 0.10$ in favor of specialized MR nurses. When comparing the specialized MR nurse to the inpatient hospital nurse there was an effect size

of r = 0.59, in favor of the specialized MR nurses (Bluemke & Breiter, 2000). Coloures, Beach, Cravero, Monroe, & Hertzog (2011) also looked at labor quality with regard to provider types (anesthesiologists, pediatric intensivist, pediatric emergency medicine, pediatrician, and others including radiologist, surgeon, dentist, pediatric resident or fellow, advanced practice nurse, certified registered nurse anesthetist, or registered nurse) and sedation administration on major complications (aspiration, death, cardiac arrest, unplanned hospital admission, level of care increase, or emergency anesthesia consultation). Each practitioner type was compared to anesthesiologists with the largest effect size found in favor of anesthesiologists over pediatricians (OR 1.9, CI 0.4-9.1, r = 0.17) (Couloures et al., 2011). Fatima et al. (2008) reviewed levels of nursing experience (Level 1: sedated 1-29 procedures, Level 2: sedated 30-99 procedures, Level 3: sedated 100 or more procedures) with minor (SBP<90 mmHg, SpO2 of <90%, and HR <50 bpm, O2> 4L NC) and major sedation complications (death, neurologic sequelae, permanent injury, need for hospitalization, or endotracheal intubation) for nurse administered propofol sedation. No major complications occurred however, an effect was reported for higher level of nursing experience and minor complications (Level 2 vs. Level 1, OR 0.78, CI 0.51-1.18, p=0.24 r = 0.07; Level 3 vs. Level 1, OR 0.61, CI 0.41-0.92, p=0.02, r = 0.14) (Fatima et al., 2008).

Aiken et al. (2011) studied the impact of nursing education level on 30-day inpatient mortality and failure to rescue. The results of this study showed decreased mortality and failure to rescue with higher levels of education (mortality and education, OR 0.958, CI 0.937-0.980, p<0.0001, r = 0.0118; FTR and education, OR 0.956, CI 0.935-0.978, p<0.0001, r = 0.0214)(L. H. Aiken et al., 2011). Kendall-Gallagher, Aiken, Sloane, & Cimiotti (2011) looked at specialty certification related to inpatient 30-day mortality and failure to rescue (deaths in surgical inpatients following a major complication). While certification did not appear to be an

influential variable in this study, the proportion of registered nurses with BSN degrees did have an influence (mortality and BSN, OR 0.94, $p<0.001$, $r = 0.0171$; FTR and BSN, OR 0.93, $p<0.001$, $r = 0.02$) (Kendall-Gallagher et al., 2011).

2.4 Other Concepts of Interest

Role of Nursing

Nursing formally joined radiology in the 1970s to care for increased patient needs as technology advanced in the field (Makanjee, Bergh, & Hoffmann, 2003). Prior to this, an inpatient care nurse provided nursing care on an as-needed basis. In their 1964 publication, *The Nurse on the Radiological Team,* Miller & Gerard discuss this original role of nursing in caring for patients receiving radiologic exams. Nursing is described as both a liaison between the referring physician and radiologist, and the caretaker of the patient who assists in patient care through proper patient preparation for imaging studies (Miller & Gerard, 1964). The authors state, "The radiologically informed nurse can strengthen her usefulness by her knowledgeable support and careful preparation of her patient for x-ray studies (Miller & Gerard, 1964)." Since the 1970s, the role of nursing has grown to encompass patient education, advocacy, and care and nurses are now seen as essential health care professionals in radiology departments. They must be able to incorporate rapid technological advances and an understanding of radiologic imaging, while keeping the patient as their focus. Examples of radiology nursing care include patient assessment, education, monitoring, positioning, comfort, nutrition, and medication administration (Goodhart & Page, 2007). A noted primary role of the radiologic nurse is the administration of moderate sedation under the supervision of a radiologist (Goodhart & Page, 2007).

The history of nursing in radiology provides information on its responsibility within this service. The ACR describes practice parameters that help define what is necessary for successful IR practices including administrative services, outpatient and inpatient care, imaging equipment, specific interventional suite requirements, and the clinical team ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014). As stated very generally by the ACR, nursing services are used to "augment" clinical services. Unfortunately, how nursing is organized within IR practice and whether they are consistently part of the procedural team is not well defined. Mueller et al. (1997) surveyed 1,713 physician members of the Society of Cardiovascular and Interventional Radiology (now the SIR). This study focused on radiologists, types of procedures, sedation medications, nursing, and other patient care questions like pre-procedure visits, and pre, intra, and post-procedure monitoring and recovery. The authors noted specific variations with regard to nursing availability. Of the respondents, 87% reported the use of full-time nurses and only 30% reported specific radiology nursing availability "after hours (Mueller et al., 1997)." More recent studies of staffing by Natcheva et al (2014) yielded similar results with at least one nurse reported per IR room in 90% of daytime cases and 93.6% of cases during off hours (Natcheva et al., 2014).

Moderate Sedation

Moderate sedation is another practice that is not well defined within radiology. The ACR offers guidelines that define moderate sedation as " a minimally depressed level of consciousness induced by the administration of pharmacologic agents in which the patient retains a continuous and independent ability to maintain protective reflexes and a patent airway and to be aroused by physical or verbal stimulation" and recommends its use within IR procedures ("ACR-SIR Practice Guideline for Sedation/Analgesia," 2010). However, substantial variability exists in the

literature in terms of medications, location, and staff. Moderate sedation can incorporate the use of multiple types of medications, including fentanyl, midazolam, chloral hydrate, pentobarbital sodium, diazepam, propofol, ketamine, and alprazolam. Furthermore, there are substantial limits to the study of nurse administered sedation and patient outcomes. Only four studies completed within a radiologic modality describe nurse-administered sedation and the relationship to outcomes (Applegate et al., 2016; Arepally et al., 2001; Bluemke & Breiter, 2000; Karian et al., 1999).

Korzewski et al. (2016) more recently surveyed members of the ARIN to understand anesthesia and sedation management within a population of patients undergoing endovascular recanalization procedures. The authors specifically note the American Heart Association guidelines recommend moderate sedation over anesthesia for revascularization therapy. Yet, general anesthesia was reported as the predominant method of therapy for this group of patients (56.48% vs. 37.04% for moderate sedation) (Korzewski et al., 2016). This was a descriptive study only and did not include patient outcomes.

Other publications commenting on moderate sedation have described the use of deep sedation within procedures and the potential for "scope creep" within this area, as outlined in the case study by Davidson et al. (2007) (N. Crego, 2015; Davidson et al., 2007; Krauss & Green, 2008). The result of these differences in professional guidelines, as well as statewide variation, and even scope of practice differences within hospitals, results in many providers remaining "secretive" about their sedation practices. This can have significant impact on the study of outcomes in this population.

The Study of Outcomes

A final controversial definition is the study of adverse outcomes as a result of sedation medications. Crego (2015) specifically identified the lack of consistent definitions for adverse sedation events, noting that this makes understanding the true rate of complications challenging, and comparison of results between studies impossible. Each of the seven articles reviewed for health services research variables offered different definitions for adverse events. Applegate et al. (2016) and Fatima et al. (2008) even presented different definitions for oxygen desaturation (</= 92% vs. < 90%, respectively). The controversies within these definitions create challenges for the study of health services research variables on patient outcomes for patients receiving moderate sedation. However, they also provide opportunities for study to help better define these concepts and understand the specific practice as it currently exists.

2.5 Definition of Terms

The following definitions are compiled based on the previous review of the literature and the use of this framework within the available publications and dissertations (L. H. Aiken et al., 2011; L. H. Aiken et al., 2013; Barnett, 2012; Encinosa & Bernard, 2005; Kendall-Gallagher et al., 2011; Maxwell, 2012; McHugh et al., 2013; A. F. Minnick et al., 2007; A. F. Minnick et al., 1997; J. Needleman et al., 2002; Oberlies, 2016; Olds & Clarke, 2010; Rogers et al., 2004). These definitions were refined and further developed through the use of the card sort process (Table 5 - Card Sort Definitions).

Employment terms: Employment terms are defined as workload requirement or employment policies.

Workload requirements: Amount of work completed by employee (i.e. number of patients, room assignments).

Temporal conditions: Hours of operation, employee shift structure and length, hours of work, and call.

Organizational facets: Organizational facets are defined as organizational policies and procedures and the culture and climate of the work environment.

Work environment: Conditions in which an employee works; includes processes and procedures.

Organizational structures: Organizational characteristics that influence clinical practice.

Characteristics of labor: Labor quantity refers to the total providers, full-time equivalents (FTEs), or total labor hours worked. Labor quality refers to the competence, certification, training, degree, or level of experience of the staff.

Labor quality: Competence and training, certification, degree, and level of experience.

Labor quantity: How many and types of providers (total providers and full-time equivalents [FTEs]).

Chapter Three

3.1 Research Design and Assumptions

The study aims sought to describe three specific health services research variables during cases of moderate sedation in IR. As described by the Minnick & Roberts Outcomes Production Framework, there are many variables that have the potential to impact patient outcomes. These include capital inputs, employment terms, organizational facets, labor quality and labor quantity, employee attitudes, employee behavior, patient characteristics, and the patient experience. Based on a detailed review of the literature, priority was given to employment terms, organizational facets, and labor quality and quantity. The aims of this dissertation were answered using survey methodology.

3.2 Description of Research Setting

The research setting was a national survey mailed to samples of teaching hospitals and non-teaching hospitals offering adult IR services (refer to description below). The survey was addressed to leadership for IR.

3.3 Sample and Sampling Plan

Nature and Size of Sample

The principal investigator (PI) used information regarding membership in the Council of Teaching Hospitals (COTH) from the 2015 American Hospital Association (AHA) data set as a basis for generating the samples of teaching and non-teaching hospitals to be contacted for participation in this study. The AHA data set included each individual hospital's name, address,

and phone number. The website for each hospital on the list was reviewed to ensure that the hospital met the following inclusion/exclusion criteria.

Criteria for Sample Selection, Criteria for Inclusion and Exclusion

- Inclusion criteria
    - Teaching hospital
        - AHA listed member of COTH (AHA data set variable: Member of the Council of Teaching Hospitals; 1=Yes, 2=No).
        - "Teaching hospitals educate and train future medical professionals, conduct state of the art research, care for the nation's poor and uninsured people, and stand ready to provide highly specialized clinical care to the most severely ill and injured (AHA, 2017).
    - Non-teaching hospital
        - Not an AHA listed member of COTH (AHA data set variable: Member of the Council of Teaching Hospitals; 1=Yes, 2=No).
    - Additional criteria for both teaching and non-teaching hospitals include:
        - AHA Control Code (AHA data set variable: CNTRL)
            - Government, Nonfederal
                - State (AHA CNTRL 12)
                - County (AHA CNTRL 13)
                - City (AHA CNTRL 14)
                - City-county (AHA CNTRL 15)
                - Hospital district or authority (AHA CNTRL 16)
            - Nongovernment, not-for-profit

        - Church operated (AHA CNTRL 21)
        - Other not-for-profit (AHA CNTRL 23)
        - Investor owned (for profit)
        - Individual (AHA CNTRL 31)
        - Partnership (AHA CNTRL 32)
        - Corporation (AHA CNTRL 33)
- Interventional radiology
    - There were no fields in the AHA data set that identify hospitals offering IR services. Therefore, the website for each hospital in the teaching and non-teaching hospital samples was reviewed to determine if IR services were offered. If the websites did not provide enough information to make the determination as to whether IR is offered, the hospital was called. The criteria for determination are according to the definitions of IR provided by the ACR and the SIR.
    - ACR definition: Interventional radiology and interventional neuroradiology are clinical subspecialties of radiology focused on minimally invasive, image-guided therapy for numerous diseases ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014).
        - The ACR is a nonprofit organization representing approximately 30,000 radiologists and physicists in the United States. The ACR provides accreditation services for

many radiology services ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014).

- SIR definition: Interventional radiology is the minimally invasive, image-guided treatment of medical conditions that once required open surgery ("What is interventional radiology?," 2017).
    - SIR is a nonprofit organization representing approximately 7,000 interventional radiologists practicing in the United States ("About SIR," 2017).

- Provision of primarily adult (age >/= 18 years) IR services (AHA data set variable: Does the hospital restrict admissions primarily to children: RADMCHI 1=Yes, 0=No)
    - Adult IR was selected due to the available use of moderate sedation in this population. Non- anesthesia personnel (i.e. registered nurses) trained in its administration can perform moderate sedation. Special considerations are often provided for pediatric (<18 years of age) populations (i.e. advanced anesthesia personnel, medications used for deep sedation as opposed to moderate sedation).
- AHA Service Code (AHA data set variable: SERV). The following four listed service codes are the four types found in the sample of teaching hospitals. Therefore, these four service codes were identified in the non-

teaching hospital sample in order to keep both samples as similar as possible.

- General medical and surgical (AHA SERV 10)
- Cancer (AHA SERV 41)
- Obstetrics and gynecology (AHA SERV 44)
- Orthopedic (AHA SERV 47)

- Exclusion criteria
  - Federal government facilities (AHA data set variable Control Code: CNTRL). Excluded due to homogenous population and strict regulations placed on providers.
    - Air Force (AHA CNTRL 41)
    - Army (AHA CNTRL 42)
    - Navy (AHA CNTRL 43)
    - Public Health Service other than 47 (AHA CNTRL 44)
    - Veterans Affairs (VA) hospitals (AHA CNTRL 45).
    - Federal other than 41-45, 47-48 (AHA CNTRL 46)
    - Public Health Service Indian Service (AHA CNTRL 47)
    - Department of Justice (AHA CNTRL 48)
  - Children's hospitals offering primarily pediatric services only (AHA data set variable: Does the hospital restrict admissions primarily to children: RADMCHI 1=Yes, 0=No). Excluded as sedation in pediatric populations often requires advanced anesthesia considerations beyond RN administered moderate sedation.

- AHA data set service codes other than the following four are excluded in order to ensure the list of teaching and non-teaching hospitals are as similar as possible. Examples of excluded service codes are psychiatric (AHA SERV 22) and alcoholism and other chemical dependency (AHA SERV 82). The four included codes are:
  - General medical and surgical (AHA SERV 10)
  - Cancer (AHA SERV 41)
  - Obstetrics and gynecology (AHA SERV 44)
  - Orthopedic (AHA SERV 47)

Methods for Subject Recruitment

Teaching hospitals. Teaching hospitals were the primary sample of interest due to their diversity and complex patient population, specialized services and technologies, and missions, which include advanced clinical care as well as education and teaching (Ayanian & Weissman, 2002). Total COTH membership for the sample selection equaled 323 hospital/health system members. Of these, 259 met inclusion/exclusion criteria. Each hospital website was reviewed to determine if these hospitals offered IR services. If that information was unable to be obtained from the hospital website, the hospitals were called directly (see Criteria for sample selection, criteria for inclusion and exclusion). Four additional hospitals were excluded from this list resulting in a final total sample of 255 (two facilities were closed, two did not offer IR services). The resulting service codes were as follows: SERV 10 = 247, SERV 41 = 5, SERV 44 = 2, SERV 47 = 1.

Non-teaching hospitals. A total of 5,972 non-COTH member hospitals were listed in the 2015 AHA data set. These non-teaching hospitals were of interest to compare practices to the

teaching facilities. Meeting inclusion/exclusion criteria resulted in a sample of 4,383 hospital/health system members. Due to the much larger population of non-teaching medical hospitals (i.e. private, community), a stratified random sampling approach was used to select a sample of 255 non-teaching hospitals from the total listed in the AHA data set that represented a similar distribution of service codes represented in the sample of 255 teaching hospitals. Upon selection, each hospital's website was reviewed to ensure that they met inclusion/exclusion criteria. If that information was unable to be obtained from the hospital website, the hospitals were called directly (see Criteria for sample selection, criteria for inclusion and exclusion).

Each selected hospital's website was reviewed for information regarding the administrative leader within the IR suite. The PI called each hospital to confirm or update the contact information for each of those administrative leaders using the hospital phone numbers in the AHA database. Calling the hospitals avoided error due to websites that are not updated regularly and addressed variability in IR leadership. Some hospitals have directors; others have nurse, or technologist managers. Calling each hospital to determine leadership assisted in identifying the appropriate person to whom the survey should be directed to maximize survey response.

Strategies to Ensure Human Subjects Protection

- The PI's dissertation committee reviewed this project proposal. A detailed project proposal and application, the postcard, the three letters, and the survey were submitted to the Vanderbilt IRB in accordance with their criteria for evaluation and approval.
- Aims 1, 2, and 3 did not involve any clinical risk to patients or any changes to the care the patient receives at these facilities. No identifiable patient information was collected.

- At the end of the survey, respondents were given the option to provide their title. Providing this information was optional and not required. The PI and the advisor's name and contact email were provided so that participants could contact them with any questions.
- This was a survey that was administered to health professionals, thereby posing a risk of identification of these individual healthcare professionals and their relation to specific healthcare organizations and their locations. To maintain confidentiality upon return of the paper survey, the PI entered answers into the Research Electronic Capture (REDCap) database (Harris et al., 2009). REDCap is an encrypted and secure system providing resources to build and manage electronic databases and surveys. Any identifying data for survey participants was stored on this secure server. Survey respondents were assigned a unique identifier that was unrelated to the study participant to ensure confidentiality. No names or other identifying data were associated with the responses and only aggregate data was reported.
- All paper copies of the survey are maintained under double locks (i.e. locked file cabinet, and locked room) for security.
- Any file downloaded for statistical analysis from the REDCap database had all identifiers removed.
- The PI will destroy all identifiers in three years following completion of the study via deletion of the electronic record and destroying paper copies of the survey.

3.4 Data collection methods

Procedures

The survey was specifically developed for the purposes of this dissertation (see *Instruments*). Instrument delivery consisted of a mailed survey at specified intervals (see below) that provided the survey participant with a paper copy of the survey as well as an electronic link to complete the survey online if preferred (Appendix C - Complete Survey). Mailing of the survey is an essential technique in survey research that is shown to achieve response rates of 50% or higher and is the preferred method by respondents over other methods like phone or email (Dillman, Smyth, & Christian, 2014). Surveys completed by email alone have an estimated response rate that is 20% lower than paper versions (Nulty, 2008; Shih & Fan, 2009). A combination of a mailed survey with an option for a web survey link in the mailed letter was determined to be the best approach for hospital managers and executives who may be concerned with web survey privacy and anonymity (Cycyota & Harrison, 2006). This also prevented an email survey from being identified as spam for those who may work at institutions with restricted email filters.

Upon receipt of the returned paper surveys, the PI entered answers into the Research Electronic Capture (REDCap) database. REDCap is an encrypted and secure system providing resources to build and manage electronic databases and surveys. A second independent entry of the paper surveys was completed within a separate REDCap database and the responses were compared and corrected as necessary to ensure the accuracy of the data entry.

Mailing and Timeline

The survey timeline and mailings followed the schedule below.

- Post card: The survey was introduced with a post card to alert potential respondents they will receive the survey (Appendix C – Initial Postcard).
- First survey mailing: The first survey mailing was personally addressed to the identified leader for IR within each facility and sent approximately three weeks after the post card. The mailing included:
    - A personalized introductory letter from the PI (Appendix C – First Letter)
    - An encrypted link to complete the survey online
    - The written survey in booklet format
    - A postage paid addressed envelope to return survey materials. The return address was to the Vanderbilt University School of Nursing.
- Second survey mailing: The second mailing was personally addressed to the identified leader for IR within each facility and sent approximately three weeks after the first mailing. The mailing included:
    - A personalized reminder letter from the PI (Appendix C – Second Letter)
    - An encrypted link to complete the survey online
    - The written survey in booklet format
    - A postage paid addressed envelope to return survey materials. The return address was to the Vanderbilt University School of Nursing.
- Final (third) survey mailing: The third and final mailing was personally addressed to the identified leader for IR within each facility and sent two weeks after the second mailing. The mailing included:

- A personalized final reminder letter from the PI (Appendix C – Final Letter)
- An encrypted link to complete the survey online
- The written survey in booklet format
- A postage paid addressed envelope to return survey materials. The return address was to the Vanderbilt University School of Nursing.
- Each mailing and subsequent mailing was numbered so that the PI did not send duplicates to those who had already responded.

- The mailings were sent via the following timeline with each letter asking a specific date of return. The participants were given approximately three weeks to respond to the survey from the date of mailing. This longer time frame accounted for the time it would take for the survey to reach the participant through the hospital mail system. The timeline followed the proposed schedule below:

Table 2: Survey mailing timeline

Timeline				
	Day 0	Day 21	Day 42	Day 63
Initial post card mailing	X			
First mailing		X		
Second mailing			X	
Final (third) mailing				X

- Specific dates included:
  - Postcards mailed: 5/4/2018.
  - First survey mailing: 5/22/2018; Requested return date: 6/11/2018.
  - Second survey mailing: 6/18/2018; Requested return date: 7/9/2018.
  - Third survey mailing: 7/18/2018; Requested return date: 8/8/2018.

Instruments

There are no existing instruments available to study the specific nature of the concepts in this phenomenon of interest (POI). Therefore, a survey was developed for purposes of this dissertation using the conceptual framework; the Minnick & Roberts Outcomes Production Framework as a guide (Appendix C – Survey).

Survey questions were developed to obtain the most robust information on the concepts of interest; employment terms, organizational facets, and aspects of labor (Appendix A – Table A 8). The questions were crafted from a detailed literature search on the phenomenon of interest as well as the work completed by previous surveys studying the concepts of interest (A. F. Minnick et al., 2007; Jack Needleman & Minnick, 2009; Widmar, 2012).

Overall validity, reliability, and credibility of the survey design were enhanced by using the method of card sorting the questions to the concept definitions as well as pilot testing the survey prior to administration to the proposed study sample. Identified weaknesses (i.e. unclear concept definitions) were addressed immediately during survey development.

Credibility, Rigor, Validity of Design, Methods, and Strategies for Minimizing Weaknesses

As described, the credibility, rigor, and validity of the survey design were enhanced by using the method of card sorting the questions to the concept definitions as well as pilot testing the survey prior to administration to the proposed study sample. Identified weaknesses (i.e. unclear concept definitions) were addressed immediately during survey development.

- Card sort
    - Card sort one: Card sort completed with six individuals
        - Definitions (Appendix A - Table A 5)

        - The concept definitions for card sort one, were drawn from the health services literature.
        - Results (Appendix A - Table A 6)
    - Card sort two: Based on the result and feedback from card sort one, a second card sort was completed for nine questions with five of the six original participants. One participant from the original group was no longer able to participate due to scheduling constraints.
        - The definitions for card sort two were adjusted for clarity based on the results of card sort one (Appendix A - Table A 5).
        - Results (Appendix A - Table A 7).
- Pilot test
    - The survey was pilot tested by a panel of experts in order to identify weaknesses in the survey design or question construction. The panel of experts consisted of six individuals all with ties to IR and other outpatient procedure areas.
    - The individuals were each asked to complete the surveys while the PI timed the total minutes until completion, put a check mark next to difficult questions, underlined unclear words, and finally debriefed with the PI to review each question.
    - The results of this pilot test were compiled and the survey questions were adjusted to address concerns. Examples of feedback included not abbreviating moderate sedation as MS, adding grid lines and check boxes to questions where necessary, adjusting unclear question spacing, and addressing language throughout the survey to more clearly state questions.

- Average total minutes to completion = 15 minutes.
- The panel of experts interestingly requested adding questions addressing the process of verbal orders within these procedural areas. Unfortunately, this could not be completed in this dissertation due to space constraints. The topic of medication ordering has such depth that it is feasible that a second survey could be constructed which studies this topic alone. Therefore, this is certainly a topic that could be addressed in future studies.

Additional Information Collected about the Facilities

Additional data points were obtained from the most recent AHA data set. This information added organizational detail and descriptors that were not collected by the survey, which enhanced the survey results. Examples of these data points include demographics of the hospitals, total licensed beds, registered nurse, licensed practical nurse, or vocational nurse FTEs, and average daily census.

3.5 Data Analysis

Data analyses was completed using the IBM Statistical Package for the Social Science (SPSS) for all aims. Missing response values were evaluated prior to analysis to determine whether there actually was an applicable response option. If not, the missing response was coded to indicate that the data value was truly missing. Truly missing values were minimal (<6%) for any particular question. Due to the small sample size it was impossible to determine whether the missing data values were random or systematic.

Specific Aim 1: To describe employment terms within IR departments.

Specific Aim 1a: To describe workload requirements within IR departments.

Specific Aim 1b: To describe temporal conditions (shift length, hours of work) within IR departments.

Aim 1 is descriptive in nature. Frequency distributions were used to summarize the nominal data. Normally distributed continuous data was summarized using means and standard deviations; skewed distributions were summarized using medians and interquartile ranges. COTH and non-COTH hospital nominal data responses were compared using Chi-square, while continuous comparisons used Mann-Whitney tests.

Specific Aim 2: To describe the organizational facets within IR departments.

Specific Aim 2a: To describe the work environment within IR departments.

Specific Aim 2b: To describe organizational structures (policies and procedures) within IR departments.

Aim 2 is descriptive in nature. Frequency distributions were used to summarize the nominal data. Normally distributed continuous data was summarized using means and standard deviations; skewed distributions were summarized using medians and interquartile ranges. COTH and non-COTH hospital nominal data responses were compared using Chi-square, while continuous comparisons used Mann-Whitney tests.

Specific Aim 3: To describe the characteristics of labor (quality and quantity) within IR departments.

Specific Aim 3a: To describe the quality (competence and training, certification, degree, and level of experience) of labor within IR departments.

Specific Aim 3b: To describe the quantity (total providers and full-time equivalents [FTEs]) of labor within IR departments.

Aim 3 is descriptive in nature. As with the prior aims, frequency distributions were used to summarize the nominal data. Normally distributed continuous data was summarized using means and standard deviations; skewed distributions were summarized using medians and interquartile ranges. COTH and non-COTH hospital nominal data responses were compared using Chi-square, while continuous comparisons used Mann-Whitney tests.

Chapter Four

4.1 Sample Characteristics, Data Reduction Techniques

Chapter Four presents a discussion of response rates, a description of overall sample characteristics, and summaries of the survey responses. The results of the analyses are presented by aim. While the primary goal of the aims was to describe the characteristics of employment, organizational policies and procedures, and labor within IR, comparisons are presented between COTH and non-COTH hospitals to identify any variations in practice for the hospital types.

Sample Characteristics

The 2015 AHA data set was used to obtain the sample for the COTH and non-COTH hospitals as described in Chapter Three. The non-COTH sample was closely matched to the COTH sample based on inclusion/exclusion criteria. A total of 510 surveys (n = 255 COTH, n = 255 non-COTH) were sent to participating hospitals. After correcting for undeliverable mail, respondents stating they had no IR, and declination of participation, the final overall response rate was 16.8% (n = 82) (Appendix B - Figure B 3).

Because of the low response rate, an initial evaluation of the representativeness of the respondent hospitals to those not responding was conducted within the COTH and non-COTH samples selected from the AHA data set. Characteristics of the respondent and non-respondent COTH hospitals are shown in Table 3. No statistically significant differences were observed ($p > .05$) suggesting that the sample of COTH hospitals was representative of the larger AHA COTH sample.

Table 3: American Hospital Association Descriptors, Total COTH Hospitals

	Total Hospitals n = 252	**Respondent Hospitals n = 47**	**Non-Respondent Hospitals n = 205**	**p-value**
	n (%)	n (%)	n (%)	
Region	252 (100.0)	47 (100.0)	205 (100.0)	.978
New England: CT, MA, ME, NH, RI, VT	29 (11.5)	5 (10.6)	24 (11.7)	
Mid Atlantic: NJ, NY, PA	53 (21.0)	10 (21.3)	43 (21.0)	
South Atlantic: DE, DC, FL, GA, MD, NC, SC, VA, WV,	39 (15.5)	7 (14.9)	32 (15.6)	
East North Central: OH, IN, IL, MI, WI	47 (18.7)	7 (14.9)	40 (19.5)	
East South Central: AL, KY, MS, TN	10 (4.0)	2 (4.3)	8 (3.9)	
West North Central: IA, KS, MO, MN, NE, ND, SD	18 (7.1)	4 (8.5)	14 (6.8)	
West South Central: AR, LA, OK, TX	21 (8.3)	3 (6.4)	18 (8.8)	
Mountain: AZ, CO, ID, MT, NM, NV, UT, WY	11 (4.4)	3 (6.4)	8 (3.9)	
Pacific: AK, CA, HI, OR, WA	24 (9.5)	6 (12.8)	18 (8.8)	
Control Code	252 (100.0)	47 (100.0)	205 (100.0)	.312
Government, Nonfederal	55 (21.8)	14 (29.8)	41 (20.0)	
Nongovernment, not-for-profit	188 (74.6)	31 (66.0)	157 (76.6)	
Investor-owned (for-profit)	9 (3.6)	2 (4.3)	7 (3.4)	
Service Code	252 (100.0)	47 (100.0)	205 (100.0)	
General medical and surgical	244 (96.8)	46 (97.9)	198 (96.6)	.650
Specialty	8 (3.2)	1 (2.1)	7 (3.4)	
Bed Size Code	252 (100.0)	47 (100.0)	205 (100.0)	.734
6-99 beds	3 (1.2)	1 (2.1)	2 (1.0)	
100-299 beds	33 (13.1)	7 (14.9)	26 (12.7)	
300-500+ beds	216 (85.7)	39 (83.0)	177 (86.3)	

Characteristics of the respondent and non-respondent non-COTH hospitals are shown in Table 4. As with the COTH sample, no statistically significant differences were observed ($p > .05$) suggesting that the sample of non-COTH hospitals was representative of the larger sample of AHA non-COTH hospitals that was similar to the COTH hospitals.

Table 4: American Hospital Association Descriptors, Total Non-COTH Hospitals

	Total Hospitals n = 236	**Respondent Hospitals n = 35**	**Non-Respondent Hospitals n = 201**	**p-value**
	n (%)	n (%)	n (%)	
Region	236 (100.0)	35 (100.0)	201 (100.0)	.493
New England: CT, MA, ME, NH, RI, VT	8 (3.4)	1 (2.7)	7 (3.5)	
Mid Atlantic: NJ, NY, PA	44 (18.6)	6 (17.1)	38 (18.9)	
South Atlantic: DE, DC, FL, GA, MD, NC, SC, VA, WV,	38 (16.1)	5 (13.5)	33 (16.4)	
East North Central: OH, IN, IL, MI, WI	40 (16.9)	5 (13.5)	35 (17.4)	
East South Central: AL, KY, MS, TN	11 (4.7)	1(2.7)	10 (5.0)	
West North Central: IA, KS, MO, MN, NE, ND, SD	19 (8.1)	3 (8.1)	16 (8.0)	
West South Central: AR, LA, OK, TX	26 (11.0)	4 (11.4)	22 (10.9)	
Mountain: AZ, CO, ID, MT, NM, NV, UT, WY	16 (6.8)	6_b (16.2)	10_a (5.0)	
Pacific: AK, CA, HI, OR, WA	34 (14.4)	4 (10.8)	30 (14.9)	
Control Code	236 (100.0)	35 (100.0)	201 (100.0)	.917
Government, Nonfederal	28 (11.9)	4 (11.4)	24 (11.9)	
Nongovernment, not-for-profit	169 (71.6)	26 (74.3)	143 (71.1)	
Investor-owned (for-profit)	39 (16.5)	5 (14.3)	34 (16.9)	
Service Code	236 (100.0)	35 (100.0)	201 (100.0)	.262
General medical and surgical	229 (97.0)	35 (100.0)	194 (96.5)	
Specialty	7 (3.0)	0 (0.0)	7 (3.5)	
Bed Size Code	236 (100.0)	35 (100.0)	201 (100.0)	.331
6-99 beds	54 (22.9)	5 (14.3)	49 (24.4)	
100-299 beds	113 (47.9)	17 (48.6)	96 (47.8)	
300-500+ beds	69 (29.2)	13 (37.1)	56 (27.9)	

Summaries of hospital descriptors of the entire sample of respondent hospitals, as well as the COTH and non-COTH hospitals are shown in Table 5. Regions were fairly well distributed across the country. 69.5% of hospitals were nongovernment, not-for-profit status, 22% were government nonfederal status, and 8.5% were investor owned, for-profit status. Most of the respondent hospitals (98.8%) were general medical and surgical service type. A majority of the

hospitals (63.4%) were a bed size of 300 or more, however, the non-COTH hospital sample had a higher proportion of smaller hospitals than did the COTH hospital sample (63% with < 300 beds vs. only 17% with < 300 beds in the COTH sample, $p < .001$) (Table 5).

Table 5: American Hospital Association Descriptors, Total Respondent Hospitals

	Total Hospitals n = 82	**COTH n = 47**	**Non-COTH n = 35**	**p-value**
	n (%)	n (%)	n (%)	
Region	82 (100.0)	47 (100.0)	35 (100.0)	.789
New England: CT, MA, ME, NH, RI, VT	6 (7.3)	5 (10.6)	1 (2.9)	
Mid Atlantic: NJ, NY, PA	16 (19.5)	10 (21.3)	6 (17.1)	
South Atlantic: DE, DC, FL, GA, MD, NC, SC, VA, WV,	12 (14.6)	7 (14.9)	5 (14.3)	
East North Central: OH, IN, IL, MI, WI	12 (14.6)	7 (14.9)	5 (14.3)	
East South Central: AL, KY, MS, TN	3 (3.7)	2 (4.3)	1 (2.9)	
West North Central: IA, KS, MO, MN, NE, ND, SD	7 (8.5)	4 (8.5)	3 (8.6)	
West South Central: AR, LA, OK, TX	7 (8.5)	3 (6.4)	4 (11.4)	
Mountain: AZ, CO, ID, MT, NM, NV, UT, WY	9 (11.0)	3 (6.4)	6 (17.1)	
Pacific: AK, CA, HI, OR, WA	10 (12.2)	6 (12.8)	4 (11.4)	
Control Code	82 (100.0)	47 (100.0)	35 (100.0)	.059
Government, Nonfederal	18 (22.0)	14_b (29.8)	4_a (11.4)	
Nongovernment, not-for-profit	57 (69.5)	31 (66.0)	26 (74.3)	
Investor-owned (for-profit)	7 (8.5)	2 (4.3)	5 (14.3)	
Service Code	82 (100.0)	47 (100.0)	35 (100.0)	.385
General medical and surgical	81 (98.8)	46 (97.9)	35 (100)	
Specialty	1 (1.2)	1 (2.1)	0 (0.0)	
Bed Size Code	82 (100.0)	47 (100.0)	35 (100.0)	< .001
6-99 beds	6 (7.3)	1_b (2.1)	5_a (14.3)	
100-299 beds	24 (29.3)	7_b (14.9)	17_a (48.6)	
300-500+ beds	52 (63.4)	39_b (83.0)	13_a (37.1)	

4.2 Analysis of Hypothesis or Research Questions

Specific Aim 1: To describe employment terms within IR departments.

Specific Aim 1 is focused on employment terms within IR departments and was divided into two parts; workload requirements and temporal conditions.

Specific Aim 1a: To describe workload requirements within IR departments.

Questions relating to workload requirement inquired about concurrent and total numbers of patients an RN is assigned over an entire shift. Respondents reported that a median of one patient was cared for concurrently (IQR 1.0, 1.0) and a median of five patients were cared for over an entire shift (IQR 4.0, 7.3). No statistically significant differences were observed between the two groups of hospitals ($p > .05$).

Table 6: Total Assigned Patients

	Total	**COTH**	**Non-COTH**	**p-value**
Total patients (concurrently)				.745
n	79	46	33	
Median	1.0	1.00	1.00	
IQR	1.0, 1.0	1.00, 1.13	1.00, 1.25	
Total patients (over whole shift)				.054
n	77	45	32	
Median	5.00	5.5	5.0	
IQR	4.00, 7.25	4.0, 8.0	3.5, 6.0	

Specific Aim 1b: To describe temporal conditions (shift length, hours of work) within IR departments.

Survey questions related to this aim focused on the availability of IR, which included staff shift length during the week, weekend, on-call hours, and overall hours of IR operation. Descriptive statistical summaries of the IR RN and IR RT shift length Monday through Friday

within the sample of hospitals are presented in Table 7. One non-COTH respondent indicated that the hospital did not have a shift length that was predominantly used Monday through Friday. Of those who reported shift availability during this time period, there was a statistically significant difference in those values between the COTH and non-COTH respondents ($p < .001$). Approximately 60% (28 of 47) of COTH respondents reported the use of 10-hour shifts for IR RNs. This was in contrast to only 17% (6 of 35) non-COTH respondents reporting the use of those shifts; eight-hour IR RN shifts were most commonly reported in that group (74.3%, 26 of 35). Of the participants reporting "other," these responses included nine-hour shifts and combinations of the other shift options listed in the question. Approximately 65% of total respondents reported the use of eight-hour shifts for IR RTs however, there was a tendency for the non-COTH group to report a higher use of those than did the COTH group (84% vs. 51% respectively, $p = .019$). For participants reporting "other," responses ($n = 3$) included combinations of eight and 10-hour shifts ($n = 2$) and on-call ($n = 1$) shifts.

Table 7: Shift Length Monday through Friday

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
IR RN	82 (100.0)	47 (100.0)	35 (100.0)	< .001
8 hours	36 (43.9)	10_a (21.3)	26_b (74.3)	
10 hours	34 (41.5)	28_a (59.6)	6_b (17.1)	
12 hours	5 (6.1)	3 (6.4)	2 (5.7)	
Other	7 (8.5)	6 (12.8)	1 (2.9)	
IR RT	77 (100.0)	45 (100.0)	32 (100.0)	.019
8 hours	50 (64.9)	23_a (51.1)	27_b (84.4)	
10 hours	22 (28.6)	17_a (37.8)	5_b (15.6)	
12 hours	2 (2.6)	2 (4.4)	0 (0.0)	
Other	3 (3.9)	3 (6.7)	0 (0.0)	

A higher percentage of those responding from non-COTH hospitals indicated that they did not have shifts during the weekend for IR RNs or IR RTs (non-COTH, 34.3%, 12 of 35 and

35.3%, 12 of 34 respectively; COTH 10.9%, 5 of 41 and 11.1% 5 of 40, respectively, both p = .01). Of those who reported a shift length for the weekend hours, more than half of total respondents chose 'other' for both the IR RN (59.4%, 38 of 64) and IR RT (67.7%, 42 of 62). Those reporting 'other' conveyed the overwhelming use of on-call shifts for both provider types (RN on-call: 36 of 46; RT on-call: 38 of 46). In fact, a median of 60 on-call hours (n = 76, IQR 20.0, 127.5) were reported for the IR RN and a median of 90.5 on-call hours (n = 70, IQR 28.0, 128.0) were reported for the IR RT. No statistically significant difference between the total reported on-call hours between the two groups was observed (p > .05).

Table 8: *Shift Length During the Weekend*

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
IR RN	64 (100.0)	41 (100.0)	23 (100.0)	.535
8 hours	3 (4.7)	3 (7.3)	0 (0.0)	
10 hours	3 (4.7)	2 (4.9)	1 (4.3)	
12 hours	8 (12.5)	6 (14.6)	2 (8.7)	
24 hours	7 (10.9)	5 (12.2)	2 (8.7)	
48 hours	5 (7.8)	4 (9.8)	1 (4.3)	
Other	38 (59.4)	21 (51.2)	17 (73.9)	
IR RT	62 (100.0)	40 (100.0)	22 (100.0)	.663
8 hours	6 (9.7)	4 (10.0)	2 (9.1)	
10 hours	2 (3.2)	1 (2.5)	1 (4.5)	
12 hours	3 (4.8)	2 (5.0)	1 (4.5)	
24 hours	6 (9.7)	5 (12.5)	1 (4.5)	
48 hours	3 (4.8)	3 (7.5)	0 (0.0)	
Other	42 (67.7)	25 (62.5)	17 (77.3)	

Summaries of the availability of IR per day are shown in Table 9. Overall, the hospitals reported a median 24 hours availability per day (IQR 10.0, 24.0) for all days of the week including weekends. While COTH hospitals offered a median 24 hours of operation every day, the median availability was 10 hours per day for the non-COTH hospitals for all days during the week (p = .002). On weekends, both groups reported a median 24 hours per day, yet more than

25% of the non-COTH respondents had no availability during the weekend resulting in a statistically significant difference between the two groups ($p < .05$, see Table 9).

Table 9: Hours of Availability Per Day

	Total	**COTH**	**Non-COTH**	**p-value**
Monday				.002
n	82	47	35	
Median	24.0	24.0	10.0	
IQR	10.0, 24.0	11.0, 24.0	8.0, 24.0	
Tuesday				.002
n	82	47	35	
Median	24.0	24.0	10.0	
IQR	10.0, 24.0	11.0, 24.0	8.0, 24.0	
Wednesday				.002
n	82	47	35	
Median	24.0	24.0	10.0	
IQR	10.0, 24.0	11.0, 24.0	8.0, 24.0	
Thursday				.002
n	82	47	35	
Median	24.0	24.0	10.0	
IQR	10.0, 24.0	11.0, 24.0	8.0, 24.0	
Friday				.002
n	82	47	35	
Median	24.0	24.0	10.0	
IQR	10.0, 24.0	11.0, 24.0	8.0, 24.0	
Saturday				.025
n	82	47	35	
Median	24.0	24.0	24.0	
IQR	24.0, 24.0	24.0, 24.0	0.0, 24.0	
Sunday				.029
n	82	47	35	
Median	24.0	24.0	24.0	
IQR	24.0, 24.0	24.0, 24.0	0.0, 24.0	

Specific Aim 2: To describe the organizational facets within IR departments.

Specific Aim 2 is focused on organizational facets within IR departments and was divided into two parts; work environment and organizational structure.

Specific Aim 2a: To describe the work environment within IR departments.

Questions related to the work environment inquired about moderate sedation privileges for adults, pediatrics, specific medications, moderate sedation education, responsibilities of providers, organization of nursing care, and roles of unit-based personnel. Some of the hospitals did not employ all types of providers in IR with regard to adult patients. All hospitals employed RNs in IR yet there was a tendency for the COTH hospitals to be much more likely to employ the other types of providers than were the non-COTH hospitals. All of the COTH hospitals employed anesthesiologists and most of them employed CRNAs and had medical residents or fellows (44 of 45, 97.8%; 36 of 43, 83.7% respectively). Those respective values for the non-COTH hospitals were 84.8% (28 of 33), 61.8% (21 of 34), and 26.7% (8 of 30) ($p < .05$).

Statistical summaries comparing provider moderate sedation privileges for adult patients by hospitals with those providers are presented by provider in Table 10. Of those that responded "yes" or "no" with regard to adult sedation privileges, 100% of total respondents reported these privileges for CRNAs and anesthesiologists, 92.6% of total respondents (75 of 81) reported that RNs had sedation privileges, and 59.1% (26 of 44) for medical residents or fellows. Differences were not statistically significant by hospital type for any provider ($p > .05$). Write-in options for 'other,' ($n = 10$) included an attending with privileges ($n = 1$), faculty MD/DO ($n = 2$), IR attendings ($n = 2$), IR MDs ($n = 2$), NP ($n = 1$), staff ($n = 1$), and a radiologist ($n = 1$).

Table 10: Adult Sedation Privileges by Provider

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
RN	81 (100.0)	47 (100.0)	34 (100.0)	.203
Yes	75 (92.6)	45 (95.7)	30 (88.2)	
No	6 (7.4)	2 (4.3)	4 (11.8)	
CRNA	65 (100.0)	44 (100.0)	21 (100.0)	
Yes	65 (100.0)	44 (100.0)	21 (100.0)	Constant
No	0 (0.0)	0 (0.0)	0 (0.0)	
Anesthesiologist	74 (100.0)	46 (100.0)	28 (100.0)	Constant
Yes	74 (100.0)	46 (100.0)	28 (100.0)	
No	0 (0.0)	0 (0.0)	0 (0.0)	
Medical Resident or Fellow	44 (100.0)	36 (100.0)	8 (100.0)	.563
Yes	26 (59.1)	22 (61.1)	4 (50.0)	
No	18 (40.9)	14 (38.9)	4 (50.0)	

A similar question was asked about sedation privileges by provider for pediatric patients (Table 11). 65.9% (54 of 82) of hospitals reported that they offered services to pediatric patients. 85.1% of COTH respondents (40 of 47) and 40% of non-COTH respondents (14 of 35) reported that they provided services to pediatric patients ($p < .001$). Most hospitals reported employing RNs (43 of 50, 86%), CRNAs (41 of 50, 82%), anesthesiologists (45 of 50, 90%), and medical residents or fellows (27 of 45, 60%) with regard to pediatric patients. COTH hospitals were more likely to employ CRNAs (34 of 37, 91.9%) and medical residents or fellows (24 of 32, 75%) than non-COTH hospitals (7 of 13, 53.8%; 3 of 13, 23.1%, respectively) ($p < .05$).

Of those describing pediatric sedation privileges for their respective institutions, 46.5% (20 of 43) of total respondents reported RNs had pediatric sedation privileges, 95.1% (39 of 41) reported these privileges for CRNAs, 97.8% (44 of 45) for anesthesiologists, and 48.1% (13 of 27) for medical residents or fellows. No statistically significant differences were observed between groups of hospitals by provider. Those choosing the write in option of 'other' ($n = 7$)

included faculty (MD/DO) (n = 2), IR Attending (n = 2), NP (n = 1) a PICU attending (n = 1) and radiologist (n = 1).

Table 11: *Pediatric Sedation Privileges by Provider*

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
RN	43 (100.0)	33 (100.0)	10 (100.0)	.801
Yes	20 (46.5)	15 (45.5)	5 (50.0)	
No	23 (53.5)	18 (54.5)	5 (50.0)	
CRNA	41 (100.0)	34 (100.0)	7 (100.0)	.511
Yes	39 (95.1)	32 (94.1)	7 (100.0)	
No	2 (4.9)	2 (5.9)	0 (0.0)	
Anesthesiologist	45 (100.0)	35 (100.0)	10 (100.0)	.589
Yes	44 (97.8)	34 (97.1)	10 (100.0)	
No	1 (2.2)	1 (2.9)	0 (0.0)	
Medical Resident or Fellow	27 (100.0)	24 (100.0)	3 (100.0)	.586
Yes	13 (48.1)	12 (50.0)	1 (33.3)	
No	14 (51.9)	12 (50.0)	2 (66.7)	

Additional survey questions were asked about privileges related to the administration of specific medications. Statistical summaries of medication administration by provider are described in Table 12. Similar to the previous questions, hospitals were given the option to report if specific provider types were not employed in IR. All hospitals reported employment of RNs (79 of 79), and most reported employing CRNAs (66 of 80, 82.5%), and anesthesiologists (76 of 80, 95%). About half of total respondents reported employing medical residents or fellows (34 of 67, 50.7%). COTH hospitals were more likely to employ CRNAs (45 of 46, 97.8%) and anesthesiologists (46 of 46, 100%) than non-COTH hospitals (21 of 34; 61.8%; 30 of 34, 88.2%, respectively) ($p < .05$).

Of those respondents who described specific medication sedation privileges for each provider, all of the respondents reported that RNs were allowed to administer both fentanyl and versed. Almost all (77 of 79, 97.5%) reported that RNs could administer morphine, while 88.6%

(70 of 79) could administer dilaudid, and 16.6% (13 of 79) propofol. No statistically significant differences were observed between the hospital groups for RN medication administration. CRNAs were more likely to have privileges to administer the five medication types in COTH respondent hospitals (fentanyl, versed, and morphine 65 of 80, or 81.3% for each; propofol 64 of 80, 80%; and dilaudid 63 of 80, 78.8%), as compared to non-COTH respondent hospitals (fentanyl, versed, morphine, and propofol 20 of 34 or 58.8% for each; dilaudid 19 of 34, 55.9%; $p < .001$). Similar differences were observed for the COTH and non-COTH hospitals employing anesthesiologists and medical residents. 100% of COTH hospitals reported that anesthesiologists had privileges to administer fentanyl, versed, and morphine, while 95.7% (44 of 46) reported privileges for both propofol and dilaudid. 78.8% (26 of 33) of non-COTH respondents reported these privileges for both fentanyl and versed, 75.8% (25 of 33) for morphine, 81.8% (27 of 33) for propofol, and 72.7% (24 of 33) for dilaudid ($p < .05$). Medical residents had less privileges overall with only approximately 50% of COTH respondents reporting privileges for fentanyl, versed, morphine, and dilaudid, and only 14.3% of non-COTH respondents reporting privileges for these medications ($p < .05$). This question also allowed a write in option for 'other.' These responses (n = 11) included IR MDs (n = 6), MDs/DOs (n = 1), PA (n = 1), a PICU attending (n = 1), IR attending (n = 1), and a radiologist (n = 1).

Table 12: Medication Administration Privileges

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
RN Fentanyl	79 (100.0)	47 (100.0)	32 (100.0)	Constant
Checked	79 (100.0)	47 (100.0)	32 (100.0)	
Unchecked	0 (0.0)	0 (0.0)	0 (0.0)	
RN Versed	79 (100.0)	47 (100.0)	32 (100.0)	Constant
Checked	79 (100.0)	47 (100.0)	32 (100.0)	
Unchecked	0 (0.0)	0 (0.0)	0 (0.0)	
RN Morphine	79 (100.0)	47 (100.0)	32 (100.0)	.782
Checked	77 (97.5)	46 (97.9)	31 (96.9)	

Unchecked	2 (2.5)	1 (2.1)	1 (3.1)	
RN Propofol	79 (100.0)	47 (100.0)	32 (100.0)	.284
Checked	13 (16.5)	6 (12.8)	7 (21.9)	
Unchecked	66 (83.5)	41 (87.2)	25 (78.1)	
RN Dilaudid	79 (100.0)	47 (100.0)	32 (100.0)	.798
Checked	70 (88.6)	42 (89.4)	28 (87.5)	
Unchecked	9 (11.4)	5 (10.6)	4 (12.5)	
CRNA Fentanyl	80 (100.0)	46 (100.0)	34 (100.0)	< .001
Checked	65 (81.3)	45_a (97.8)	20_b (58.8)	
Unchecked	15 (18.8)	1_a (2.2)	14_b (41.2)	
CRNA Versed	80 (100.0)	46 (100.0)	34 (100.0)	< .001
Checked	65 (81.3)	45_a (97.8)	20_b (58.8)	
Unchecked	15 (18.8)	1_a (2.2)	14_b (41.2)	
CRNA Morphine	80 (100.0)	46 (100.0)	34 (100.0)	< .001
Checked	65 (81.3)	45_a (97.8)	20_b (58.8)	
Unchecked	15 (18.8)	1_a (2.2)	14_b (41.2)	
CRNA Propofol	80 (100.0)	46 (100.0)	34 (100.0)	< .001
Checked	64 (80.0)	44_a (95.7)	20_b (58.8)	
Unchecked	16 (20.0)	2_a (4.3)	14_b (41.2)	
CRNA Dilaudid	80 (100.0)	46 (100.0)	34 (100.0)	< .001
Checked	63 (78.8)	44_a (95.7)	19_b (55.9)	
Unchecked	17 (21.3)	2_a (4.3)	15_b (44.1)	
Anesthesiologist Fentanyl	79 (100.0)	46 (100.0)	33 (100.0)	.001
Checked	72 (91.1)	46_a (100.0)	26_b (78.8)	
Unchecked	7 (8.9)	0_a (0.0)	7_b (21.2)	
Anesthesiologist Versed	79 (100.0)	46 (100.0)	33 (100.0)	.001
Checked	72 (91.1)	46_a (100.0)	26_b (78.8)	
Unchecked	7 (8.9)	0_a (0.0)	7_b (21.2)	
Anesthesiologist Morphine	79 (100.0)	46 (100.0)	33 (100.0)	< .001
Checked	71 (89.9)	46_a (100.0)	25_b (75.8)	
Unchecked	8 (10.1)	0_a (0.0)	8_b (24.2)	
Anesthesiologist Propofol	79 (100.0)	46 (100.0)	33 (100.0)	.044
Checked	71 (89.9)	44_a (95.7)	27_b (81.8)	
Unchecked	8 (10.1)	2_a (4.3)	6_b (18.2)	
Anesthesiologist Dilaudid	79 (100.0)	46 (100.0)	33 (100.0)	.004
Checked	68 (86.1)	44_a (95.7)	24_b (72.7)	
Unchecked	11 (13.9)	2_a (4.3)	9_b (27.3)	
Medical Resident Fentanyl	67 (100.0)	39 (100.0)	28 (100.0)	.002
Checked	24 (35.8)	20_a (51.3)	4_b (14.3)	
Unchecked	42 (64.2)	19_a (48.7)	24_b (85.7)	
Medical Resident Versed	67 (100.0)	39 (100.0)	28 (100.0)	.002
Checked	24 (35.8)	20_a (51.3)	4_b (14.3)	
Unchecked	43 (64.2)	19_a (48.7)	24_b (85.7)	
Medical Resident Morphine	67 (100.0)	39 (100.0)	28 (100.0)	.002

Checked	24 (35.8)	20_a (51.3)	4_b (14.3)	
Unchecked	43 (64.2)	19_a (48.7)	24_b (85.7)	
Medical Resident Propofol	67 (100.0)	39 (100.0)	28 (100.0)	.128
Checked	13 (19.4)	10 (25.6)	3 (10.7)	
Unchecked	54 (80.6)	29 (74.4)	25 (89.3)	
Medical Resident Dilaudid	67 (100.0)	39 (100.0)	28 (100.0)	.003
Checked	23 (34.3)	19_a (48.7)	4_b (14.3)	
Unchecked	44 (65.7)	20_a (51.3)	24_b (85.7)	

Summaries of reports of moderate sedation education prior to providers receiving privileges are presented in Table 13. Written material developed by the hospital (69 of 80, 86.3%), online modules (62 of 75, 82.7%), and verbal instruction (53 of 67, 79.1%) were the most commonly used methods of moderate sedation instruction for total respondents, followed by internet websites (38 of 67, 56.8%), written materials developed by the individual unit (32 of 71, 45.1%), classroom training (32, of 71, 45.1%), and videos or DVDs (27 of 67, 40.3%). No statistically significant differences were observed by hospital types ($p > .05$). Respondents writing in an option for 'other' (n = 7), included unit-based preceptor quiz (n = 1), hands on training (n = 1), classroom training (n = 1), hospital testing (n = 1), verification by the credentialing department (n = 1), on the job training (n = 1), and annual competency checks (n = 1).

The second part of this question asked about the requirement of training after moderate sedation privileges were obtained. 79.7% of total respondents (63 of 79) reported that training is an "annual requirement," 6.3% (5 of 79) reported "another time period," and 13.9% (11 of 79) reported it was not required. Again, no statistically significant differences were found by hospital type ($p > .05$). If respondents reported training was "at another time period," respondents were asked to include these time frames (n = 5). These included annual training (n = 1) and training every two years (n = 4).

Table 13: Moderate Sedation Education Resources

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Written material developed by the hospital	80 (100.0)	46 (100.0)	34 (100.0)	.127
Used	69 (86.3)	42 (91.3)	27 (79.4)	
Not Used	11 (13.8)	4 (8.7)	7 (20.6)	
Written material developed by the individual units	71 (100.0)	40 (100.0)	31 (100.0)	.343
Used	32 (45.1)	20 (50.0)	12 (38.7)	
Not Used	39 (54.9)	20 (50.0)	19 (61.3)	
Video or DVD	67 (100.0)	38 (100.0)	29 (100.0)	.875
Used	27 (40.3)	15 (39.5)	12 (41.4)	
Not Used	40 (59.7)	23 (60.5)	17 (58.6)	
Classroom training	71 (100.0)	40 (100.0)	31 (100.0)	.989
Used	32 (45.1)	18 (45.0)	14 (45.2)	
Not Used	39 (54.9)	22 (55.0)	17 (54.8)	
Internet website	67 (100.0)	39 (100.0)	28 (100.0)	.952
Used	38 (56.7)	22 (56.4)	16 (57.1)	
Not Used	29 (43.3)	17 (43.6)	12 (42.9)	
Online module	75 (100.0)	43 (100.0)	32 (100.0)	.130
Used	62 (82.7)	38 (88.4)	24 (75.0)	
Not Used	13 (17.3)	5 (11.6)	8 (25.0)	
Verbal instruction	67 (100.0)	36 (100.0)	31 (100.0)	.373
Used	53 (79.1)	27 (75.0)	26 (83.9)	
Not Used	14 (20.9)	9 (25.0)	5 (16.1)	

The responsibilities of providers during cases of moderate sedation are presented in Table 14. Responsibilities included monitoring of hemodynamics, retrieving supplies, retrieving medications, patient documentation, and calling of report. The primary RN was indicated as responsible for hemodynamic monitoring (75 of 80, 93.8%), retrieving medications (64 of 80,

80.0%), patient documentation (72 of 81, 88.9%) and the calling of report (76 of 79, 96.2%), while the RT primarily managed supplies (65 of 81, 80.2%). A statistically significant difference in the responsibility of calling report was observed between the groups of hospitals for the primary RN ($p = .042$). The primary RN was responsible for calling report 100% of the time for COTH hospitals and 91.2% (31 of 34) of the time for non-COTH hospitals.

Table 14: Responsibility During Procedures Using Moderate Sedation

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Hemodynamics-Charge RN	80 (100.0)	46 (100.0)	34 (100.0)	.388
Checked	3 (3.8)	1 (2.2)	2 (5.9)	
Unchecked	77 (96.3)	45 (97.8)	32 (94.1)	
Hemodynamics-Primary RN	80 (100.0)	46 (100.0)	34 (100.0)	.080
Checked	75 (93.8)	45 (97.8)	30 (88.2)	
Unchecked	5 (6.3)	1 (2.2)	4 (11.8)	
Hemodynamics-Second RN	80 (100.0)	46 (100.0)	34 (100.0)	.743
Checked	3 (3.8)	2 (4.3)	1 (2.9)	
Unchecked	77 (96.3)	44 (95.7)	33 (97.1)	
Hemodynamics-RT	80 (100.0)	46 (100.0)	34 (100.0)	.388
Checked	3 (3.8)	1 (2.2)	2 (5.9)	
Unchecked	77 (96.3)	45 (97.8)	32 (94.1)	
Hemodynamics-Other	80 (100.0)	46 (100.0)	34 (100.0)	.242
Checked	1 (1.3)	0 (0.0)	1 (2.9)	
Unchecked	79 (98.8)	46 (100.0)	33 (97.1)	
Supplies-Charge RN	81 (100.0)	47 (100.0)	34 (100.0)	.223
Checked	2 (2.5)	2 (4.3)	0 (0.0)	
Unchecked	79 (97.5)	45 (95.7)	34 (100.0)	
Supplies-Primary RN	81 (100.0)	47 (100.0)	34 (100.0)	.113
Checked	17 (21.0)	7 (14.9)	10 (29.4)	
Unchecked	64 (79.0)	40 (85.1)	24 (70.6)	
Supplies-Second RN	81 (100.0)	47 (100.0)	34 (100.0)	.197
Checked	12 (14.8)	9 (19.1)	3 (8.8)	
Unchecked	69 (85.2)	38 (80.9)	31 (91.2)	
Supplies-RT	81 (100.0)	47 (100.0)	34 (100.0)	.468
Checked	65 (80.2)	39 (83.0)	26 (76.5)	
Unchecked	16 (19.8)	8 (17.0)	8 (23.5)	
Supplies-Other	81 (100.0)	47 (100.0)	34 (100.0)	Constant
Checked	0 (0.0)	0 (0.0)	0 (0.0)	
Unchecked	81 (100.0)	47 (100.0)	34 (100.0)	
Medications-Charge RN	80 (100.0)	46 (100.0)	34 (100.0)	.907

Checked	5 (6.3)	3 (6.5)	2 (5.9)	
Unchecked	75 (93.8)	43 (93.5)	32 (94.1)	
Medications-Primary RN	80 (100.0)	46 (100.0)	34 (100.0)	.497
Checked	64 (80.0)	38 (82.6)	26 (76.5)	
Unchecked	16 (20.0)	8 (17.4)	8 (23.5)	
Medications-Second RN	80 (100.0)	46 (100.0)	34 (100.0)	.572
Checked	14 (17.5)	9 (19.6)	5 (14.7)	
Unchecked	66 (82.5)	37 (80.4)	29 (85.3)	
Medications-RT	80 (100.0)	46 (100.0)	34 (100.0)	.387
Checked	1 (1.3)	1 (2.2)	0 (0.0)	
Unchecked	79 (98.8)	45 (97.8)	34 (100.0)	
Medications-Other	80 (100.0)	46 (100.0)	34 (100.0)	.828
Checked	2 (2.5)	1 (2.2)	1 (2.9)	
Unchecked	78 (97.5)	45 (97.8)	33 (97.1)	
Documentation-Charge RN	81 (100.0)	47 (100.0)	34 (100.0)	.377
Checked	3 (3.7)	1 (2.1)	2 (5.9)	
Unchecked	78 (96.3)	46 (97.9)	32 (94.1)	
Documentation-Primary RN	81 (100.0)	47 (100.0)	34 (100.0)	.381
Checked	72 (88.9)	43 (91.5)	29 (85.3)	
Unchecked	9 (11.1)	4 (8.5)	5 (14.7)	
Documentation-Second RN	81 (100.0)	47 (100.0)	34 (100.0)	.480
Checked	4 (4.9)	3 (6.4)	1 (2.9)	
Unchecked	77 (95.1)	44 (93.6)	33 (97.1)	
Documentation-RT	81 (100.0)	47 (100.0)	34 (100.0)	.206
Checked	14 (17.3)	6 (12.8)	8 (23.5)	
Unchecked	67 (82.7)	41 (87.2)	26 (76.5)	
Documentation-Other	81 (100.0)	47 (100.0)	34 (100.0)	Constant
Checked	0 (0.0)	0 (0.0)	0 (0.0)	
Unchecked	81 (100.0)	47 (100.0)	34 (100.0)	
Report-Charge RN	79 (100.0)	45 (100.0)	34 (100.0)	.099
Checked	2 (2.5)	0 (0.0)	2 (5.9)	
Unchecked	77 (97.5)	45 (100.0)	32 (94.1)	
Report-Primary RN	79 (100.0)	45 (100.0)	34 (100.0)	.042
Checked	76 (96.2)	45_a (100.0)	31_b (91.2)	
Unchecked	3 (3.8)	0_a (0.0)	3_b (8.8)	
Report-Second RN	79 (100.0)	45 (100.0)	34 (100.0)	.213
Checked	2 (2.5)	2 (4.4)	0 (0.0)	
Unchecked	77 (97.5)	43 (95.6)	34 (100.0)	
Report-RT	79 (100.0)	45 (100.0)	34 (100.0)	Constant
Checked	0 (0.0)	0 (0.0)	0 (0.0)	
Unchecked	79 (100.0)	45 (100.0)	34 (100.0)	
Report-Other	79 (100.0)	45 (100.0)	34 (100.0)	.247
Checked	1 (1.3)	0 (0.0)	1 (2.9)	
Unchecked	78 (98.7)	45 (100.0)	33 (97.1)	

A similar question highlighted the performance of stocking, cleaning, hospitality activities, and transport by unit-based personnel (Table 15). Of the respondents, 82.7% (67 of 81) reported unit- based personnel for stocking, 77.8% (63 of 81) for cleaning, 70.7% (53 of 75) for hospitality activities, and 60.8% (48 of 79) for transport. Again, no statistically significant differences were observed by hospital type ($p > .05$).

Table 15: Activities of Unit-Based Personnel

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Stocking	81 (100.0)	47 (100.0)	34 (100.0)	.504
Yes	67 (82.7)	40 (85.1)	27 (79.4)	
No	14 (17.3)	7 (14.9)	7 (20.6)	
Cleaning	81 (100.0)	47 (100.0)	34 (100.0)	.764
Yes	63 (77.8)	36 (76.6)	27 (79.4)	
No	18 (22.2)	11 (23.4)	7 (20.6)	
Hospitality Activities	75 (100.0)	43 (100.0)	32 (100.0)	.180
Yes	53 (70.7)	33 (76.7)	20 (62.5)	
No	22 (29.3)	10 (23.3)	12 (37.5)	
Transport	79 (100.0)	45 (100.0)	34 (100.0)	.874
Yes	48 (60.8)	27 (60.0)	21 (61.8)	
No	31 (39.2)	18 (40.0)	13 (38.2)	

Overall, 43% (34 of 79) reported that unit-based personnel performed nursing activities; reported as a median of 75.0% of their daily work (IQR 3.25, 90.00). The specific titles of those completing this work included: RN (23 of 57, 40.4%) RT (13 of 57, 22.8%), nurse/RT assistant (12 of 57, 21.1%), and 'other' (9 of 57, 15.8%). Examples of titles reported for 'other' included but were not limited to supply person, supply coordinator, transport and building services. Of those performing nurse-related activities the specific activities included: patient care (39 of 69, 56.5%), medications (11 of 69, 15.9%), education (3 of 69, 4.3%), stocking/ cleaning/ transport (11 of 69, 15.9%), and 'other' (5 of 69, 7.2%). Examples of activities reported for 'other' included but were not limited to glucometer quality checks and scheduling. No statistically

significant differences in any of these reports were observed between the two hospital groups ($p > .05$).

Summaries of the specific organization of care within IR is presented in Table 16. Of all respondents, 41.3% (33 of 80) reported that the RN has the same patients from pre-procedure to recovery, while 45.0% (36 of 80) reported different patients were cared for in pre-procedure, intra-procedure, and recovery. Yet, there was a statistically significant difference for those rates between the two hospital groups ($p < .05$). Within the group of non-COTH respondents, nurses were considerably more likely to have the same patient throughout (21 of 33, 63.6%,) than they were in the COTH respondent hospitals (12 of 47, 25.5%). Those respondents writing in an option for 'other,' (n = 4) included a hybrid process of the two options (n = 2) and the RN having the same patient in prep and recovery (n = 2).

Table 16: Organization of Care

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
	80 (100.0)	47 (100.0)	33 (100.0)	
RN has same patient from pre-procedure, intra-procedure through to recovery	33 (41.3)	12_a (25.5)	21_b (63.6)	.001
RNs have different patients in pre-procedure, intra-procedure, and recovery	36 (45.0)	29_a (61.7)	7_b (21.2)	
Other	11 (13.8)	6 (12.8)	5 (15.2)	

Specific Aim 2b: To describe organizational structures (policies and procedures) within IR departments.

Questions relating to organizational structure inquired about total cases completed with moderate sedation, use of end-tidal carbon dioxide monitoring (ETCO2), use of moderate

sedation policies, rooms authorized for moderate sedation, percent of inpatient and outpatients, and number of cases completed in IR.

As shown in Table 17, respondents reported that the RN was responsible for a median of 90.0% of the sedation administered for adult patients (IQR 80.0, 98.0), with 1.5% being administered by CRNAs (0.0, 10.0). However, within the groups of hospitals it was found that RNs were reported to administer a lower percentage of sedation in the COTH respondent hospitals (n = 47, median 85.0, IQR 75.0, 95.0) than the non-COTH respondent hospitals (n = 33, median 95.0, IQR 80.0, 99.5, p = .036). Correspondingly, the CRNAs administered a higher percentage of sedation in COTH respondent hospitals (n = 47, median 5.0, IQR 0.0, 15.0) than in non-COTH respondent hospitals (non-COTH n = 33, median 0.00, IQR 0.00, 3.75, p = .004). The response for 'other' (n = 6) included local anesthesia (n = 2), attending physician (n = 1), CRNA with an anesthesiologist (n = 1), a PA (n = 1), and a radiologist (n = 1). Within the group of respondents for pediatric sedation, it was reported that anesthesia was administered very infrequently (median = 0.0) by any of the providers. The responses for 'other' (n = 5) included sedationist MD (n = 1), local anesthesia only (n = 1), PICU attending (n = 1), sedation team (n = 1) and a pediatrician credentialed in sedation (n = 1).

Table 17: Percent of Adult Cases Receiving Moderate Sedation by Provider

	Total	**COTH**	**Non-COTH**	**p-value**
RN				.036
n	80	47	33	
Median	90.0	85.0	95.0	
IQR	80.0, 98.0	75.0, 95.0	80.0, 99.5	
CRNA				.004
n	80	47	33	
Median	1.5	5.0	0.00	
IQR	0.0,10.0	0.0, 15.0	0.00, 3.75	
Anesthesiologist				.094
n	79	47	32	
Median	5.0	5.0	2.0	

IQR	0.0, 10.0	0.0, 12.5	0.0, 5.0	
Medical Resident or Fellow				.362
n	80	47	33	
Median	0.0	0.0	0.0	
IQR	0.0, 0.0	0.0, 0.0	0.0, 0.0	

Total median case volumes for adult patients receiving moderate sedation in the prior year was defined as a median of 1250 patients (n = 66, IQR 396.25, 2825.00) with COTH respondent hospitals (n = 35, median 2500.0, IQR 1200.0, 4800.0) reporting more adult cases completed with moderate sedation than non-COTH respondents overall (n = 31, median 540.0, IQR 180.0, 1095.0), ($p < .001$). Similar results were reported for total pediatric patients receiving moderate sedation (n = 34, median 12.50, IQR 1.0, 100.0) as COTH respondents (n = 23, median 40, IQR 5.0, 100.0) reported significantly more pediatric cases than non-COTH respondents (n = 11, median 5, IQR 1.0, 10.0) ($p = .029$). Notably, approximately half of total respondents reported the presence of pediatric services in IR (46 of 82, 56.1%). COTH hospitals (33 of 47, 70.2%) were more likely to offer pediatric services than non-COTH hospitals (13 of 35, 37.1%) ($p = .003$). These results are consistent with previous results describing pediatric services being offered more frequently in COTH than non-COTH hospitals.

An overall median of 3.50 rooms (n = 82, IQR 2.0, 5.0) were reported as authorized for radiology procedures with moderate sedation. Total respondents reported a median value of 2656.5 (n = 74, IQR 1175.0, 5833.0) cases completed in these rooms in the last year with a higher percentage of outpatients (n = 80, mean 59.29%, SD 19.56, 50.00-73.75) as compared to inpatients (n = 80, mean 40.75%, SD 19.73, 26.25-50.00) overall. Of the total reported cases, just under half received moderate sedation (n = 82, median 1500.0, IQR 600.0, 2725.0) and procedures utilizing moderate sedation applied ETCO2 monitoring in a median of 100.0% of

cases (n = 74, IQR 17.5, 100.0). Within the groups of hospitals, COTH respondents reported more radiology rooms authorized for IR procedures (n = 47, median 5.0, IQR 3.0, 6.0), significantly higher numbers of total cases overall (n = 41, median 4000.0, IQR 2500.0, 7797.0), and significantly higher numbers of total patients receiving moderate sedation (n = 39, median 2352.00, IQR 1580.00, 5200.00) than non-COTH respondents (n = 35, median 3.0, IQR 1.0, 4.0; n = 33, median 1200.0, IQR 350.0, 2650.0; n = 35, median 600.00, IQR 142.00, 1800.0, respectively) ($p < .001$).

Table 18 presents the results of the use of a unit-based or hospital-based moderate sedation policy. 32.9% (26 of 79) of total respondents reported the use of a unit-based policy for moderate sedation, which was reported as used for all patients by 81.3% of respondents (28 of 34). 98.4% (63 of 64) of respondents reported the use of a hospital-based moderate sedation policy, which was reported as used for all patients by 96.9% (62 of 64) of respondents.

Table 18: Moderate Sedation Policy

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Unit-based MS policy	79 (100.)	45 (100.0)	34 (100.0)	.927
Yes	26 (32.9)	15 (33.3)	11 (32.4)	
No	53 (67.1)	30 (66.7)	23 (67.6)	
Is it used for all patients?	34 (100.0)	18 (00.0)	16 (100.0)	.874
Yes	28 (82.4)	15 (83.3)	13 (81.3)	
No	6 (17.6)	3 (16.7)	3 (18.8)	
Hospital-based MS policy	64 (100.0)	39 (100.0)	25 (100.0)	.208
Yes	63 (98.4)	39 (100.0)	24 (96.0)	
No	1 (1.6)	0 (0.0)	1 (4.0)	
Is it used for all patients?	64 (100.0)	39 (100.0)	25 (100.0)	.747
Yes	62 (96.9)	38 (97.4)	24 (96.0)	
No	2 (3.1)	1 (2.6)	1 (4.0)	

Specific Aim 3: To describe the characteristics of labor (quality and quantity) within IR departments.

Specific Aim 3 is focused on characteristics of labor and was divided into two parts; quality and quantity.

Specific Aim 3a: To describe the quality (competence and training, certification, degree, and level of experience) of labor within IR departments.

Questions relating to quality inquired about competence, training, certification, degree, and level of experience. Statistical summaries related to the status of hospital-mandated moderate sedation training prior to receiving moderate sedation privileges are presented in Table 19. Respondents were asked to report not only employment status in IR of specific providers but whether providers were additionally authorized to provide moderate sedation. A majority of hospitals reported the employment and sedation privileges of RNs (79 of 82, 96.3%), CRNAs (63 of 80, 78.8%), anesthesiologists (69 of 78, 88.5%), and physicians (64 of 74, 86.5%), while less than half described these allowances for medical residents and fellows (33 of 77, 42.9%) and RTs (12 of 77, 15.6%). CRNAs (43 of 46, 93.5%), anesthesiologists (45 of 46, 97.8%), and medical residents or fellows (27 of 44, 61.4%) were more likely to be employed and/or have sedation privileges in COTH than non-COTH respondent hospitals (20 of 34, 58.8%; 24 of 32, 75.0%; 6 of 33, 18.2%) ($p < .05$).

Of those who described the requirement of hospital-mandated moderate sedation training, 94.9% (75 of 79) of total respondents reported training was required for the RN prior to receiving moderate sedation privileges, 87.3% (55 of 63) reported this requirement for CRNAs, 88.4% (61 of 69) for anesthesiologists, 87.9% (29 of 33) for the medical resident or fellow, 33.3% (4 of 12) for the RT, and 89.1% (57 of 64) for the physician. Differences by hospital type

were statistically significant for the medical resident or fellow only, as COTH respondents (25 of 27, 92.6%) were more likely to require this training than non-COTH (4 of 6, 66.7%) (p = .007).

Table 19: Moderate Sedation Training

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
RN	79 (100.0)	47 (100.0)	33 (100.0)	.324
Required	75 (94.9)	45 (97.8)	30 (90.9)	
Not required	1 (1.3)	0 (0.0)	1 (3.0)	
Offered but not required	3 (3.8)	1 (2.2)	2 (6.1)	
CRNA	63 (100.0)	43 (100.0)	20 (100.0)	.618
Required	55 (87.3)	37 (86.0)	18 (90.0)	
Not required	6 (9.5)	4 (9.3)	2 (10.0)	
Offered but not required	2 (3.2)	2 (4.7)	0 (0.0)	
Anesthesiologist	69 (100.0)	45 (100.0)	24 (100.0)	.572
Required	61 (88.4)	39 (86.7)	22 (91.7)	
Not required	6 (8.7)	4 (8.9)	2 (8.3)	
Offered but not required	2 (2.9)	2 (4.4)	0 (0.0)	
Medical Resident or Fellow	33 (100.0)	27 (100.0)	6 (100.0)	.007
Required	29 (87.9)	25 (92.6)	4 (66.7)	
Not required	2 (6.1)	0_a (0.0)	2_b (33.3)	
Offered but not required	2 (6.1)	2 (7.4)	0 (0.0)	
RT	12 (100.0)	5 (100.0)	7 (100.0)	.659
Required	4 (33.3)	2 (40.0)	2 (28.6)	
Not required	7 (58.3)	3 (60.0)	4 (57.1)	
Offered but not required	1 (8.3)	0 (0.0)	1 (14.3)	
Physician	64 (100.0)	41 (100.0)	23 (100.0)	.064
Required	57 (89.1)	38 (92.7)	19 (82.6)	
Not required	5 (7.8)	1 (2.4)	4 (17.4)	
Offered but not required	2 (3.1)	2 (4.9)	0 (0.0)	

Respondents were additionally asked to report if their moderate sedation education included: 1. evaluating patients prior to moderate sedation, 2. performing moderate sedation, and 3. rescuing patients with deeper than intended moderate sedation levels. All hospitals (82 of 82) reported the inclusion of the first two topics, while 95% (76 of 80) reported the inclusion of the third. Of those who described the use of the included content, almost all hospitals reported the use of all three topics (81 of 82, 98.8%; 79 of 81, 97.5%; 76 of 77, 98.7%). There were no

identified differences by hospital type ($p > .05$). In a write in option for 'other,' one respondent noted that all providers must be ACLS certified and another stated that the content was "for RN."

Specific certification and clinical experience survey questions were asked for both RNs and RTs. 100% of total hospitals (77 of 77) reported the requirement of basic life-saving (BLS) for RNs, while 97.4% (75 of 77) reported the requirement of ACLS, 17.9% (10 of 56) the requirement of critical care nursing certification (CCRN), and 7.4% (4 of 54) the requirement of certified radiology nurse (CRN). There were no statistically significant differences observed by hospital type ($p < .05$). Those who wrote in an answer for 'other' ($n = 3$) included Pediatric Advanced Life Saving (PALS) ($n = 2$) and American Association of Moderate Sedation Nurses (AAMSN) ($n = 1$).

Differences between COTH and non-COTH respondents with regard to clinical experiences for the RN including number of years of experience are described in Table 20. Experience as an RN was reported as required by almost 90% (66 of 74) of total hospital respondents, with some respondents specifying the requirement of a median of two years ($n = 28$, IQR 2.0, 3.0). Experience in the intensive care unit (ICU) was reported as required by approximately half of total respondents (36 of 70, 51.4%) and experience in another interventional area less often (25 of 67, 37.3%), with a median requirement of two years ($n = 18$, IQR 1.0, 2.0) and one year ($n = 8$, IQR 1.00, 2.75) respectively. No statistically significant differences by hospital type were observed ($p > .05$). Those who wrote in an answer for 'other' ($n = 6$) included experience in the ED ($n = 4$) or critical care ($n = 2$). Length of the orientation/training period was reported as a median of 10 weeks ($n = 68$, SD 4.45, 0-20) but varied by hospital type. COTH hospitals ($n = 40$, mean 12 weeks, SD 3.83, 1.5-20.0) were more

likely to have longer orientations than non-COTH hospitals (n = 28, mean 9 weeks, SD 4.74, range 0.0-16.0) (p = .005).

Table 20: Clinical Experiences for RN

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Experience as an RN	74 (100.0)	44 (100.0)	30 (100.0)	.087
Yes	66 (89.2)	37 (84.1)	29 (96.7)	
No	8 (10.8)	7 (15.9)	1 (3.3)	
If yes, total number of years?				.530
n	28	17	11	
Median	2.0	2.0	2.0	
IQR	2.0, 3.0	2.0, 3.5	2.0, 2.0	
Experience in the ICU	70 (100.0)	43 (100.0)	27 (!00.0)	.156
Yes	36 (51.4)	25 (58.1)	11 (40.7)	
No	34 (48.6)	18 (41.9)	16 (59.3)	
If yes, total number of years?				.919
n	18	11	7	
Median	2.0	2.0	2.0	
IQR	1.0, 2.0	1.0, 2.0	1.0, 2.0	
Experience in other interventional area	67 (100.0)	40 (100.0)	27 (100.0)	.113
Yes	25 (37.3)	18 (45.0)	7 (25.9)	
No	42 (62.7)	22 (55.0)	20 (74.1)	
If yes, total number of years?				.252
n	8	6	2	
Median	1.00	1.50	1.0	
IQR	1.00, 2.75	1.00, 3.13	1.0, 1.0	

Almost all hospitals reported employing RTs in IR (80 of 82, 97.6%). Of those respondents, 94.7% (72 of 76) required BLS, 26.7% (16 of 60) required ACLS, 11.1% (6 of 54) cardiac-interventional (CI) certification, and 29.5% (18 of 61) vascular-interventional (VI) certification. No statistically significant differences were observed by hospital type (p > .05).

Those who wrote in an answer for 'other' (n = 7) included: American Registry of Radiologic Technologists (ARRT) (n = 1), VI (n = 5), and ACLS (n =1).

Summaries of required RT clinical experiences are described in Table 21. 81.1% (60 of 74) of total respondents reported the requirement of experience as an RT and 27.7% (18 of 66) required experience in another interventional area. Median required experience was 1.5 years (n = 25, IQR 1.0, 2.0) and 1.25 years (n = 6, IQR 1.0, 2.0) respectively. Again, no statistically significant differences were observed by hospital type ($p > .05$). Those who wrote in an answer for 'other', (n = 1) included: bachelor of science in IR (n = 1). Length of orientation for an RT was defined by total respondents as a median of 12 weeks (n = 69, IQR 8.0, 17.5) with COTH respondents (n = 39, median 12 weeks, IQR 10.0, 20.0) reporting significantly longer orientations than non-COTH (n = 30, median 10.50, IQR 4.0, 13.0) respondents ($p < .05$).

Table 21: Clinical Experiences for RTs

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Experience as an RT	74 (100.0)	45 (100.0)	29 (100.0)	.131
Yes	60 (81.1)	34 (75.6)	26 (89.7)	
No	14 (18.9)	11 (24.4)	3 (10.3)	
If yes, total number of years?				.134
n	25	14	11	
Median	1.5	1.0	2.0	
IQR	1.0, 2.0	1.0, 2.0	1.0, 3.0	
Experience in other interventional area	65 (100.0)	39 (100.0)	26 (100.0)	.651
Yes	18 (27.7)	10 (25.6)	8 (30.8)	
No	47 (72.3)	29 (74.4)	18 (69.2)	
If yes, total number of years?				.653
n	6	3	3	
Median	1.25	1.0	1.67	
IQR	1.00, 2.00	1.0, 1.0	1.00, 2.00	

Descriptive summaries for nursing degree are presented in Table 22. Total respondents reported the largest median number of nurses possessed a bachelor of science in nursing (BSN) (n = 76, median 5.0, IQR 3.0, 10.0). Only a few nurses had an associate degree (n = 75, median 1.0, IQR 0.0, 4.0), master of science in nursing degree (MSN) (n = 75, median 0.0, IQR 0.0, 10.0), or doctorate in nursing (n = 77, median 0.03, IQR 0.00, 0.00). Statistically significant differences ($p < .05$) were observed for BSNs and MSNs with COTH hospitals reporting more nurses with BSNs (n = 42, median 9.00, IQR 5.00, 13.25) and MSNs (n = 41, median 0.0, IQR 0.0, 2.0) than non-COTH respondents (BSN n = 34, median 3.0, IQR 2.0, 5.0: MSN n = 34, median 0.0, IQR 0.0, 0.0).

Table 22: Highest Nursing Degree

	Total	**COTH**	**Non-COTH**	**p-value**
Associates Degree-Nursing				.054
N	75	41	34	
Median	1.0	2.0	1.00	
IQR	0.0, 4.0	0.0, 5.0	0.00, 2.25	
Bachelor of Science in Nursing				.000
n	76	42	34	
Median	5.0	9.00	3.0	
IQR	3.0, 10.0	5.00, 13.25	2.0, 5.0	
Master of Science in Nursing				.002
n	75	41	34	
Median	0.0	0.0	0.0	
IQR	0.0, 1.0	0.0, 2.0	0.0, 0.0	
Doctorate				.867
n	77	43	34	
Median	0.03	0.00	0.00	
IQR	0.00, 0.00	0.00, 0.00	0.00, 0.00	

Specific Aim 3b: To describe the quantity (total providers and full-time equivalents [FTEs]) of labor within IR departments.

Summaries for total number of IR RNs and IR RTs are presented in Table 23. Total respondents (n = 79) reported a median of six full time RNs (IQR, 3.0, 10.0), one part time RN (n = 78, IQR 0.0, 2.0), one per-diem RN (n = 78, IQR 0.0, 2.0) and zero supplemental/traveler RNs (n = 78, IQR 0.0, 1.0). Statistically significant differences were observed by hospital type for full-time ($p < .001$) and per diem ($p = .001$) RNs. COTH respondents reported higher median numbers of full-time (n = 44, median 10.00, IQR 6.00, 16.75) and per-diem (n = 44, median 1.5, IQR 0.0, 3.0) RNs than non-COTH respondents (full-time n = 35, median 3.0, IQR 1.0, 4.0; per-diem n = 34 median 0.0, IQR 0.0, 1.0).

Similar trends were observed for RTs with total respondents (n = 76) reporting a median of six full-time RTs (n = 76, IQR 3.00, 9.75), and a median of zero part-time (n = 75, IQR 0.0, 1.0), per-diem (n = 76, IQR 0.0, 0.0), and supplemental/traveler RTs (n = 76, IQR 0.0, 0.0). Again, COTH respondents reported significantly higher median numbers of RTs (n = 42, median 9.00, IQR 6.53-12.00) than non-COTH respondents (n = 34, median 3.00, IQR 1.75, 5.00) ($p < .001$).

Table 23: Total RN and Total RT

	Total	**COTH**	**Non-COTH**	**p-value**
Full-time RN				.000
n	79	44	35	
Median	6.0	10.00	3.0	
IQR	3.0, 10.0	6.00, 16.75	1.0, 4.0	
Part-time RN				.062
n	78	44	34	
Median	1.0	1.00	0.0	
IQR	0.0, 2.0	0.00, 2.75	0.0, 2.0	
Per-diem RN				.001
n	78	44	34	
Median	1.0	1.5	0.0	
IQR	0.0, 2.0	0.0, 3.0	0.0, 1.0	
Supplemental/traveler RN				.270
n	78	44	34	
Median	0.0	0.0	0.0	

IQR	0.0, 1.0	0.0, 1.0	0.0, 0.0	
Full-time RT				.000
n	76	42	34	
Median	6.00	9.00	3.00	
IQR	3.00, 9.75	6.53, 12.00	1.75, 5.00	
Part-time RT				.712
n	75	42	33	
Median	0.0	0.0	0.0	
IQR	0.0, 1.0	0.0, 1.0	0.0, 1.0	
Per-diem RT				.506
n	76	43	33	
Median	0.0	0.0	0.0	
IQR	0.0, 0.0	0.0, 0.0	0.0, 0.0	
Supplemental/traveler RT				.504
n	76	43	33	
Median	0.0	0.0	0.0	
IQR	0.0, 0.0	0.0, 0.0	0.0, 0.0	

Specific providers present during IR cases using moderate sedation are shown in Table 24. Again, respondents were asked to verify that providers were employed in IR. Almost all respondents reported employing a procedure nurse (78 of 79, 98.7%), first (78 of 79, 98.7%) and second RTs (65 of 67, 97.0%). Most respondents reported the employment of anesthesiologists (56 of 63, 88.9%), CRNAs (44 of 56, 78.6%), and a second procedure nurse (49 of 56, 87.5%), while a little more than half reported the employment of a resident (38 of 58, 65.5%), fellow (38 of 62, 61.3%), NP (30 of 55, 54.5%), or PA (31 of 53, 58.5%). COTH respondents were more likely to employ anesthesiologists (33 of 34, 97.1%), CRNAs (28 of 29, 96.6%), a second procedure nurse (33 of 34, 97.1%), a resident (28 of 32, 87.5%), fellow (30 of 36, 83.3%), NP (22 of 30, 73.3%), or a PA (22 of 28, 78.6%) than non-COTH respondents (anesthesiologist 23 of 29, 79.3%; CRNA 16 of 27, 59.3%; second procedure nurse 16 of 22, 72.7%; resident 10 of 26, 38.5%; fellow 8 of 26, 30.8%; NP 8 of 25, 32.0%; PA 9 of 25, 36.0%; $p < .05$).

Of those who reported the presence of specific providers during IR cases with moderate sedation, the providers most commonly present were the procedure nurse (77 of 78, 98.7%), the RT (76 of 78, 97.4%) and the second RT (52 of 65, 80.0%). 48.2% (27 of 56) reported the presence of an MD anesthesia provider, 18.2% (8 of 44) the presence of a CRNA, 29.4% (15 of 51) a second procedure RN, 44.7% (17 of 38) a resident, 55.3% (21 of 38) a fellow, 10% (3 of 30) an NP, and 19.4% (6 of 31) a PA. The presence of a fellow was the only provider type that was statistically different between hospital groups (p = .006). 66.7% (n = 20) of COTH respondents and 12.5% (n = 1) of non-COTH respondents reported the presence of a fellow during an IR case with moderate sedation. Of the respondents that chose 'other' (n = 9) they included an attending proceduralist (1), faculty MD/DO (1), ICU RN (1), and IR attending (2) IR tech (1), radiologist (2), and scrub tech (1).

Table 24: Provider Presence During IR Case with Moderate Sedation

	Total n (%)	**COTH n (%)**	**Non-COTH n (%)**	**p-value**
Anesthesia provider MD	56 (100.0)	33 (100.0)	23 (100.0)	.621
Yes	27 (48.2)	15 (45.5)	12 (52.2)	
No	29 (51.8)	18 (54.5)	11 (47.8)	
Anesthesia provider CRNA	44 (100.0)	28 (100.0)	16 (100.0)	.941
Yes	8 (18.2)	5 (17.9)	3 (18.8)	
No	36 (81.8)	23 (82.1)	13 (81.3)	
Procedure RN	78 (100.0)	44 (100.0)	34 (100.0)	.376
Yes	77 (98.7)	43 (97.7)	34 (100.0)	
No	1 (1.3)	1 (2.3)	0 (0.0)	
Second procedure RN	51 (100.0)	35 (100.0)	18 (100.0)	.650
Yes	15 (29.4)	9 (27.3)	6 (33.3)	
No	36 (70.6)	24 (72.7)	12 (66.7)	
RT	78 (100.0)	44 (100.0)	34 (100.0)	.103
Yes	76 (97.4)	44 (100.0)	32 (94.1)	
No	2 (2.6)	0 (0.0)	2 (5.9)	
Second RT	65 (100.0)	38 (100.0)	27 (100.0)	.801
Yes	52 (80.0)	30 (78.9)	22 (81.5)	
No	13 (20.0)	8 (21.1)	5 (18.5)	
Resident	38 (100.0)	28 (100.0)	10 (100.0)	.067

Yes	17 (44.7)	15 (53.6)	2 (20.0)	
No	21 (55.3)	13 (46.4)	8 (80.0)	
Fellow	38 (100.0)	30 (100.0)	8 (100.0)	.006
Yes	21 (55.3)	20 (66.7)	1 (12.5)	
No	17 (44.7)	10 (33.3)	7 (87.5)	
Nurse Practitioner (NP)	30 (100.0)	22 (100.0)	8 (100.0)	.271
Yes	3 (10.0)	3 (13.6)	0 (0.0)	
No	27 (90.0)	19 (86.4)	8 (100.0)	
Physician Assistant (PA)	31 (100.0)	22 (100.0)	9 (100.0)	.457
Yes	6 (19.4)	5 (22.7)	1 (11.1)	
No	25 (80.6)	17 (77.3)	8 (88.9)	

Chapter Five

5.1 Meaning of Findings in Relation to Hypotheses or Research Questions

Using the Minnick & Roberts Outcomes Production Framework, this study follows the first step of the research continuum (describing, relating, and then determining cause) to describe the variables, organizational facets, employment terms, and labor (quality and quantity), as they exist for a sample of hospitals offering IR services. This dissertation represents the first time this framework has been applied to the field of IR. In order to direct the future study of outcomes for this population, there must be an understanding of the details of the variables that may influence these outcomes. Chapter Five presents a discussion of response rate, a discussion and interpretation of survey results by research aim, as well as limitations of the research and recommendations for future study.

Sample Characteristics

Various publications note that mailed paper surveys have an estimated response rate of approximately 50% or higher (Dillman et al., 2014; Shih & Fan, 2009). Meta-analyses reviewing studies completed in organizational research report an overall estimated response rate of 52.7% for individuals, 35.7% for organizations, and 32% for executives (Baruch & Holtom, 2008; Cycyota & Harrison, 2006). However, these studies were completed more than 10 years ago, a time during which overall survey response rates declined. This study was a paper survey sent to IR management in healthcare organizations. Based on the information on paper surveys, organizational research, and executive level response rates, an estimated response rate for this proposed study was approximately 35-45%. Statistical summaries presented in Chapter Four

show a final response rate of 16.8% after correcting for undeliverable mail, respondents stating they had no IR, and declination of participation (Appendix B: Figure B 3).

Various strategies were utilized to increase the response rate for the sample. Examples included minimizing the request for sensitive information, using a professional survey format, reducing complexity and length, and making it convenient to respond (Dillman et al., 2014). Despite the use of these techniques to decrease cost, increase benefit, and establish trust, the variation in expected and actual response rate could be due to participants not wanting to respond to the survey or not fully understanding the questions (Fink, 2009). Dillman et al. (2014) recognized that while it is important to provide multiple modes of response for convenience, this very action could also cause a decreased response rate by complicating the decision making process for participants (Dillman et al., 2014). This survey offered both a return mail option and an option for web response.

Similarly, Dillman et al. (2014) noted that offering a monetary incentive helped to increase reward and establish trust in the participants (Dillman et al., 2014). However, studies evaluating response rates in organizational research indicate that strategies that work well in the general public do not translate effectively to higher level management, particularly given that hospital organizations often have policies forbidding employees from accepting such incentives (Baruch & Holtom, 2008). It has also been noted that some companies may have organizational constraints and specific policies prohibiting the sharing of information, which can additionally contribute to poor response rates (Baruch & Holtom, 2008; Cycyota & Harrison, 2006). Respondents may have viewed this survey asking questions about employment, organizational structure, and labor as sensitive information and may have been unwilling or unable to respond.

Comparisons of total respondents by hospital type demonstrated that hospitals differed by bed size only. Most COTH respondents (21.3%) were from the mid-Atlantic (NJ, NY, and PA) with the lowest number of respondents (4.3%) from the east south-central region (AL, KY, MS, and TN). 66% of respondents were nongovernment, not-for-profit status, 97.9% were a general medical and surgical service code, and 83% were greater than 300 beds. 17.1% of non-COTH respondents were from the mid-Atlantic (NJ, NY, and PA), with the lowest number of respondents (2.7%) from east south-central (AL, KY, MS, and TN) and the new England (CT, MA, ME, NH, RI, and VT) (2.7%) regions. 74.3% of non-COTH respondents were a nongovernment, not-for-profit status, and 100% were of the general medical and surgical service code. Unlike the COTH respondents, 48.6% of non-COTH respondents were a bed size of 100-299.

Unfortunately, the low overall response rate decreases the external validity of any findings by limiting the overall generalizability of these results. However, the survey provided valuable descriptive information and statistical significance in certain areas raising questions about variability in practice with regard to the described concepts. These areas are discussed in detail in the following discussion of study aims.

Specific Aim 1: To describe employment terms within IR departments.

Specific Aim 1a: To describe workload requirements within IR departments.

Workload requirements

There was variation in the concurrent and total volume of assigned patients per nurse. The reported pattern was one nurse will care for one patient at a time and approximately five patients over the course of an entire shift. These results were not statistically significant by

hospital type, however, there was variation in the reported results within the individual hospital groups. Although 74.5% (n = 35) of COTH respondents answered that only one patient was cared for concurrently, 23.3% (n =11) of respondents reported caring for more than one patient. Similarly, 68.6% (n = 24) of non-COTH respondents answered that only one patient was cared for concurrently, while 22.9% (n = 8) reported caring for more than one patient.

These responses are interesting in terms of workflow, because IR nurses are typically assigned to care for a single patient during a procedure, in order to monitor the patient, support hemodynamics, and administer medications. Nurses are usually required to have no other responsibilities aside from monitoring and medications if they are administering sedation (ARIN, 2018). Although there is no other identified literature that specifically studies nurse to patient ratios in IR, the recent position statement by the ARIN, advocates for adequate nurse staffing, defined as one nurse assigned per each procedure room (ARIN, 2018). A similar position statement from the SIR suggests that at least one RN should be a part of the IR procedure team (Baerlocher et al., 2016). A survey of members of SIR regarding the availability of staff reported one nurse as assigned per procedure room in 90% of cases during regular hours (Natcheva et al., 2014). This study is not specific to nurse-to-patient ratios, but it does provide some insight into the potential workload requirements of radiology nurses.

Limitations of these results include the possibility that respondents could have interpreted the question differently. If some respondents read the question as *any* IR nurse, this could include pre-procedure or post-procedure nurses who care for multiple patients at the same time based on required hospital ratios, in which case, caring for multiple patients concurrently would be easily explained. More research is warranted to better understand the workflow and patient care models utilized in IR.

Specific Aim 1b: To describe temporal conditions (shift length, hours of work) within IR departments.

Temporal Conditions

There are some important observations based on the analysis of the results for this aim. First, RNs and RTs work very closely together in IR procedures. A similar shift length was reported for RNs and RTs at non-COTH respondent hospitals as the use of eight-hour shifts was primarily reported for both provider types. This same trend was not seen in the COTH respondent hospitals which primarily reported 10-hour shifts for RNs and eight-hour shifts for RTs. More research is needed to determine if differing shift lengths for essential IR staff is the most effective use of resources for the smooth operation of a procedure room.

Second, COTH hospitals offered significantly greater hours of operation than non-COTH respondents. COTH hospitals reported a median of 24 hours of availability for all days of the week (Monday through Friday IQR 11.00, 24.00; Saturday and Sunday IQR 24.00, 24.00), while non-COTH hospitals reported a median of 10 hours Monday through Friday (IQR 8.00, 24.00) and a median of 24 hours on Saturday and Sunday (IQR 0.00, 24.00). These differences between the two hospital types were statistically significant, however it is possible that the respondents viewed 'hours of operation' as active hours and not those staffed with an on-call model. If this interpretation were used it could explain why some facilities reported < 24 hours of availability. However, another potential explanation could be that some hospitals have outpatient only practice and would not require the hours of availability an inpatient/outpatient model necessitates, also explaining the variations in hours. This could also indicate differences in acuity of patients as COTH hospitals might need longer hours for emergent care needs that are

not required by non-COTH hospitals. For example, a level one trauma center will typically offer more services and longer hours of operation than a non-trauma setting.

The majority of current literature mentions temporal conditions as a by-product of staff availability. However, the position statement from the SIR about IR practice parameters specifically notes that for facilities with inpatient practice:

> "The number of physicians in the group who provide interventional services and have admitting privileges should be sufficient to provide 24-hour interventional call coverage ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014)."

Otherwise, hours of operation are mentioned in the literature as staffing availability of nursing assistance during 'business hours' or until a certain time period (i.e. procedure staffing until four or five PM) (Natcheva et al., 2014). Limitations of the result for this aim include the interpretation of questions and the small sample size, however, future studies of outcomes should consider risk adjustment strategies if this variable is pursued.

Specific Aim 2: To describe the organizational facets within IR departments.

Specific Aim 2a: To describe the work environment within IR departments.

Work Environment

No differences were observed in provider sedation privileges for adult and pediatric patients by hospital type. However, there was variation in the reported employment of specific sedation providers within IR. COTH respondent hospitals reported higher employment of CRNAs, anesthesiologists, and medical residents or fellows overall. These results are not necessarily surprising as non-COTH facilities may not have medical education training programs

and therefore would be less likely to have medical residents or fellow. Similarly, a greater need for higher level anesthesia care is supported based on the discussion of hours of operation, which indicated the potential for more complex patients at COTH respondent hospitals. Anesthesia care by an anesthesiologist or CRNA is utilized in IR if the patient condition warrants a need for a greater level of care than an RN can provide under the scope of their licensure and training. However, the difference in employment for CRNAs is an interesting variation based on hospital type. Advanced practice nurses are often considered to be essential members of an IR team and multiple studies have demonstrated the value of CRNAs on patient outcomes and cost effectiveness (Dulisse & Cromwell, 2010; Hogan, Seifert, Moore, & Simonson, 2010; Jack Needleman & Minnick, 2009; Pine, Holt, & Lou, 2003) (Beach, Swischuk, & Smouse, 2006). This is an important area for further study, and may help to determine whether differences are due to patient acuity or there are alternative explanations. CRNAs are valuable anesthesia providers and it is essential understand how CRNAs are utilized in IR, how this may change workflow, as well as any potential differences in both patient and hospital outcomes.

Analysis of medication administration privileges for fentanyl, versed, morphine, propofol, and dilaudid showed provider variations in the administration of these medications for CRNAs, anesthesiologists, and medical residents or fellows. Interestingly, while nursing practice with these medications was consistent by hospital type, 12.8% of COTH hospital respondents and 21.9% of non-COTH hospital respondents reported RNs as having privileges to administer propofol sedation. As discussed in Chapter One, propofol administration by nursing remains a controversial action as unclear guidelines of care can lead to differences in sedation practices and standards of care that vary within states, hospitals, and even units within the same facility. This is an essential area for further study, and may help to determine the specific use of

propofol within IR and help characterize any State Board of Nursing regulations that may exist and their effect on patient care.

Written material (86.3%), online modules (82.7%), and verbal instruction (79.1%) were the most commonly used methods of moderate sedation instruction and were consistent across hospital type. Most respondents for both COTH and non-COTH reported the training was either annual (79.7%) or another time frame (6.3%), but some hospitals reported there was no required training (13.9%). Further inquiry into these results would be warranted in order to determine if there are absolutely no requirements for education after initial privileges are obtained for these hospitals, or if other training is provided that was not captured by this question. Continuing education for nursing has been and continues to be a standard core of nursing practice (Gallagher, 2007). How it influences IR outcomes, if at all, has not been determined.

Results about the structure of care provides insight into the roles and responsibilities of the radiology nurse within an IR procedure and the organization of patient flow through IR. The practice parameters for IR issued by the ACR suggest that there should be a dedicated RN per procedure room to provide monitoring and patient care and at least one RT for case assistance, supply management, and other functions of imaging ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014). The primary RN was responsible for hemodynamic monitoring (93.8%), retrieving medications (80%), patient documentation (88.9%), and the calling of report (96.2%), while the RT primarily managed supplies (80.2%), for both COTH and non-COTH hospitals. Non-nursing actions like stocking, cleaning, and transport were reported as completed primarily by unit-based personnel for both hospital types, although respondents also indicated that these unit-based personnel performed nursing activities.

These results are consistent with the position statement from the ACR as the results indicate there is most likely at least one nurse providing primary care and at least one RT managing imaging responsibilities during procedures for the majority of hospital respondents ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014; ARIN, 2018; Natcheva et al., 2014). These answers also indicate that nursing may be completing or assisting with the completion of non-direct patient care tasks which gives insight into the structure of the radiology team and the use or non-use of support personnel. However, given that there is very limited literature regarding the specific actions of radiology nursing, it is imperative that more studies explore this area.

Variations in care were seen in the organization of patient flow through IR. 61.7% of COTH respondents reported the structure of care as different patients in pre-procedure, intra-procedure, and recovery as compared to 63.6% of non-COTH respondents reporting the continuity of care from pre-procedure through to post procedure. Patient organization and flow through hospital systems is a highly researched focus area. Different publications discuss the importance of patient flow optimization through radiology to decrease wait times (Cheung, Goodman, & Osunkoya, 2016; White, 2018). Given the variations in practice seen in survey responses, this is another area for further study, and may help to optimize workflow processes within radiology departments.

Tools like the Practice Environment scale, developed from the Nursing Work Index (NWI), and other studies about organizational structure demonstrate that aspects of the work environment are essential to positive patient outcomes (Lake, 2002). Examples include adequate staffing, continuity of care, continuing education, clinical competence, and the appropriate use of support services (Linda H. Aiken, Clarke, Sloane, Lake, & Cheney, 2008; L. H. Aiken &

Patrician, 2000; Lake, 2002). This sub aim described many of these components of the work environment as they apply to IR and identified the need to continue to understand the details and their potential effect on patient outcomes. Interpretation of these results is hindered by the low response rate, however, the significant variation described within this aim allows many opportunities for further study.

Specific Aim 2b: To describe organizational structures (policies and procedures) within IR departments.

Organizational Structures

RNs were reported to administer moderate sedation to a higher percentage of adult patients at non-COTH respondent hospitals. CRNAs and anesthesiologists, however, were reported to perform higher percentages of cases requiring moderate sedation at COTH respondent hospitals. These responses suggest both the potential for higher acuity patients and greater levels of employment of CRNAs at COTH respondent hospitals. Both hospital types reported pediatric cases requiring moderate sedation as being completed primarily by anesthesia, with non-COTH respondents reporting less availability of pediatric services overall.

COTH respondents also described a higher median number of adult and pediatric cases completed in the last year with moderate sedation, a greater total number of cases overall, and more rooms authorized for IR procedures than non-COTH respondents. These differences, coupled with the previously discussed hours of operation and differences in anesthesia care, could provide inferences into program size. COTH respondents appear to have larger IR programs (more patients and rooms), with longer hours of operation. However, the initial statistical summaries comparing characteristics of COTH and non-COTH respondents

demonstrated differences in bed size. COTH respondents reported more hospital beds which may indicate larger IR program and more resources, thus explaining any differences.

Reports of a hospital based moderate sedation policy were greater than a unit-based version, and the use of capnography was consistent between hospital type. However, a range in the use of capnography monitoring was presented between hospital types. 10.6% of COTH respondents and 28.6% of non-COTH respondents reported 0%, when asked the total percentage of moderate sedation cases for which ETCO2 monitoring was used for patients. Capnography is not yet required for all procedures, and there is literature on both sides to both support and refute its usefulness, however the majority of literature appears to support its use for procedures requiring sedation (Conway, Douglas, & Sutherland, 2016; Saunders, Erslon, & Vargo, 2016).

Furthermore, capnography is recommended by the ASA, the American Association of Nurse Anesthetists, the ARIN, and the ACR to decrease hypoxemic events ("ACR-SIR Practice Guideline for Sedation/Analgesia," 2010; "Capnography," 2018; "Practice Guidelines for Moderate Procedural Sedation and Analgesia," 2018; *Standards for Nurse Anesthesia Practice*, 2013). A 2017 perspective released by the Joint Commission stated that the New York State Department of Health now requires continual capnography monitoring for patients receiving moderate sedation, deep sedation, and general anesthesia in office based-surgical practices as of January 31st 2019 (*Capnography Monitoring Required in NY Office-Based Surgery Practices*, 2017).

It is suspected that with the overwhelming support in favor of ETCO2 monitoring, that any reports of non-use will decrease over time. Further research is needed to understand the use of capnography. Given the limits of a cross sectional survey, a repeated measure would better

assess change in the rates of capnography use and would provide valuable information about this monitoring device.

Specific Aim 3: To describe the characteristics of labor (quality and quantity) within IR departments.

Specific Aim 3a: To describe the quality (competence and training, certification, degree, and level of experience) of labor within IR departments.

Labor Quality

Questions related to moderate sedation training prior to providers receiving privileges allowed an option for respondents to indicate if providers were not employed in IR or could not give moderate sedation. Although not significant, the highest percentage of this response was seen for RTs for total respondents. This is expected based on the previously described role of the RT and the scope of their practice which does not include moderate sedation administration. Variation was observed by hospital type for CRNAs, anesthesiologists, and medical residents or fellows. Differences can be explained based on previous descriptions of CRNA employment, patient acuity, and medical education programs at non-COTH facilities. Those who described the use of moderate sedation education demonstrated that the requirement prior to receiving privileges was consistent between hospital type for all providers excepting medical residents and fellows. COTH hospitals reported higher levels of required training for these providers than non-COTH respondents.

The content of moderate sedation education was consistent by hospital type. Only four respondents reported they "did not know" with regard to the inclusion of specific educational content. Both COTH and non-COTH respondents (98.8%) reported 'evaluating patients prior to

moderate sedation' was part of the education. A total of 97.5% reported 'performing moderate sedation' and 98.7% reported the inclusion of 'rescuing patients with deeper than intended moderate sedation levels' was included in the education. There are limits to the interpretation of these results given the low response rate, but it is important to note that these specific elements of the content have been outlined as part of the performance standards by the Joint Commission that define a qualified individual (N. Crego, 2015; Kost, 2004).

Hospital respondents reported the largest median number of nurses practicing in IR held a BSN degree. COTH respondents reported a median of nine RNs with a BSN as compared to three RNs by non-COTH respondents ($p < .001$). Certifications required for nursing were primarily reported as Basic Life Saving (BLS) (100%) and ACLS (Advanced Cardiac Life Saving) (97.4%) and to a lesser extent CCRN (Critical Care Nursing) (17.9%) and CRN (Certified Radiology Nurse) (7.4%) for total respondents. This discrepancy in certification requirement for total respondents is additionally seen for RTs. They included BLS (94.7%), ACLS (26.7%), CI (11.1%) and VI (29.5%) for total respondents.

Clinical experiences for the RN varied, with 89.2% reporting the requirement of prior experience, 51.4% the requirement of ICU experience, and 37.3% the requirement of experience in another interventional area. For RTs, 81.1% reported the requirement of prior experience as an RT and 27.7% reported the requirement of experience in another interventional area. Descriptions of orientation had similar inconsistencies, and were described as a mean of 12 weeks for COTH respondents for the RN and RT and a mean of 9 weeks and 10.5 weeks for non-COTH respondents for the RN and RT respectively. Orientation length is often highly-dependent on previous experience, which may shorten or lengthen the time it takes to onboard new staff.

This analysis highlights several inconsistencies in competencies, specific training requirements, and education for providers in IR, which is consistent with the radiologic literature which states that there is no single consensus statement or set of competencies for moderate sedation RN practice in the United States (N. Crego, 2015). The effect of labor quality on patient outcomes is an extensively studied topic outside of the radiologic literature in terms of previous experience, provider type, levels of nursing experience, nursing education, and certification (L. H. Aiken et al., 2011) (Kendall-Gallagher et al., 2011). Higher numbers of BSN nurses have been correlated to decreasing negative patient outcomes like mortality and failure-to-rescue (L. H. Aiken et al., 2011; L. H. Aiken, Clarke, Cheung, Sloane, & Silber, 2003).

Studies specific to radiology that evaluate sedation experience and provider type indicate that there is a similar effect of labor quality on patient outcomes (Couloures et al., 2011) (Bluemke & Breiter, 2000) (Fatima et al., 2008). However, these studies are limited, due to a lack of generalizability with single facility sites, the use of registries like the Pediatric Sedation Research Consortium database that focuses on a single population (pediatrics), ill-defined variables, and no conceptual frameworks to guide the research. Moderate sedation administration and the care of the IR patient are complex. Further research is required to understand the impact of labor quality on patient outcomes within this specialized treatment area and whether some form of standardized training for providers involved in care is necessary.

Specific Aim 3b: To describe the quantity (total providers and full-time equivalents [FTEs]) of labor within IR departments.

Labor Quantity

Analysis of the results of total RNs and RTs indicated COTH hospitals had statistically significantly higher numbers of full-time (median 10.00) and per-diem RNs (median 3.00) and higher numbers of full-time RTs (median 9.00) than non-COTH hospitals (medians 3.00, 0.00, 3.00). The examination of provider presence during cases with moderate sedation indicated that the highest percentage of providers reported was the procedure RN (98.7%), followed by the RT (97.4%), and the second RT (80.0%). The presence of a fellow was the only statistically significant difference by hospital type, which is consistent with the mission of teaching vs. non-teaching hospitals which may not offer medical training programs. 55.3% of COTH and 12.5% of non-COTH respondents reported the presence of a fellow.

Labor quantity is another highly studied health services variable, with a broad depth of research outside of the radiologic literature. Nurse staffing has long been associated with lower rates of poor patient outcomes like urinary tract infections, upper gastrointestinal bleeding, failure to rescue, shock and cardiac arrest (L. H. Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; A. F. Minnick & Mion, 2009; J. Needleman et al., 2002; J. Needleman et al., 2011). The practice parameters issued by the ACR recommend greater than one nurse and one RT full-time equivalents (FTE) per procedure room depending on non-productive hours, and shifts per day. Similarly, the position statement from the SIR recommended at least one RN for monitoring and one RT for supply management (Baerlocher et al., 2016). Based on the previously described information about room availability and total case volumes, differences could be explained by program size. When the numbers of RNs and RTs are compared with the total number of rooms

(COTH median 5.0, non-COTH median 3.0), it appears that hospital respondents are approximately meeting the ACR and SIR recommendations for staffing.

The results from this survey for RN staffing are additionally supported in the radiology literature through various staffing surveys. Mueller et al (1997) reported 87% of their survey respondents (n = 634) had a dedicated radiology nurse (Mueller et al., 1997). A 2016 survey of nurse staffing levels in the UK reported that 75% of respondents (n = 91) have a dedicated radiology nurse for patient monitoring (Christie & Robertson, 2016). A 2014 survey reported that 90% of respondents (n = 777) had one radiology nurse per room as well as a second technologist (n = 341, 44%) during regular hours (Natcheva et al., 2014). However, these surveys resolve the *amounts* of providers only. There is no literature specific to radiology that studies labor quantity and any potential impacts on patient outcomes. A study of sedation outcomes in pediatric diagnostic MRI by provider type exists but does not specifically address staffing and is limited by the population (pediatrics) and type of radiology (diagnostic). (Nancy Crego, Baernholdt, & Merwin, 2017). Further research is required to determine any potential impact of staffing and patient outcomes in radiology.

5.2 Strengths and Limitations of the Study

A significant strength of this study is the use of an organized structure to complete the research aims. The variables of interest were selected through the use of a well-applied conceptual framework. This framework assisted in the conceptualization of concepts as they may exist within IR. Subsequent survey development was based on this framework and questions were crafted from a detailed literature search on the phenomenon of interest. Validity, reliability, and credibility of the survey design were enhanced by card sorting questions to

concept definitions and pilot testing to address any identified weaknesses (i.e. unclear concept definitions). The use of the described approach meets the goal of high-quality descriptive research and has not been seen in previous surveys conducted in radiology.

Another strength is the method of survey distribution. The vast majority of research completed in this area is the result of surveys sent to listservs of members of an organization like the ARIN or SIR. While this captures valuable data, it does not control for duplicate responses from providers who may work in the same institution. The survey in this study focused on the practice in individual hospitals and therefore surveys were sent directly to radiology leadership in specific institutions. Therefore, this survey was more accurately able to capture organizational qualities and characteristics than other radiologic surveys.

A weakness of this study is the small sample size despite the use of measures to increase benefits to the participants. This limits the generalizability of study findings. Additionally, the study was sent to radiology administration assuming that they were both the best to answer specific questions about their departmental operations and that the information they provided was accurate. The accuracy of the answers cannot be confirmed, which is a limit of self-administered questionnaires. Another limitation of these results is the possibility that the responses to some questions could simply be a matter of varied interpretations. While the survey was pilot tested and participants were provided the contact information of the PI for questions, the nature of self- administered questionnaires leaves room for participants to interpret questions in different ways.

Other limitations relate to question construction and timing of administration. The survey used a combination of open- and closed-ended questions. While more efficient for coding methods, it is possible the selected responses for any multiple-choice questions were not

comprehensive of the practice at all participant institutions. Open-ended questions that included requests for numerical values stated that requests were 'approximate' or 'estimates' for this information. While this might have made it easier for participants to answer these questions, the information is limited in that they are estimations only. Finally, as a cross-sectional survey it did not consider any changes that may occur with time over the course of survey administration. One such example is the use of capnography. As previously discussed, a second survey to hospitals would help to determine if rates of the use of capnography have changed given the overwhelming support of this monitoring device.

5.3 Implications for Nursing

This was a descriptive study and therefore there are no recommendations to alter nursing practice based on these finding alone. However, the results from this research may be of significant interest to administrators or organizations with questions about workload, temporal conditions, the work environment, organizational structure, or aspects of labor within radiology. Furthermore, these results contribute new knowledge that can benefit the understanding of the value of radiology nursing. First, as a descriptive study, significant information was gained about the role and practice of nursing within IR during cases of moderate sedation. Understanding what radiology nurses do, how they practice, and the teams that surround them are essential components to help define value.

Second, descriptive research is the foundation upon which to build relational or causal research. Therefore, the results of this study could be used to support future research relating the described variables to outcomes of patients receiving moderate sedation in radiology. Studies focusing on the radiologic environment will complement the known aspects of the value of

nursing providers and demonstrate the importance of nursing in these specialized procedure areas. Third, noteworthy results of this study included the reported differences in labor quantity and labor quality for providers in IR. There is an overall lack of standardized guidelines or competencies to direct moderate sedation nursing practice in the United States, which could potentially negatively impact patient outcomes (N. Crego, 2015).

Two recent surveys completed in radiology specifically discuss the necessity for standardizing labor in IR. Natcheva et al (2014) described the need for general staffing guidelines for radiology procedures in order to improve quality and outcomes through better staff retention (Natcheva et al., 2014). Similarly, Korzewski et al. (2016) advocated for policies and procedures that standardize the role of each provider during neuro-intervascular therapies. The authors noted that all nurses participating in the care of these procedures should have appropriate education related to care of patients suffering from acute ischemic stroke (AIS), including education about moderate sedation (Korzewski et al., 2016). The analysis of survey results from this dissertation support the development of future studies to examine the relationship between aspects of labor during cases of moderate sedation and patient outcomes.

5.4 Recommendations for Future Research

This research is the first of its kind to study the variables, organizational facets, employment terms, and labor (quality and quantity), as they exist for a sample of hospitals offering IR services. It follows the research continuum of describing, relating, and then determining cause and provides a high-quality descriptive framework upon which relational or causal studies can be based. There are a few recommendations for future research which will build upon the results of this study.

Employment Terms

Results from the analysis of this variable indicated that radiology nurses may care for more than one patient at a time which is inconsistent with current position statements issued by societies like the ACR and ARIN. Therefore, further research must be conducted to better understand the workflow and patient care models in IR. The study of nurse-to-patient ratios in procedures is broadly applicable to other areas where nurses are responsible for sedation management. Examples include interventional cardiology, endoscopy, dentistry, the emergency room, or even some outpatient surgical centers where sedation management is the responsibility of the nurse. Nurses are required to have no other responsibilities aside from monitoring and medications if they are administering sedation (ARIN, 2018). There is no known literature that studies nurse-to-patient ratios in IR and therefore this is a significant opportunity for future study (ARIN, 2018).

Organizational Facets

The study of this variable identified variation in the use of anesthesia providers, privileges in sedation medication administration, patient flow, and the role and responsibilities of providers in IR. The most poignant points were related to the utilization of CRNAs and the administration of propofol. Multiple studies have demonstrated the value of CRNAs based on improved patient outcomes and cost effectiveness (Dulisse & Cromwell, 2010; Hogan et al., 2010; Liao, Quraishi, & Jordan, 2015; Jack Needleman & Minnick, 2009; Pine et al., 2003). Understanding the role and use of CRNAs in radiology is an important area for further study given the value of this provider.

While nursing practice with propofol was consistent by hospital type, a few institutions reported RNs having privileges to administer propofol sedation. The administration of propofol

by nursing is a highly controversial action marred by inconsistencies between state guidelines and various issued regulations and position statements (Bosslet et al., 2010; Dumonceau et al., 2010; Lin & Weigel, 2018; Sato et al.; Weaver, 2006). Further research on propofol is warranted as more medical groups lobby for its use by nursing during procedures outside of the operating room. This is especially important given the variability in the use of capnography described by this survey.

Characteristics of Labor

The analysis of the results of labor quality highlighted the overall inconsistencies in competencies, specific training requirements, and education. The need for further research in this area is supported by studies specific to radiology that indicate there is an effect of labor quality on patient outcomes (Bluemke & Breiter, 2000; Couloures et al., 2011; Fatima et al., 2008). However, there are significant limits to these studies and more research is needed to understand any association between radiology labor quality and outcomes. As this is a highly researched area that has shown correlations between previous experience, provider type, levels of nursing experience, nursing education, certification, and patient outcomes, there is strong support to continue this research as it applies to IR (L. H. Aiken et al., 2011; Kendall-Gallagher et al., 2011).

A study of labor quantity demonstrates the scarcity of evidence describing nurse staffing in IR. The position statements from the ACR, the ARIN, and SIR provide staffing recommendations, but there are no studies specific to radiology reviewing the relation of labor quantity to patient outcomes. Nurse staffing has long been associated with lower rates of poor patient outcomes like urinary tract infections, upper gastrointestinal bleeding, failure to rescue, shock and cardiac arrest (L. H. Aiken et al., 2002; A. F. Minnick & Mion, 2009; J. Needleman et

al., 2002; J. Needleman et al., 2011). Further study of nurse to patient ratios, total numbers of nurses, and other aspects of staffing are required given the overwhelming evidence in the literature supporting the importance of these variables.

Radiologic Technologists

It is argued by this author that there is a clear need to complete studies relating aspects of nursing to patient outcomes in IR. The value of nursing has been demonstrated in many studies in the health services literature. While not all of these studies are specifically applicable to IR given the differences from the general hospital structure to the specialized radiologic environment, it is hypothesized that certain aspects of variables like staffing, nurse experience, and certification will translate to positive patient outcomes in radiology. It is also noted by the author that while the need exists to continue these studies for nursing, there is an even greater need to complete studies describing these health services variables as they exist for radiologic technologists.

While nursing may be the largest workforce in the overall hospital structure, radiologic technologists are the largest workforce within radiology. Technologists are specialized providers that have an associate's or bachelor's degree in radiography. Depending on state requirements, they may have specific licensure or certification by the American Registry of Radiologic Technologist (ARRT), a national organization supporting education, certification, and examination requirements (Technologists, 2018a). Technologists additionally may have specialized training in radiologic modalities that include but are not limited to magnetic resonance imaging (MRI), computed tomography (CT), nuclear medicine, and IR, as well as advanced certification in cardiac-interventional (CI) and/or vascular interventional (VI) radiography procedures ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical

Practice and Management," 2014). They are experts in the care of the radiologic environment including the operation and care of imaging equipment, data management, and the quality and storage of the vital images utilized throughout the hospital by all services lines ("ACR-SIR-SNIS-SPR Practice Parameter for Interventional Clinical Practice and Management," 2014). Given their described role as integral, irreplaceable members of the IR team, there is a significant gap in the literature studying their value.

The ARRT has a number of reports of 'practice analyses' that seek to describe the current responsibilities of the technologist in their specialized areas (Technologists, 2018b). These reports provide significant information as to the roles and responsibilities of these providers and begins to define the value of their care. Many studies have examined the role of multidisciplinary team composition and its ability to decrease negative patient outcomes (Bosch et al., 2009; Epstein, 2014; He, Ni, Chen, Jiang, & Zheng, 2014). The Minnick & Roberts Outcomes Production Framework indicates that patient outcomes are a result of multiple influential factors that are not limited to nursing alone. The RT staffing in procedure rooms is typically one-to-one or even two-to-one as it relates to nursing in IR procedures. Therefore, the study of patient outcomes in IR, would not be complete without a study of technologists.

5.5 Conclusions

The overall phenomenon of interest driving the conceptualization of this dissertation is health services research variables as defined in the Minnick & Roberts Outcomes Production Framework and their relation to patient outcomes for patients receiving moderate sedation in IR. This dissertation presented a comprehensive review of the following points:

- A description of the significance of issues, supported by the understanding of the symbiotic relationship between IR and moderate sedation and the role of the providers that participate in the care of the patient.
- An analysis of various conceptual frameworks and an analysis of the literature studying the concepts employment terms, organizational facets, and characteristics of labor, both inside and outside of radiology literature.
- A detailed description of the creation and administration of a survey to radiology administrators.
- A detailed presentation of the results of this survey by research aim.
- An analysis of these results and a detailed description of their implication for future research.

Future research direction for the PI as a result of this dissertation include:

- Defining adverse sedation outcomes in radiology procedures that could be related to the variables described in this dissertation.
    - The SIR recently published an update to their classification system for adverse events, describing the crucial role a detailed system has for clinical practice and research (Khalilzadeh et al., 2017). Having a standardized framework is an essential component in the study of patient outcomes.

Other points for future study include:

- An analysis by state of any regulations (i.e. Board of Nursing or otherwise) surrounding propofol administration by RNs in procedures requiring sedation.

    - This is predicted to continue to be an important topic given the potential benefits but inherent risks of this medication for patients.
- A study of the processes of communication and teamwork within the IR team structure.
    - There is a significant body of literature describing these processes in the operating room and given the close work of IR RNs and IR RTs, understanding their dynamic would be beneficial in the study of patient outcomes in IR.

Defining the specific relationship between health services research variables and outcomes for patients receiving moderate sedation is particularly important in the current healthcare market as the numbers of patients receiving anesthesia and sedation outside of the operating room continues to increase (Nagrebetsky et al., 2017). The overall use of moderate sedation outside of the operating room administered by non-anesthesia personnel has increased to address the greater demand for procedures that require these medications (N. Crego, 2014; Korzewski et al., 2016; Metzner & Domino, 2010; Mueller et al., 1997). Yet we have little information on the safety, quality, and the patient outcomes of sedation provided in these locations.

The understanding of outcomes for patients in this population suffers from overwhelming neglect. The overall state of the literature for patients receiving moderate sedation is fraught with challenges due to a lack of consistent variables and outcome definitions, small sample sizes, issues with biased data collection, and limits to both internal and external validity. The literature specifically studying outcomes for patients in IR is overwhelmingly focused on clinical results. There is very limited information on the study of health services research outcomes like cost

effectiveness, patient satisfaction, mortality, or failure to rescue, and less information on the impact and role of the nurse during these procedures and any effects on moderate sedation outcomes (Werthman, 2018).

In addition to the limited number of studies, there are no universally accepted quality measures for reporting, tracking, and evaluating sedation use or complications. This makes it challenging to understand the true rate of complications that adversely affect patients and drastically increase the burden on hospitals challenged with managing costs and increasing efficiencies (Arepally et al., 2001; Martin & Lennox, 2003). Based on the importance of this topic for the quality and safety of society, healthcare, and patient populations, it is essential to explore this research area, and as described, there is substantial opportunity. The continued study of this phenomenon of interest and the study of outcomes for this patient population will significantly benefit all areas where nurse administered moderate sedation is performed as well as those seeking care in the exceptional and technologically advanced specialty that is interventional radiology.

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APPENDIX A - TABLES

Table A 1: *Conceptual Models*

Framework, Source, Author	Major Concepts	Definitions of Concepts	Relationships of Concepts	Clarity & Consistency	Limitations	Other
General system theory General system theory Von Bertanlanffy (1968)	*System*- A complex of interacting elements. Consists of both *closed system* and *open systems* There are additional concepts within the theory however, these are the most applicable to the POI	A scientific paradigm contrasting the analytical, mechanical paradigm, characterizing classical science; a scientific exploration of wholeness. Systems are organized and composed of some sort of interdependent relationships between parts A system is closed if no materials enter or leave it A system is open if there is both inflow and outflow and therefore a change of component materials	Systems exist in all fields of science. Closed system examples are thermodynamic principles in physics. Otherwise all organisms by nature are open systems, taking and returning information to their environment. Can study isolated parts, but more important to understand the interaction between those parts	This is a highly reviewed and written about theory that provides a framework for other conceptual models	Complex framework. Notes that given interaction effects between variables within any field of study, it is challenging to isolate one variable for study Extremely high level	Framework provides the basis for other models and understanding of variables and interaction of those variables within health services research
Structure, process, and outcomes The quality of care: How can it be assessed? Donabedian (1988)	*Structure* *Process* *Outcomes*	Attributes of the setting in which process (care) takes place, including material resources, human resources and organizational structure How medicine is practiced and applied and whether medicine is properly practiced; what is actually done in giving and receiving care Result of medical care, or effect of care. Often	Structure precedes and increases the chances of improved process; process precedes and increases the chances of an improved outcome	Model reads clearly from left to right; demonstrating clear temporal precedence between structure and process on outcomes Concepts are well defined, resulting in a highly consistent framework	Broad concepts, very high level. Does not adequately recognize relationship of patient characteristics or environmental factors, or how structure and process may interact to result in outcome	First introduced in 1960s; major framework in HSR Notes that outcomes remain the ultimate validators of the effectiveness and quality of medical care

		seen as a proxy measure of quality				
Health outcomes equation Conducting health outcomes research Kane & Radosevich (2011)	*Outcomes* *Baseline* *Patient clinical characteristics* *Patient demographic /psychosocial characteristics* *Treatment* *Setting*	Patient or other clinical result of equation variables Includes status at the outset of treatment and usual status before the onset of the problem Multiple parts including diagnosis, comorbidities, severity Age, gender, social support as examples Therapy; includes type, dosage, duration and timing Physical location where care is provided, organization of that site or the philosophy of care	Outcome is a result of the equation variables. Recognizes two types of factors: risk factors (baseline, clinical characteristics, demographics/psychosocial characteristics) and treatment factors (treatment, setting). The goal is ultimately to isolate the outcome as a result of the treatment by risk adjusting for any potentially influential factors	Model illustration is simple, showing outcomes as a function of multiple variables; clear to understand and follow Well-recognized and utilized framework in outcomes research. Concepts are well defined resulting in a highly consistent framework Draws influence from aspects of Donabedian's structure, process and outcomes model	Outcomes may be influenced by many factors not all of which are potentially recognized in this equation or even measurable at all	Specific model in outcomes research Result of multiple regression analysis may be difficult to understand
Quality health outcomes model Quality health outcomes model Mitchell et al. (1998)	*System characteristics* *Interventions* *Client characteristics*	Traditional structure and process elements, specific to level of analysis. Includes the individual, organization or group Include direct and indirect clinical activities and all related activities Characteristics of the clients to whom the interventions are directed	Incorporates structure, process and outcomes framework with dynamic feedback points occurring between client and system. Two-way relationship between all concepts, but no direct relationship between interventions and outcomes	The model is clearly illustrated demonstrating the interactions between factors. Builds upon Donabedian framework while incorporating impact of system and client characteristics Definitions are clear, but very high level. Literature suggests further testing outside of nursing	Model indicates multiple reciprocal interactions between factors, not direct link to outcomes from intervention. Given that categories of system and client are so broad, represents challenge to distill specific variables	First presented in 1998. Tested in various nursing studies. Needs further analysis in disciplines outside of nursing

	Outcomes	Result of disease and disorder, but also the effect of the health problem on functioning				
The conceptual framework for the international classification for patient safety Towards an international classification for patient safety: the conceptual framework Sherman et al. (2009)	*Incident type* *Patient outcomes* *Patient characteristics* *Incident characteristics* *Contributing factors/hazards* *Organizational outcomes* *Detection* *Mitigating factors* *Ameliorating actions* *Actions taken to reduce risk*	Event that could have or did result in patient harm, type is the shared category of incidents Impact to patient Demographics and reason seeking care Information about incident circumstances Origin of incident or influencing factors Impact on organization Action resulting in discovery Actions to prevent or moderate incident and harm Actions taken to better or compensate from harm Steps taken to prevent reoccurrence	Continuous improvement cycle with an emphasis on prevention, detection and risk reduction. Flow from contributing factors to ameliorating actions. Incidents and resulting factors influence actions to reduce risk which ultimately inform learning and analytical processes	The model is clearly illustrated, however there is a challenging flow from contributing factors to ameliorating actions, with each step in between informing further actions taken to reduce risk which increases the learning of the organization	The "concepts" shown are high-level classes. Each class has associated concepts that group incidents into clinically meaningful categories (~600). This results in a highly complex model with multiple interactions of factors	Intent is to create uniform classification for patient safety concepts with standard definitions that is applicable throughout patient safety
The Minnick & Roberts Outcomes Production Framework	*Capital inputs* *Employment terms*	Not labor; aspects of the built environment, equipment, and technology systems Timing, workload requirements	Left to right flow, with outcome a product of input from multiple variables. Multiple feedback loops from outcome	The model is clearly illustrated with defined concepts. Feedback loops are implied, not specifically illustrated	Complex interaction of multiple factors. Challenging to measure all in a single study	Most applicable model to POI

Outcomes assessment in advanced practice nursing Minnick et al. (2013)	*Organization facets* *Employee behavior* *Labor inputs (quality and quantity)* *Employee attitudes* *Patient experience* *Patient characteristics* *Outcomes*	Organizational structure, culture, climate, other traits How employee behaves and actions Labor quality (competence) and quantity (heads, FTEs) Internal thoughts or feelings of the employee Subjective and objective events patient goes through Psychosocial demographics, patient baseline, severity, comorbidities Final result of defined variables				

Table A 2: Radiology Studies - Effect Size

Study	Purpose/Aim	HSR Factor/ Variable	How Defined	Outcome	Design	N, Effect Index Unadjusted/Adjusted	Common Effect Size (*r*)	Direction of Effect
Applegate et al. (2001)	Aim 1: Determine the incidences of alarm events (total number of desaturations, hypoventilation, and deeper than intended sedation events) Aim 2: Determine whether advanced monitor use is associated with fewer alarm events	Capital equipment	Type of monitoring used during procedure (standard vs. advanced)	Intergroup difference in total alarm events during procedure related sedation (PRS) (SpO2 </=92%+RRa</=8BPM+PSI</=50 events)	Quasi-experimental, 2 group comparison	Standard n= 44 (median, 2.5; 95% CI, 1.3-4.2) Advanced n=46 (median, 5.5; 95% CI, 2.8-9.0) Significant difference between groups (z=2.073, p=0.038) Unadjusted	r = 0.22	Use of advanced monitoring equipment showed fewer alarm events
Arepally et al. (2001)	Identify rates of adverse events associated with the use of conscious sedation for IR procedures	Patient characteristic	5 most common procedure types; biliary tube placement/exchange, tunneled catheter placement, diagnostic arteriography, vascular intervention, other catheter insertions	Adverse events: defined as respiratory (oral airway, jaw thrust, ambu bag), sedation (change in clinical status due to sedation, use of reversal agents, unresponsiveness or agitation) and major (hypotension, CPR, cardiac or respiratory arrest)	Prospective observational	n= 594	No data provided to calculate effect size	No data provided to calculate effect size
Bluemke & Breiter (2000)	Measure the safety and effectiveness of conscious sedation in order to assess utilization and the effect on magnetic resonance (MR) imaging examinations	Labor quality	Staff experience administering sedation, specialized MR nurses, general radiology nurses, inpatient hospital nurses	Sedation time utilization, sedation effectiveness, break-even costs. (Sedation effectiveness includes sedation success; defined as MR completed and free of motion with no additional testing required)	Descriptive design, /Quantitative methods; retrospective review	n=4,761 A=Primary Radiology RN (N=3,621); Time to sedate 23.6 min (+/- 15.2) B=Other Radiology RN (N=937); Time to sedate 26.8 min (+/- 20.1)	A and B group r = 0.10 A and C group r = 0.59	Use of primary radiology RN group reduced sedation time

						C=Inpatient floor RN (N=113); Time to sedate 47.3 min (+/- 36.6) Unadjusted		
Couloures et al. (2011)	To determine if pediatric procedural sedation-provider medical specialty affects major complication rates when sedation-providers are part of an organized sedation service	Labor quality	Provider type: Provider groups were anesthesiologist (both pediatric and general), pediatric intensivist, pediatric emergency medicine, pediatrician, and other (radiologist, surgeon, dentist, pediatric resident or fellow, advanced practice nurse, certified registered nurse anesthetist, or registered nurse)	Major complication rate defined as aspiration, death, cardiac arrest, unplanned hospital admission, or level of care increase, or emergency anesthesia consultation	Descriptive design, /Quantitative methods; retrospective review	n=131,751 Odds Ratio: Anesthesiologist (Reference) Emergency MD (OR 1.2; 95% CI 0.4-3.9) Intensivist (1.8; 95% CI 0.6-5.7) Pediatrician (1.9: 95% CI 0.4-9.1) Other (1.7; 95% CI 0.5-5.4) *Other includes pediatric resident or fellow, radiologist, surgeon, dentist, APRN, CRNA, RN Adjusted for age emergency status, ASA>2, NPO for solids, propofol use and clustering by site	Anesthesiologist v. Emergency MD: r = 0.05 v. Intensivist: r = 0.16 v. Pediatrician: r = 0.17 v. Other: r = 0.14	Anesthesiologist < all other specialties Being an anesthesiologist showed the least complications
Fatima et al. (2008)	Primary: Examine the safety of nurse administered propofol sedation (NAPS) and the variables associated with complications for a consecutive series of outpatients undergoing EUS at a tertiary referral hospital	Patient characteristics Labor quality	Age (only characteristic reported in the article) Level of nursing experience: Level 1: 1-29 procedures Level 2: 30-99 procedures Level 3: 100 or more procedures	Complications: Minor defined as SBP<90 mmHg, SpO2 of <90%, and HR <50 bpm, O2> 4L NC. Major defined as death, neurologic sequelae, permanent injury, need for hospitalization, or endotracheal intubation	Descriptive design, /Quantitative methods; retrospective review	n=806 5- year increase in patient age + minor complications: (OR 1.00, 95% CI 0.99-1.01, p=0.62) Nursing experience: 2 vs. 1, (OR 0.78, 95% CI 0.51-1.18, p=0.24) 3 vs. 1, (OR 0.61, 95% CI 0.41-0.92, p=0.02)	Age + minor complications : r = 0 2 vs. 1: r = 0.07 3 vs. 1: r = 0.14	A 5- year increase in patient age was not associated with minor complications Having more experience was associated with minor complications

	Secondary: Ascertain the effect of nursing experience on the risk of adverse events					Unadjusted		
Karamnov et al. (2014)	Aim 1: Evaluate the nature of adverse events associated with moderate sedation Aim 2: Examine their relation to patient characteristics and outcomes	Patient characteristics	Patient characteristics include BMI, age, sex, procedure location	Adverse events associated with moderate sedation: over sedation/apnea, hypoxemia, hypotension, patient discomfort, reversal agent, bag-mask>5 minutes, unplanned admission, miscommunication or patient harm	Descriptive design, /Quantitative methods; retrospective review	n=52 Odds Ratio Adjusted	Table A3	Depending on the variable (Table A3). To note, location was associated with complications like over-sedation, hypoxemia, hypotension, and patient discomfort
Karian et al. (2002)	Determine the incidence of sedation failure and paradoxical reaction and to identify potentially correctable causes among patients undergoing sedation for radiologic procedures	Patient characteristics	Sex, age group, diagnosis, scan type, time of day, NPO status, use of IV contrast, and type of sedation	Sedation failure: *primary* (never falling asleep) or *secondary* (awakening during exam) resulting in incomplete study Paradoxical reaction: Extreme inconsolable irritability for more than 30 minutes after administration of medication	Prospective data collection	n=1665 Only data reported is type of agent as only statistically significant variable. Children receiving pentobarbital/fentanyl/midazolam IV combination of agents compared to standard of pentobarbital or pentobarbital/fentanyl combination (OR 26.4, 95% CI 5.5- 124.7 Adjusted	Type of agent: r = 0.67	Patients receiving pentobarbital/fentanyl/midazolam combination associated with higher rates of sedation failure

Table A 3: *Effect Sizes for Karamnov et al. (2014)*

r statistic									
Variable	**Over sedation r**	**Hypoxemia r**	**Hypotension r**	**Discomfort r**	**Reversal agent r**	**Bag-Mask > 5 minutes r**	**ICU or hosp admit r**	**Miscommunication r**	**Harm Done**
Female	0.28	0.37	-	0.11	0.45	0.63	0.78	0.08	0.66
Age	0.04	0.01	0.04	0.29	0.04	0.04	-	0.01	0
Age2	0	-	0	-	0	0	0	-	0
BMI	0.01	0.08	0.11	0.04	0.01	0.08	0.01	0.05	0.14
BMI2	-	-	-	-	-	-	-	0	0.01
Comorbidities	0.06	0.02	0.02	0.06	0.07	0.02	0.51	0.13	0.05
Comorbidities2	-	-	-	-	-	-	-	0.38	0.24
ASA class 3 or 4	0.16	0.18	0.18	0.02	0.27	-0.43	0.42	0.37	0.09
Location									
ED	0.16	0.49	(n/e)	(n/e)	0.37	(n/e)	0.89	0.94	0.5
Inpatient floor	(Base)	0.63	(Base)	(Base)	(Base)	(Base)	(Base)	0.61	0.68
GI endoscopy	0.66	(Base)	0.54	0.19	0.69	0.77	0.85	(n/e)	0.9
Radiology	0.31	0.69	0.85	0.29	0.41	0.43	(n/e)	0.07	(Base)
Cardiology	0.66	0.47	0.49	0.2	0.73	0.75	0.77	(Base)	0.58
Other	0.63	(n/e)	(n/e)	(n/e)	0.69	(n/e)	(n/e)	(n/e)	0.76

Table A 4: *Effect Size*

Study	Purpose/Aim	HSR Factor/ Variable	How Defined	Outcome	Design	N, Effect Index Unadjusted/Adjusted	Common Effect Size (*r*)	Direction of Effect
Aiken et al. (2011)	Determine the conditions under which the impact of hospital nurse staffing, nurse education and work environment are associated with patient outcomes	Labor quantity, labor quality, organizatio nal facets	Nurse staffing, nurse education, and aspects of the work environment	30-day inpatient mortality (M) and failure to rescue (FTR)	Descriptive Correlational	Outcomes from 665 hospitals linked to discharge abstracts of 1,262,120 patients, and 39,038 nurses Fully adjusted OR (95% CI) for M: Nurse staffing 1.039 (1.016-1.063; p=0.001); Work Environment 0.926 (0.898-0.955; p<0.0001); Education 0.958 (0.937-0.980; p<0.0001) Fully adjusted OR (95% CI) for FTR: Nurse staffing 1.039 (1.016-1.063; p=0.001); Work Environment 0.925 (0.897-0.954; p<0.0001); Education 0.956 (0.935-0.978; p<0.0001)	For M: Nurse staffing: r = 0.0105 Work Environment: r = 0.0212 Education: r = 0.0118 For FTR: Nurse staffing r = 0.0105 Work Environment r = 0.0215 Education r = 0.0214	Results suggest for both outcomes increased workloads increase odd s of negative outcome. Better work environment and higher education decrease odds of negative outcome
Bluemke & Breiter (2000)	Measure the safety and effectiveness of conscious sedation in order to assess utilization and the effect on magnetic resonance (MR) imaging examinations	Labor quality	Staff experience administering sedation, specialized MR nurses, general radiology nurses, inpatient hospital nurses	Sedation time utilization, sedation effectiveness, break-even costs. (Sedation effectiveness includes sedation success; defined as MR completed and free of motion with no additional testing required)	Descriptive design, /Quantitative methods; retrospective review	n=4,761 A=Primary Radiology RN (N=3,621); Time to sedate 23.6 min (+/- 15.2) B=Other Radiology RN (N=937); Time to sedate 26.8 min (+/- 20.1) C=Inpatient floor RN (N=113); Time to sedate 47.3 min (+/- 36.6) Unadjusted	A and B group r = 0.10 A and C group r = 0.59	Use of primary radiology RN group reduced sedation time
Couloures et al. (2011)	To determine if pediatric procedural sedation-provider medical specialty affects major complication rates when sedation-providers are	Labor quality	Provider type: Provider groups were anesthesiologist (both pediatric and general), pediatric	Major complication rate defined as aspiration, death, cardiac arrest, unplanned	Descriptive design, /Quantitative methods; retrospective review	n=131,751 Odds Ratio: Anesthesiologist (Reference) Emergency MD (OR 1.2; 95% CI 0.4-3.9)	Anesthesiologist v. Emergency MD: r = 0.05 v. Intensivist: r = 0.16	Anesthesiologi st < all other specialties Being an anesthesiologis

	part of an organized sedation service		intensivist, pediatric emergency medicine, pediatrician, and other (radiologist, surgeon, dentist, pediatric resident or fellow, advanced practice nurse, certified registered nurse anesthetist, or registered nurse)	hospital admission, or level of care increase, or emergency anesthesia consultation		Intensivist (1.8; 95% CI 0.6-5.7) Pediatrician (1.9: 95% CI 0.4-9.1) Other (1.7; 95% CI 0.5-5.4) *Other includes pediatric resident or fellow, radiologist, surgeon, dentist, APRN, CRNA, RN Adjusted for age emergency status, ASA>2, NPO for solids, propofol use and clustering by site	v. Pediatrician: r = 0.17 v. Other: r = 0.14	t showed the least complications
Fatima et al. (2008)	Primary: Examine the safety of nurse administered propofol sedation (NAPS) and the variables associated with complications for a consecutive series of outpatients undergoing EUS at a tertiary referral hospital Secondary: Ascertain the effect of nursing experience on the risk of adverse events	Patient characteristics Labor quality	Age (only characteristic reported in the article) Level of nursing experience: Level 1: 1-29 procedures Level 2: 30-99 procedures Level 3: 100 or more procedures	Complications: Minor defined as SBP<90 mmHg, SpO2 of <90%, and HR <50 bpm, O2> 4L NC. Major defined as death, neurologic sequelae, permanent injury, need for hospitalization, or endotracheal intubation	Descriptive design, /Quantitative methods; retrospective review	n=806 5- year increase in patient age + minor complications: (OR 1.00, 95% CI 0.99-1.01, p=0.62) Nursing experience: 2 vs. 1, (OR 0.78, 95% CI 0.51-1.18, p=0.24) 3 vs. 1, (OR 0.61, 95% CI 0.41-0.92, p=0.02) Unadjusted	Age + minor complications: r = 0 2 vs. 1: r = 0.07 3 vs. 1: r = 0.14	A 5- year increase in patient age was not associated with minor complications Having more experience was associated with minor complications
Kendall-Gallagher et al. (2011)	To determine if hospital proportion of staff nurses with specialty certification is associated with risk-adjusted inpatient 30-day mortality and failure to rescue (deaths in surgical inpatients following a major complication)	Labor quality	Specialty certification	Inpatient 30-day mortality (M) and failure to rescue (FTR) (deaths in surgical inpatients following a major complication).	Descriptive Correlational	n=1,283,241 inpatient discharge data n=28,598 nurse survey data Mortality OR RN experience: 0.99 % of RN with BSN: 0.94 (p<0.001) %of RN with certification: 0.99 FTR OR RN experience: 0.99 % of RN with BSN: 0.93 (p<0.001) %of RN with certification: 0.98	Mortality OR RN experience: r=0.0028 % of RN with BSN: r=0.0171 %of RN with certification: r=0.0028 FTR OR RN experience: r=0.0028 % of RN with BSN: r=0.02 %of RN with certification: r=0.0056	Results demonstrate decreased odds of mortality or FTR with increased % of nurses with BSN

						Adjusted for patient (condition and comorbidity) and hospital (size, teaching status, technology)		
McHugh et al. (2013)	Examine the relationship between registered nurse staffing levels and hospital performance in the HRRP (Hospital Readmissions Reduction Program)	Labor quantity	Staffing measured as a ratio of registered nurse hours per adjusted patient day	Readmissions adjustment factor-the percentage by which CMS would reduce each hospital's base diagnosis-related group (DRG) payment	Descriptive Correlational	n=22,826 hospitals for FY '13, used matched high low staffing pairs (1,413 total pairs) High nurse staffing OR: 0.75; 95% CI: 0.64-0.89 Adjusted for age sex and comorbidities	High nurse staffing: r=0.0791	Higher nurse staffing resulted in lower odds of being penalized than lower staff hospitals
Needleman et al. (2002)	Examine the relation between the levels of staffing by nurses in hospitals and the rates of adverse outcomes among patients	Labor quantity	Staffing	Adverse outcomes in medical patients (LOS, UTI, Upper GI bleed, HAP, Shock or CA, FTR, in hospital death Adverse outcome surgical patients (UIT, FTR, in hospital death)	Descriptive design, /Quantitative methods; retrospective review	n=799 hospitals n=5,075,969 medical patients n=1,104,659 surgical patients **Medical patients** LOS: RN hours r =-1.12(CI -2.00 to – 0.24) p = 0.01 HPPD r= -0.09(-0.13 to -0.05) p<0.001 UTI: RN hours 0.48 (0.38 to 0.61) p<0.001 HPPD 0.99 (0.98 to 1.00) p<0.003 Upper GI bleed: RN hours 0.66 (0.45 to 0.96) p= 0.03 HPPD 0.98 (0.97 to 0.99) p<0.007 HAP: RN hours 0.59 (0.44 to 0.80) p= 0.001 HPPD 0.99 (0.98 to 1.00) p=0.08 Shock or CA: RN hours 0.48 (0.27 to 0.81) p= 0.007 HPPD 0.98 (0.96 to 1.01) p=0.22 FTR: RN hours 0.81 (0.66 to 1.00) p= 0.05 HPPD 1.00 (0.99 to 1.01) p=0.96 In hospital death:	**Medical patients** LOS: RN hours r =-1.12 HPPD r= -0.09 UTI: RN hours r = 0.1983 HPPD r = 0.0028 Upper GI bleed: RN hours r= 0.1138 HPPD r = 0.0056 HAP: RN hours r = 0.1439 HPPD r = 0.0028 Shock or CA: RN hours r = 0.1983 HPPD r = 0.0056 FTR: RN hours r = 0.058 HPPD r =0 In hospital death: RN hours r = 0.029 HPPD r = 0 **Surgical patients** UTI: RN hours r = 0.1097 HPPD r = 0 FTR:	Higher nurse staffing associated with decreased odds of certain adverse events

						RN hours 0.90 (0.74 to 1.09) p= 0.27 HPPD 1.00 (0.99 to 1.01) p=0.83 **Surgical patients** UTI: RN hours 0.67 (0.46 to 0.98) p= 0.04 HPPD 1.00 (0.98 to 1.02) p=1.00 FTR: RN hours 0.73 (0.49 to 1.09) p= 0.12 HPPD 0.98 (0.96 to 0.99) p=0.008 In hospital death: RN hours 0.99 (0.67 to 1.47) p= 0.97 HPPD 1.00 (0.99 to 1.01) p=0.98 Adjusted	RN hours r = 0.0864 HPPD r = 0.0056 In hospital death: RN hours r = 0.0028 HPPD r = 0	
Olds et al. (2010)	Is there a relationship between registered nurses' extended work duration with adverse events and errors, including needlestick injuries, work-related injuries, patient falls with injury, nosocomial infections, and medication errors?	Employment terms	Work Hours	Adverse events defined as including needlestick injuries, work-related injuries, patient falls with injury, nosocomial infections, and medication errors	Descriptive Correlational	n= 11,516 registered nurses **Worked Over 40 hours in the Average Week (vs. Worked 40 or Fewer Hours)** Wrong Med. or Dose OR 1.28; p<0.01; CI (1.10,1.49) Falls with Injury OR 1.17; p<0.05; CI (1.02, 1.36) Nosocomial Infections OR 1.14; p<0.05; CI (1.02, 1.28) Work Injuries OR1.25; p<0.001; CI (1.11, 1.40) Any Needlestick Injuries in the Last Year OR 1.28; p<0.01; CI (1.08, 1.52) Adjusted	Wrong Med. or Dose: r=0.0679 Falls with Injury: r=0.0432 Nosocomial Infections r=0.0361 Work Injuries r= 0.0614 Any Needlestick Injuries in the Last Year r=0.0679	Increased work hours associated with increased adverse events
Rogers et al. (2004)	Is there a relationship between nurses working hours and patient safety?	Employment terms	Work hours	Errors and near misses (self-reported)	Descriptive Correlational	n= 5,317 shifts n= 393 RNs Work duration (hours) and one or more errors: Up to 8.5, OR 1.00 8.5-12.5, OR 1.85 (p=0.06) 12.5 or more 3.29 (p=0.001)	Work duration (hours) and one or more errors: Up to 8.5, r= 0 8.5-12.5, r= 0.16 12.5 or more, r=0.3119	Increased work hours correlated with increased errors and near misses

						Work duration with one or more near miss: Up to 8.5, OR 1.00 8.5-12.5, OR 1.44 (p=0.18) 12.5 or more 1.80 (p=0.04)	Work duration with one or more near miss: Up to 8.5, r= 0 8.5-12.5, r= 0.1 12.5 or more, r= 0.1599	

Table A 5: Definitions as a Result of Card Sorts

Concept	Card sort one definitions	Card sort two definitions
Labor quantity	refers to the total providers and full-time equivalents (FTEs).	refers to the total providers and full-time equivalents (FTEs).
Labor quality	refers to the competence, certification, training, degree, or level of experience of the staff.	refers to the competence, certification, training, degree, or level of experience of the staff.
Employment terms	are defined as workload requirements, employment policies and temporal conditions (shift length, hours of work).	are defined as job requirements, employment policies (such as scope of practice and privileges) and temporal conditions (such as shift length and hours of work).
Organizational facets	are defined as the work environment, organizational structures, organizational policies, procedures and the culture and climate of the work environment.	are defined as the work environment, organizational structures, organizational policies, procedures, the culture and climate of the work environment and scope such as patient population, numbers of patients served and times services are provided.

Table A 6: Results of Card Sort One

	Labor Quality	Labor Quantity	Employment Terms	Organizational Facets	Labor Quality	Labor Quantity	Employment Terms	Organizational Facets
Question								
a	0	0	0	6	0%	0%	0%	100%
b	0	0	0	6	0%	0%	0%	100%
c	0	0	0	6	0%	0%	0%	100%
d	0	1	3	2	0%	17%	50%	33%
e	0	0	1	5	0%	0%	17%	83%
f	3	0	2	1	50%	0%	33%	17%
g	1	0	3	2	17%	0%	50%	33%
h	1	0	0	5	17%	0%	0%	83%
i	0	0	0	6	0%	0%	0%	100%
j	0	0	1	5	0%	0%	17%	83%
k	0	0	2	4	0%	0%	33%	67%
l	0	0	2	4	0%	0%	33%	67%
m	0	1	3	2	0%	17%	50%	33%
n	0	0	6	0	0%	0%	100%	0%
o	0	0	6	0	0%	0%	100%	0%
p	0	1	5	0	0%	17%	83%	0%
q	0	2	2	2	0%	33%	33%	33%
r	0	6	0	0	0%	100%	0%	0%
s	0	6	0	0	0%	100%	0%	0%
t	4	2	0	0	67%	33%	0%	0%
u	2	0	1	3	33%	0%	17%	50%
v	4	1	0	1	67%	17%	0%	17%
w	4	0	0	2	67%	0%	0%	33%
x	5	0	0	1	83%	0%	0%	17%
y	6	0	0	0	100%	0%	0%	0%
z	6	0	0	0	100%	0%	0%	0%
aa	6	0	0	0	100%	0%	0%	0%
bb	0	1	4	1	0%	17%	67%	17%
cc	6	0	0	0	100%	0%	0%	0%
dd	1	1	3	1	17%	17%	50%	17%
ee	0	0	4	2	0%	0%	67%	33%
ff	1	0	2	3	17%	0%	33%	50%

Table A 7: Results of Card Sort Two

	Original Letter	Labor Quality	Labor Quantity	Employment Terms	Organizational Facets	Labor Quality	Labor Quantity	Employment Terms	Organizational Facets
Question									
a	d	0	0	0	5	0%	0%	0%	100%
b	f	0	0	5	0	0%	0%	100%	0%
c	g	0	0	2	3	0%	0%	40%	60%
d	m	0	0	0	5	0%	0%	0%	100%
e	q	0	0	0	5	0%	0%	0%	100%
f	u	2	0	0	3	40%	0%	0%	60%
g	dd	0	0	2	3	0%	0%	40%	60%
h	ee	0	0	5	0	0%	0%	100%	0%
i	ff	0	0	5	0	0%	0%	100%	0%

Table A 8: Specific Aims

Specific Aim	Survey Concept	Survey Concept Definition	Sub Concept	Sub Concept Definition	Survey Question Correlation with Concept	Survey Question Number	Question Level of Measurement
Specific Aim 1: To describe employment terms within interventional radiology.	Employment terms	Job requirements, employment policies (such as scope of practice and privileges) and temporal conditions (such as shift length and hours of work).					
• Specific Aim 1a: To describe workload requirements within interventional radiology.			Workload requirements	Amount of work completed by employee (i.e. number of patients, room assignments)			
					During an average shift, approximately how many patients will an IR RN be assigned to care for?	18	Continuous
• Specific Aim 1b: To describe temporal conditions (shift length, hours of work) within interventional radiology.			Temporal conditions	Hours of operation, employee shift structure and length, hours of work, and call			
					What shift length is predominantly used MONDAY THROUGH FRIDAY for…	15	Nominal
					What shift length is predominantly used DURING THE WEEKEND for…	16	Nominal
					How many hours per month on average is the typical provider on call?	17	Continuous
					Indicate how many hours IR is available per day.	25	Continuous
Specific Aim 2: To describe the organizational facets within interventional radiology.	Organizational facets	The work environment, organizational structures, organizational policies, procedures, the culture and climate of the work environment and scope such as patient population, numbers of patients served and times services are provided.					

• Specific Aim 2a: To describe the work environment within interventional radiology.			Work environment	Conditions in which an employee works; includes processes and procedures			
					What are the moderate sedation privileges of the following providers?	2	Nominal
					Are the following MS education resources used in your hospital prior to providers receiving privileges?	4	Nominal
					During an IR case using moderate sedation, who is responsible for:	10	Nominal
					Which of the following describes how nursing care is organized in IR?	13	Nominal
					Are there unit-based personnel who perform:	14	Nominal
• Specific Aim 2b: To describe organizational structures (policies and procedures) within interventional radiology.			Organizational structure	Organizational characteristics that influence clinical practice			
					Please verify that your hospital provides interventional radiology (IR) services.	1	Nominal
					What is the approximate % of cases in which the provider listed administered MS? If none, write "0".	8	Continuous
					For approximately what % of MS cases in IR is End-Tidal Carbon Dioxide (ETCO2) monitoring used? _____% of cases.	11	Continuous
					Is there a unit-based moderate sedation policy?	12	Nominal

					How many room(s) within radiology are authorized for IR procedures with MS?	22	Continuous
					Approximately what percent of IR cases are outpatients?	23	Continuous
					In the last year, approximately how many cases were completed in IR?	24	Continuous
Specific Aim 3: To describe the characteristics of labor (quality and quantity) within interventional radiology.	Characteristics of labor	Quality and quantity of labor					
• Specific Aim 3a: To describe the quality (competence and training, certification, degree, and level of experience) of labor within interventional radiology.			Quality of labor	Competence and training, certification, degree, and level of experience			
					What is the status of hospital mandated moderate sedation training prior to receiving MS privileges?	3	Nominal
					Is the following content included in MS education?	5	Nominal
					Prior to being given moderate sedation privileges, what are the requirements for RNs? Check here _____ if RNs do not administer MS in IR and go to question 7.	6	Nominal/Continuous
					Prior to working in IR, what are the requirements for RTs? Check here _____ if RTs are not employed in IR and go to question 8.	7	Nominal/Continuous
					How many RNs working in IR have the following as their highest nursing degrees?	21	Continuous

• Specific Aim 3b: To describe the quantity (total providers and full-time equivalents [FTEs]) of labor within interventional radiology.			Quantity of labor	How many and types of providers (total providers and full-time equivalents [FTEs])			
					Who is routinely present during an IR procedure with MS besides the person conducting the procedure?	9	Nominal
					What is the approximate number of RNs working primarily in IR at your institution?	19	Continuous
					What is the approximate number of RTs working primarily in IR at your institution?	20	Continuous

APPENDIX B - FIGURES

Figure B 1: The Minnick & Roberts Outcomes Production Framework (A. Minnick, 2013)

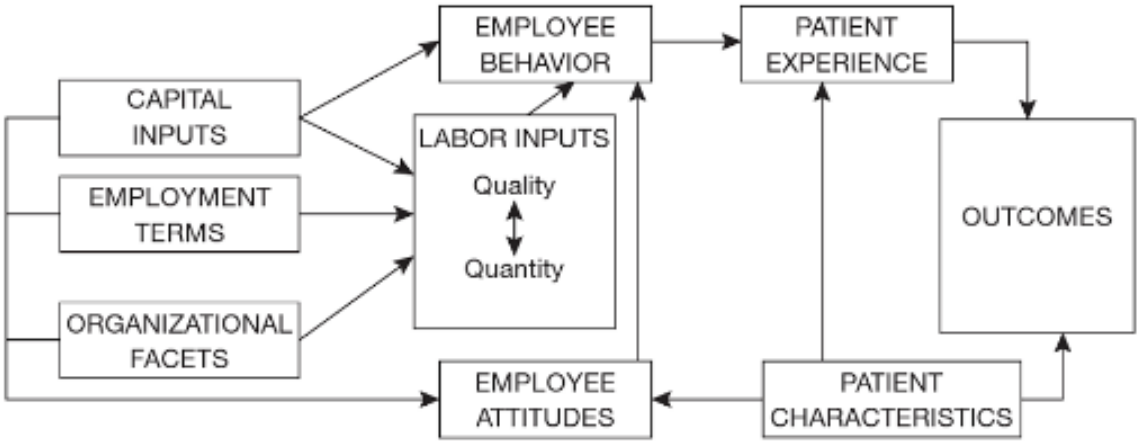


Figure B 2: Modified Minnick & Roberts Outcomes Production Framework

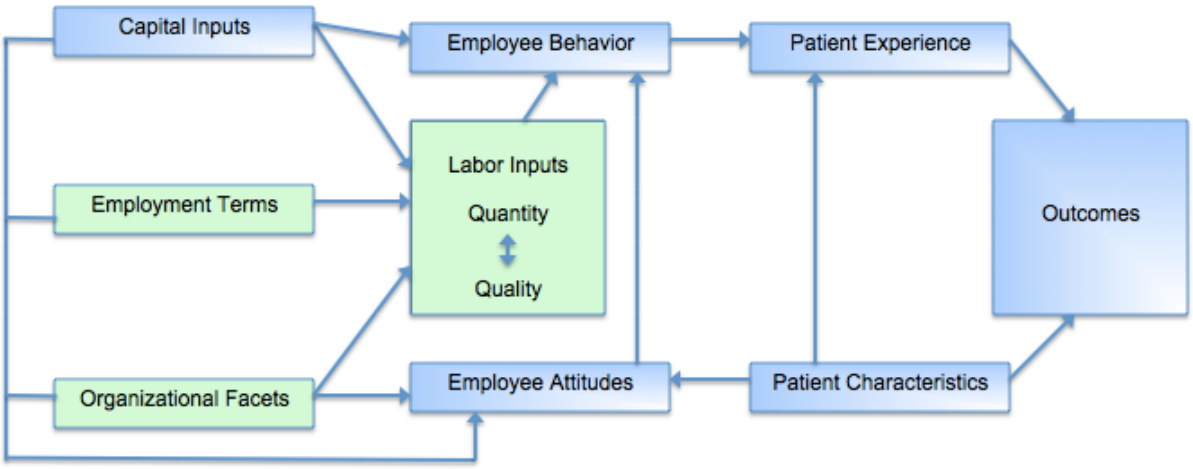
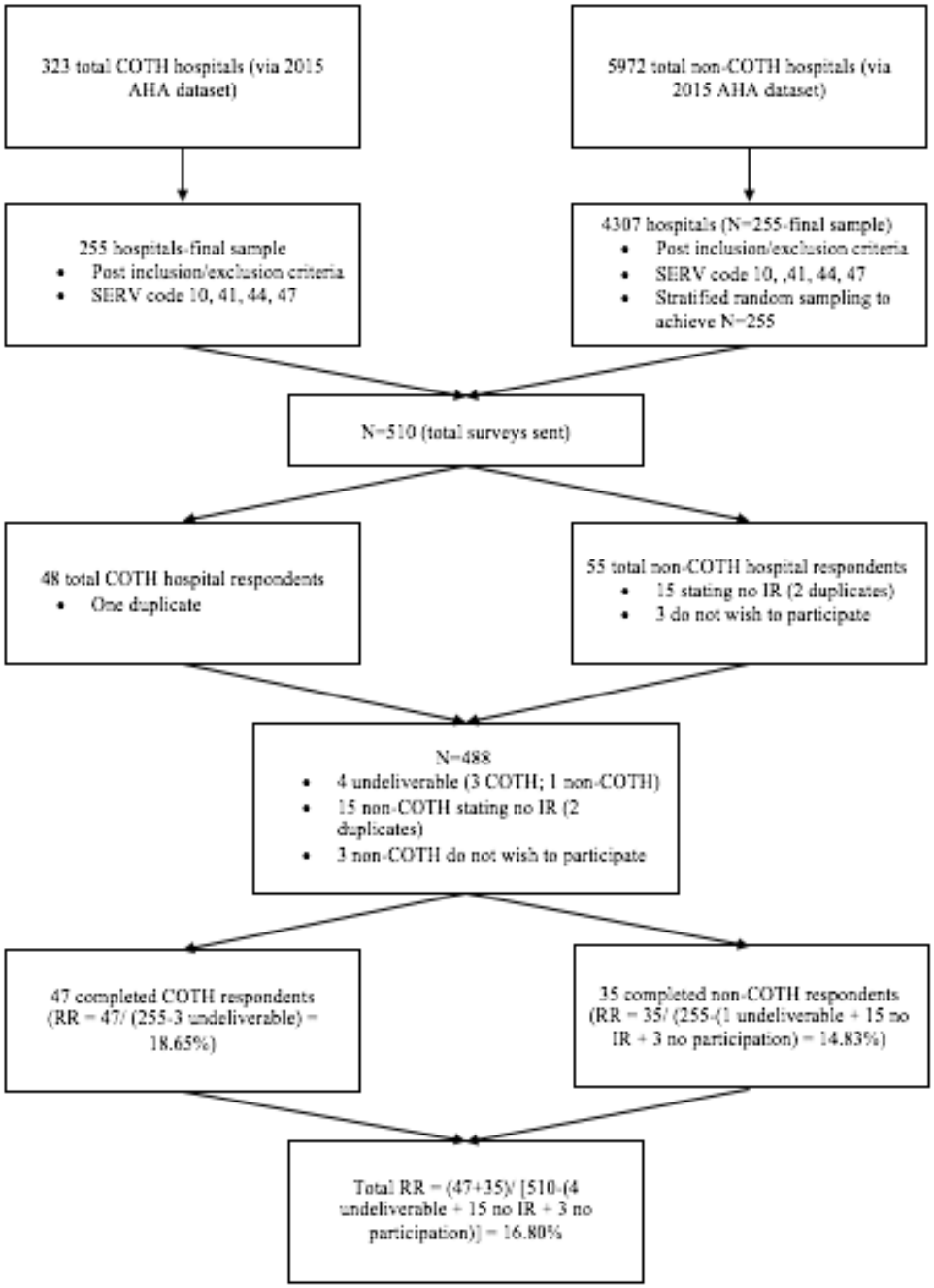


Figure B 3: Sampling Flow Chart



APPENDIX C – SURVEY MATERIALS

Initial Postcard

Dear [Name],

This is to inform you that you will receive a voluntary survey designed to fill the gaps in our knowledge of the service-related variables that may influence outcomes in patients receiving moderate sedation. I am a student conducting research as part of the requirements for a PhD in Nursing Science degree at Vanderbilt University School of Nursing, Nashville, TN. Organizations providing interventional radiology services for adult populations have been asked to participate. Your answers are essential, as information gained will inform future studies on patient outcomes within this population.

If you have any questions, please contact me at Jennifer.A.Werthman@vanderbilt.edu.

Thank you for your time and consideration.

Sincerely,

Jennifer A. Werthman PhD(c), MBA, RN, NE-BC
Vanderbilt University School of Nursing

First Letter

Dear [Name Here],

You are invited to participate in an approximately 15-minute survey designed to fill the gaps in our knowledge of the service-related variables that may influence outcomes in patients receiving moderate sedation. I am a student conducting research as part of the requirements for a PhD in Nursing Science degree at Vanderbilt University School of Nursing, Nashville, TN. There is no clear understanding of non-patient factors influencing the rates of complications and exceptionally limited literature for this patient population. With your help, we can start to define these specific variables and how they influence outcomes for patients receiving moderate sedation.

Your identity, and that of your organization, and organizational affiliation, will be kept confidential. All data collected from this research will be secured and accessible only by the researchers. To further protect you and your institution, your answers will only be reported at the aggregate and not the individual level. Your participation is voluntary. Submission of the survey constitutes informed consent.

Please return the enclosed survey by [date] in the addressed/stamped envelope. You may also complete the survey online at [website]. This website (REDCap) is a secure, web-based application designed to support data capture for research studies.

The study results will be made available as a presentation and submitted for publication in a peer-reviewed journal following completion of the research study and dissertation defense, estimated to be within a year. If you participate and are interested in the findings of the study, I will be happy to e-mail a brief summary of results. A brief summary of findings will be available by winter of 2019. You may provide an e-mail address at the end of the survey. If you have any questions, please contact me at Jennifer.A.Werthman@vanderbilt.edu, or my PhD advisor, Ann Minnick PhD, RN, FAAN, at Ann.Minnick@vanderbilt.edu.

Thank you for your time and consideration.

Sincerely,

Jennifer A. Werthman PhD(c), MBA, RN, NE-BC
Vanderbilt University School of Nursing

Second Letter

Dear [Name Here],

About two weeks ago we sent you a survey request asking for your participation in a 15-minute survey designed to fill the gaps in our knowledge of the service-related variables that may influence outcomes in patients receiving moderate sedation. I am a student conducting research as part of the requirements for a PhD in Nursing Science degree at Vanderbilt University School of Nursing, Nashville, TN. To the best of our knowledge, we have not yet received your responses. We are writing again due to the importance of your answers in understanding how these variables may influence outcomes for this patient population.

Your identity, and that of your organization, and organizational affiliation, will be kept confidential. All data collected from this research will be secured and accessible only by the researchers. To further protect you and your institution, your answers will only be reported at the aggregate and not the individual level. Your participation is voluntary. Submission of the survey constitutes informed consent.

Please return the enclosed survey by [date] in the addressed/stamped envelope. You may also complete the survey online at [website]. This website (REDCap) is a secure, web-based application designed to support data capture for research studies.

The study results will be made available as a presentation and submitted for publication in a peer-reviewed journal following completion of the research study and dissertation defense, estimated to be within a year. If you participate and are interested in the findings of the study, I will be happy to e-mail a brief summary of results. A brief summary of findings will be available by winter of 2019. You may provide an e-mail address at the end of the survey. If you have any questions, please contact me at Jennifer.A.Werthman@vanderbilt.edu, or my PhD advisor, Ann Minnick PhD, RN, FAAN, at Ann.Minnick@vanderbilt.edu.

Thank you for your time and consideration.

Sincerely,

Jennifer A. Werthman PhD(c), MBA, RN, NE-BC
Vanderbilt University School of Nursing

Final Letter

Dear [Name Here],

In recent weeks we sent you a survey request asking for your participation in a 15-minute survey designed to fill the gaps in our knowledge of the service-related variables that may influence outcomes in patients receiving moderate sedation. I am a student conducting research as part of the requirements for a PhD in Nursing Science degree at Vanderbilt University School of Nursing, Nashville, TN. To the best of our knowledge, we have not yet received your responses. We plan to start summarizing results later this month, so we hope that all questionnaires will be completed by then. Describing these variables is essential to understanding how they may influence outcomes for this patient population.

Your identity, and that of your organization, and organizational affiliation, will be kept confidential. All data collected from this research will be secured and accessible only by the researchers. To further protect you and your institution, your answers will only be reported at the aggregate and not the individual level. Your participation is voluntary. Submission of the survey constitutes informed consent.

Please return the enclosed survey by [date] in the addressed/stamped envelope. You may also complete the survey online at [website]. This website (REDCap) is a secure, web-based application designed to support data capture for research studies.

The study results will be made available as a presentation and submitted for publication in a peer-reviewed journal following completion of the research study and dissertation defense, estimated to be within a year. If you participate and are interested in the findings of the study, I will be happy to e-mail a brief summary of results. A brief summary of findings will be available by winter of 2019. You may provide an e-mail address at the end of the survey. If you have any questions, please contact me at Jennifer.A.Werthman@vanderbilt.edu, or my PhD advisor, Ann Minnick PhD, RN, FAAN, at Ann.Minnick@vanderbilt.edu.

Thank you for your time and consideration.

Sincerely,

Jennifer A. Werthman PhD(c), MBA, RN, NE-BC
Vanderbilt University School of Nursing

Survey

DIRECTIONS

- Complete items with reference to your hospital only.
- Use the definitions provided below.
- Complete as much of the survey as you can. Any information you can provide is important.
- Contact Jennifer.A.Werthman@vanderbilt.edu with any questions.

Definitions of Study Terms

Charge RN: a registered nurse responsible for the management of a patient care unit.

Conscious Sedation (CS): See moderate sedation.

General Anesthesia: (GA) is the state produced when a patient receives medications for amnesia, analgesia, muscle paralysis, and sedation. An anesthetized patient can be thought of as being in a controlled, reversible state of unconsciousness.

Hospital-based policy: A policy applied at the hospital level.

Hospitality activities: These activities include greeting visitors, answering phones, distributing books and newspapers as examples.

Interventional Radiology (IR): a medical sub-specialty of radiology utilizing minimally invasive image-guided procedures to diagnose and treat diseases in various organ systems.

Moderate sedation (MS): A drug-induced depression of consciousness during which patients respond purposefully to verbal commands, either alone or accompanied by light tactile stimulation.

Practice: The business and work of a professional person.

Primary RN: Nurse primarily responsible for the care of an assigned patient.

Radiologic Technologist (RT): the medical personnel who perform diagnostic imaging examinations, administer radiation therapy treatments, and work with specialized imaging equipment in radiology.

Registered Nurse (RN): a graduate trained nurse who has been licensed by a state authority after qualifying for registration.

Second RN: Second nurse in addition to nurse assigned to primary care (see Primary RN).

Unit-based policy: A policy applied at the unit level.

Survey # _____

The following questions relate to privileges and training for moderate sedation (MS).

1. Please verify that your hospital provides interventional radiology (IR) services.
   If yes, please continue with survey _____Yes
   If no, please stop at this point and return survey _____No

2. What are the moderate sedation privileges of the following providers?

Allowed to provide MS to:

	Adult Patients			*Pediatric Patients*		
	Yes	No	NA*	Yes	No	NA*
Provider Type						
Registered Nurse (RN)	☐	☐	☐	☐	☐	☐
Certified Registered Nurse Anesthetist (CRNA)	☐	☐	☐	☐	☐	☐
Anesthesiologist	☐	☐	☐	☐	☐	☐
Medical Resident or Fellow	☐	☐	☐	☐	☐	☐
Other (specify):_____	☐	☐	☐	☐	☐	☐

____ Check here if IR does not serve pediatric patients.

Allowed to administer intravenously the following medications:

	Fentanyl	Versed	Morphine	Propofol	Dilaudid	NA*
Provider Type						
RN	☐	☐	☐	☐	☐	☐
CRNA	☐	☐	☐	☐	☐	☐
Anesthesiologist	☐	☐	☐	☐	☐	☐
Medical Resident or Fellow	☐	☐	☐	☐	☐	☐
Other (specify): _____	☐	☐	☐	☐	☐	☐

*Not Applicable (NA): This type of provider is not employed in interventional radiology (IR).

3. What is the status of hospital-mandated moderate sedation training prior to receiving MS privileges?

Provider Type	Required	Not required	Offered but not required	NA*
RN	☐	☐	☐	☐
CRNA	☐	☐	☐	☐
Anesthesiologist	☐	☐	☐	☐
Medical resident or fellow	☐	☐	☐	☐
Radiologic technologist (RT)	☐	☐	☐	☐
Physician	☐	☐	☐	☐
Other (specify): _____	☐	☐	☐	☐

*NA: This type of provider is not employed in IR/cannot give MS.

4. Are the following MS education resources used in your hospital prior to providers receiving privileges?

Resource	Used	Not used
Written material developed by hospital	☐	☐
Written material developed by individual unit	☐	☐
Video or DVD	☐	☐
Classroom training	☐	☐
Internet website	☐	☐
Online module	☐	☐
Verbal instruction	☐	☐

Other (specify): _____

Is this training required after MS privileges are obtained?
_____Yes, annually
_____Yes, another time period (specify): _____
_____No

5. Is the following content included in MS education?

Educational Content	Used	Not used	Do not know
Evaluating patients prior to MS	☐	☐	☐
Performing MS	☐	☐	☐
Rescuing patients with deeper than intended MS levels	☐	☐	☐

Other (specify): _____

6. Prior to being given moderate sedation privileges, what are the requirements for RNs? Check here _____ if RNs do not administer MS in IR and go to question 7.

Certifications	Yes	No
Basic Life Saving	☐	☐
Advanced Cardiac Life Support	☐	☐
Critical Care RN (CCRN)	☐	☐
Certified Radiology RN	☐	☐

Other (specify): _____

Clinical Experiences	Yes	No	If "Yes" total number of years
Experience as an RN	☐	☐	_____
Experience in the Intensive Care Unit	☐	☐	_____
Experience in an interventional area	☐	☐	_____

Other (specify): _____

- Approximately how long is the IR RNs' orientation/training period? If none, write "0". _____ Weeks.

Survey # _____

7. Prior to working in IR, what are the requirements for RTs? Check here _____ if RTs are not employed in IR and go to question 8.

Certifications	Yes	No
Basic Life Saving	☐	☐
Advanced Cardiac Life Saving	☐	☐
Cardiac-Interventional (CI)	☐	☐
Vascular-Interventional (VI)	☐	☐
Other (specify): _____		

Clinical Experiences	Yes	No	If "Yes" total number of years
Experience as an RT	☐	☐	_____
Experience in an other interventional area	☐	☐	_____
Other (specify): _____			

- Approximately how long is the RTs' orientation/training period? If none, write "0".
  _____ Weeks.

The following questions relate to the roles and working conditions of personnel in IR.

8. What is the approximate % of cases in which the provider listed administered MS? If none, write "0".

Provider	% of Adult Patients
RN	_____
CRNA	_____
Anesthesiologist	_____
Medical Resident or Fellow	_____
Other (specify):	_____
Total	__100%__

What is the approximate total # of adult cases receiving MS in the last year _____?

_____ Check here if IR does not serve pediatric patients

Provider	% of Pediatric Patients
RN	_____
CRNA	_____
Anesthesiologist	_____
Medical Resident or Fellow	_____
Other (specify):	_____
Total	__100%__

What is the approximate total # of pediatric cases receiving MS in the last year _____?

Survey # _____

9. Who is routinely present during an IR procedure with MS besides the person conducting the procedure?

	Yes	No	NA*
Anesthesia provider:			
MD	☐	☐	☐
CRNA	☐	☐	☐
Procedure RN	☐	☐	☐
Second procedure RN	☐	☐	☐
RT	☐	☐	☐
Second RT	☐	☐	☐
Resident	☐	☐	☐
Fellow	☐	☐	☐
Nurse Practitioner (NP)	☐	☐	☐
Physician Assistant (PA)	☐	☐	☐
Other (specify: _____)	☐	☐	☐

*NA: This type of provider is not employed in IR.

10. During an IR case using moderate sedation, who is responsible for:

	Charge RN	Primary RN	Second RN	RT	Other
Monitoring of hemodynamics	☐	☐	☐	☐	☐
Retrieving supplies	☐	☐	☐	☐	☐
Retrieving medications	☐	☐	☐	☐	☐
Patient documentation	☐	☐	☐	☐	☐
Calling of report	☐	☐	☐	☐	☐

11. For approximately what % of MS cases in IR is End-Tidal Carbon Dioxide (ETCO2) monitoring used?
_____% of cases.

12. Is there a unit-based moderate sedation policy? ____Yes ____No
Is it used for all patients? ____Yes ____No (If no, what % ____%)
If no, is there a hospital-based moderate sedation policy? ____Yes ____No
Is it used for all patients? ____Yes ____No (If no, what % ____%)

13. Which of the following describes how nursing care is organized in IR? Select one only.
_____RN has same patient from pre-procedure, intra-procedure through to recovery
_____RNs have different patients in pre-procedure, intra-procedure, and recovery
_____Other (specify): _____

14. Are there unit-based personnel who perform:

	Yes	No
Stocking	☐	☐
Cleaning	☐	☐
Hospitality activities	☐	☐
Transport	☐	☐

Do these personnel also perform nursing activities? Yes____ No____
If yes, what are these people's titles? _____
Approximately what percent of their daily work is devoted to nursing activities? _____%
Please list the specific nursing activities performed:_____

Survey # _____

15. What shift length is predominantly used MONDAY THROUGH FRIDAY for…

	8Hr.	10Hr.	12Hr.	24Hr.	48Hr.	Other (specify)	NA
IR RN							
IR RT							

16. What shift length is predominantly used DURING THE WEEKEND for…

	8Hr.	10Hr.	12Hr.	24Hr.	48Hr.	Other (specify)	NA
IR RN							
IR RT							

17. How many hours per month on average is the typical provider on call? If none, write "0".

	Average # Call Hours/Month	NA
IR RN		
IR RT		

18. During an average shift, approximately how many patients will an IR RN be assigned to care for?
At one time (concurrently) _____patients Total (during whole shift) _____patients

The following questions concern staffing.

19. What is the approximate number of RNs practicing primarily in IR at your institution? If none, write "0".

	#	Do not know
Full-time RNs?	_____	_____
Part-time RNs?	_____	_____
Per diem RNs?	_____	_____
Supplemental/traveler RNs?	_____	_____

20. What is the approximate number of RTs practicing primarily in IR at your institution? If none, write "0".

	#	Do not know
Full-time RTs?	_____	_____
Part-time RTs?	_____	_____
Per diem RTs?	_____	_____
Supplemental/traveler RTs?	_____	_____

21. How many RNs practicing in IR have the following as their highest nursing degrees?

	# RNs
Associate Degree - Nursing	_____
Bachelor of Science in Nursing	_____
Master in Nursing	_____
Doctorate (DNP or research doctorate)	_____
Total	_____

Survey # _____

The following questions relate to volume of services and their timing.

22. How many room(s) within radiology are authorized for IR procedures with MS? If none, write "0".
_____Total rooms.

23. Approximately what percent of IR cases are outpatients? _____%.

Approximately what percent of IR cases are inpatients? _____%.

Total 100%

24. In the last year, approximately how many cases were completed in IR? _____ # of cases.

Of these, how many patients received moderate sedation? _____

25. Indicate how many hours IR is available per day. If IR is not available please write "0".

Per day # of hours

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
_____	_____	_____	_____	_____	_____	_____

THANK YOU! Please use the enclosed envelope to send the survey directly to: Jennifer Werthman, PhD(c), MBA, RN, NE-BC, Vanderbilt University School of Nursing, 461 21st Ave S, Nashville, TN 37240, within two weeks of receipt.

Please provide the title of the person completing this survey: _____

If you participate and are interested in the findings of the study, I will be happy to e-mail a brief summary of results. Please provide an e-mail address here: _____

Survey # _____