Pediatric Nurse Practitioners Role in Care Delivery within Pediatric Intensive Care Units

By

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Dissertation

Submitted to the Faculty of the

Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Nursing Science

August 11, 2017

Nashville, Tennessee

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To Sergio who shares infinite love and wisdom

and

To my parents who always encouraged me and taught me to be smart and work hard

ACKNOWLEDGEMENTS

I would like to express my gratitude to the members of my dissertation committee for their endless support, models of professionalism, and thoughtful feedback that has encouraged me to work harder and think bigger. My sincere appreciation goes to my dissertation chair, Dr. Ann Minnick who changed how I think and ask questions and promoted the highest standards of excellence and academic achievement. I am grateful to Dr. Peter Buerhaus for his early guidance, imparting visionary thinking, and showing me how to delineate my space in the research community. Dr. Mary Dietrich has guided and encouraged me to produce high-level scholarship while sharing her love of teaching. I appreciate Dr. Ruth Kleinpell's example of nursing leadership and promotion of the value of nurse practitioners in addition to her encouragement of meaningful scholarly engagement. Without these key individuals, this dissertation would not be what it is today. I hope I can follow the examples you each set.

I would like to recognize the financial support I received to conduct my dissertation research. I am grateful for support from the Vanderbilt University School of Nursing PhD Student Research Award, the Iota Chapter of Sigma Theta Tau International, and Clinical Translational Science Award (CTSA) for REDCap.

To my colleagues in the PICU at Children's Medical Center Dallas, I thank you for your encouragement, patience with my schedule needs, and showing an interest in my work during this dissertation process. To Paula, I value your critical eye, desire for clarity, and sensibility.

It is with infinite gratitude that I thank Sergio for his unconditional love and endless encouragement throughout this dissertation. He took time to celebrate accomplishments while reminding me to bend like a reed in the wind and embrace the journey. My mom has been my lifelong supporter to whom I am grateful for her listening ear, compassionate heart, and passion for learning – you and Dad have been a wonderful example to me, I hope you are proud.

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LIST OF ABBREVIATIONS

ACGME- Accreditation Council of Graduate Medical Education

AANP- American Association of Nurse Practitioners

ACA- Patient Protection and Affordable Care Act

AHRQ- Agency for Healthcare Research and

AHA- American Hospital Association

APRN- Advanced Practice Registered Nurse

CHA- Children's Hospital Association

COTH- Council of Teaching Hospitals

HRSA- Health Resources and Services Administration

HWIC- Health Workforce Information Center

ICU- Intensive Care Unit

IGM-International Medical Graduate

IOM- Institute of Medicine

IQR- Inter-quartile Range

NAPNAP- National Association of Pediatric Nurse Practitioners

NCSBN- National Council of State Boards of Nursing

NONPF- National Organization of Nurse Practitioner Faculties

NP- Nurse Practitioner

PICU- Pediatric Intensive Care Unit

PNCB- Pediatric Nursing Certification Board

PNP- Pediatric Nurse Practitioner

RN- Registered Nurse

SSOP- State Scope-of-Practice

CHAPTER I

INTRODUCTION

Statement of the Problem

In 2012, there were more than 2 million pediatric hospital admissions in the United States (Agency for Healthcare Research and Quality [AHRQ], 2012). The sickest children are served in the pediatric intensive care unit (PICU) where they receive specialized care and resources. Although the number of admissions to children's hospitals is decreasing, the number of admissions to the PICU is increasing (Randolph, Gonzales, Cortellini, & Yeh, 2004).

Despite a significant demand for pediatric providers, the pediatric workforce is inadequate to meet the current health care needs of children in pediatric intensive care units (Children's Hospital Association [CHA], 2012; Health Resources and Services Administration [HRSA], 2006). By 2020 the Society of Critical Care Medicine estimates a multifactorial shortfall in the number of hours of care that intensivist physicians will provide relative to the demand for care (Society of Critical Care Medicine, 2015). Since the impending physician shortage will influence care delivery to children (CHA, 2012) and children in the PICU must have qualified pediatric health care providers strategies to address the physician shortage must be explored before the shortage effects the care of children.

Three primary approaches to increasing the PICU physician workforce include: increased recruitment of pediatricians to critical care pediatrics, increasing quotas for International Medical Graduates candidates included in critical care medicine workforce, and increased participation (delayed retirement, more hours worked) in the workforce (Minnick, 2014). These strategies have not stemmed the decline in the number of critical care physicians. The number of critical care fellows decreased by 25% between 1998-2004 and increasing the number of fellows back to the levels of 1998 and surpassing that rate of training new PICU physicians is not expected

(HRSA, 2006). More than half of critical care trainees are IGM physicians who as a result of federal visa policies, largely must return to their home countries after training – not increasing the size of the United States PICU physician workforce (HRSA, 2006). Work hour restrictions also contribute significantly to the availability to training physicians to contribute to the care of patients in the PICU (Accreditation Council of Graduate Medical Education [ACGME], 2011). Prolonged participation in the workforce is unlikely related to burnout and exhaustion. Approximately half of the critical care workforce retires by age 60 and one-third by age 50, factors of burnout and exhaustion are imbedded in the nature of the work in critical care and not easily modified to increase workforce participation (HRSA, 2006). Additionally, women are increasingly part of the critical care physician workforce; they have been found to spend fifteen percent less time in patient care than male physicians with implications for the number of providers needed to deliver care (HRSA, 2006).

Barriers to growing the PICU physician workforce have resulted in an evolution of workforce models of care to compensate for the physician shortage (Garland & Gershengorn, 2013). These models often rely on the involvement of Advanced Practice Registered Nurses (APRNs) to deliver patient care as part of the health care provider team (Basco & Rimsza, 2013; Kleinpell, Ward, Kelso, Mollenkopf, Houghton, 2015; Shugerman et al., 2013).

Advanced Practice Registered Nurses are essential health care providers in the United States. Pediatric Nurse Practitioners (PNPs), a subspecialty of APRN providers, are increasingly utilized as health care providers in hospital-based settings (Allen, Fennie, & Jalkut, 2008; Brady & Neal, 2000; Freed, Dunham, Lamarand, Loveland-Cherry, & Martyn, 2010; Freed et al., 2014; Pitts & Seimer, 1998). The demand to increase PNP utilization is strongest among pediatric physicians in the PICU (Freed, Dunham, Loveland-Cherry, Martyn, & Moote, 2011).

The roles PICU nurse practitioner providers play in care delivery is not well known (Verger, Marcoux, Madden, Bojko & Barnestiner, 2005; Brown et al., 2012) and may be variable

based upon the PNP practice location (Kleinpell, Hudspeth, Scordo, & Magdic, 2012). Variability in the PNP role may contribute to PICU provider shortages if PNPs are inadequately or incompletely included in the team of PICU providers. Additionally, it is unknown how PICU NPs should optimally use their skills and knowledge in care delivery teams to improve patient outcomes. The purpose of my research is to describe the roles of nurse practitioners on provider teams and in the delivery of care and within the PICU.

Specific Aims

Three specific aims of my dissertation research are to:

1) Identify the roles and functions of pediatric nurse practitioners working in pediatric intensive care units. This aim is to discover if there is variation in practice patterns of PNP care across the country.

2) Examine the pediatric intensive care unit provider team composition. This aim is designed to identify if there is variation in provider staffing models within the PICUs, including utilization rates of APRNs in patient care delivery.

3) Identify hospital-reported internal regulatory characteristics and state regulatory environments influence on the practice of pediatric nurse practitioners. This aim is designed to identify areas where future intervention could modify the roles and/or restrictions placed on nurse practitioners' roles and practice influencing their ability to provide hospital care services.

Significance of Issue

PICU provider workforce.

PICU physician workforce.

A shortage of intensive care physicians is exacerbated by multiple factors that influence the supply of and demand for their care. Currently the number of physicians completing critical care training is not adequate to replace those retiring (HRSA, 2006). In addition, many international medical graduates have limited stays in the United States as a result of visa

restrictions (HRSA, 2006) and restrictions on the number of hours training physicians may work (ACGME, 2011) contribute to the shortage of critical care physicians. Studies suggest that the presence of an intensivist in the ICU improves patient outcomes, which is also driving demand for increased intensivist presence in hospital PICUs (Pronovost & Rainey, 2011).

Pediatric nurse practitioner workforce.

With the physician shortage, workforce models include the PNP role to meet pediatric health care demands (Basco & Rimsza, 2013; Shugerman et al., 2013). The nurse practitioner workforce is growing and the forecast for future growth is strong (Auerbach, 2012; Freed, Dunham, Loveland-Cherry, & Martyn, 2010). However, while other nurse practitioner subspecialties are increasing in size, the PNP workforce is stable (Freed, Dunham, Loveland-Cherry, et al., 2010; Martyn, Martin, Gutknecht, & Faleer, 2013) and among the smallest subspecialties, making up approximately five percent of the NP population (American Association of Nurse Practitioners [AANP], 2017a). The current supply of PNPs is unlikely to be adequate to meet this demand for PICU PNPs (Freed et al., 2011; Freed et al., 2014). Efforts to evaluate the recruitment and retention of acute care PNPs caring for patients in the PICU will help promote the future development and engagement of this in-demand portion of the PICU workforce.

Acute care PNPs are unique in education and clinical practice from all other ARPNs. Dedicated, nationally recognized acute care PNP education programs and national certification and state licensure are consistent with other APRNs subspecialists (APRN Consensus Work Group & National Council of State Boards of Nurse [APRN Consensus Work Group], 2008). With specialized knowledge, skills, and expertise, acute care PNPs, such as the PICU PNP, can assume roles that have traditionally been held by physicians (Lowe, Plummer, O'Brein, & Boyd, 2012; Reider-Demer, Widecan, Jones, & Goodhue, 2006). Although wide variation in role implementation has resulted and inconsistent clinical assimilation of nurse practitioners on health

care teams (Kleinpell, Ely, et al., 2008; Kleinpell, et al., 2015; Verger et al., 2005), the general public views PNPs as qualified providers (Dill, Pankow, Erikson, & Shipman, 2013; Martin, 1999) with equivalent and, in some cases, better outcomes than physician providers (Kuo, Loresto, Rounds, & Goodwin, 2013; Newhouse et al., 2011).

Regulations on APRN practice.

Despite national education standards and certification, states vary in their degree of regulation of NP practice and prescriptive authority with state scope-of-practice (SSOP) regulations. The variation in regulations has resulted in disparity of APRN responsibilities in clinical practice across the country (Reagan & Salsberry, 2013). It is imperative that pediatric nurse practitioners practice to the full extent of their legal abilities. When PNPs practice to the fullest extent, access to critical care providers is increased (Moote, Krsek, Kleinpell, & Todd, 2011).

Through credentialing and hospital privileging, PNPs are granted the ability to perform specific components of patient care, including procedures that are within the scope of their education, licensure, and certification (Kleinpell, Hravnak et al., 2008). Hospitals can place additional restrictions that are more stringent than defined through SSOP regulations (Kleinpell et al., 2012). How these hospital-based restrictions are determined, how they vary among hospitals, and their implications for patient care delivery have not been described.

As PNPs assume expanded roles such as those found in the PICU, physicians may place additional restrictions on PNPs' practice. Physician-imposed restrictions may include unnecessary supervision (Larsson & Zulkowski, 2002), limits on PNP role actualization (Lowe et al., 2012), and exacting barriers to billing as a unique provider (McCarthy, O'Rourke, & Madison, 2013; Schaum, 2010). These additional physician-imposed restrictions threaten the cohesion provider-care teams must achieve to provide collaborative, high-quality care in the

PICU. With knowledge of pediatric intensive care practice environments, future interventions can be designed to allow and enable optimum integration of PNPs in care delivery.

Evaluating the current roles and restrictions upon PNPs' practice as they relate to PICU health care delivery places practitioners' current contribution to pediatric care in context of what could be achieved with full role implementation (Institute of Medicine [IOM], 2010). PICU PNP workforce development can be supported with an understanding of the role SSOP regulation laws and hospital characteristics play in creating a supportive practice environment that produces positive child, family and organizational outcomes (Bahouth et al., 2013).

Literature Review and Theoretical Framework

A review of theoretical frameworks relevant to the NP role in PICU care delivery and a literature review pertinent to the phenomenon will be presented. Theoretical approaches to examining the clinical practice of NPs are evaluated from a nursing perspective. Policy and regulations also influence how NP roles are implemented, and additional theories of practice regulation and policy are considered important theoretical frameworks for this study. A review of the history of NPs and their utilization in the PICU provides a context for understanding the phenomena. Finally, key concepts are presented and defined to build consistent categorization from which to further evaluate this phenomenon.

Theoretical Framework.

Adoption and implementation of the Consensus Model for APRN Regulation (2008) and the Institute of Medicine (2011) recommendations support nurses practicing to the full extent of their licensure and education. Concurrently, employment of and roles for APRNs are increasing in acute care settings (Allen, Fennie, & Jalkut, 2008; Brady & Neal, 2000; Freed, Dunham, Lamarand, et al., 2010; Freed et al., 2014; Pitts & Seimer, 1998). Despite increased opportunities for APRN practice and momentum to expand practice to the fullest extent of licensure and education, regulations, formal and informal, continue to influence APRN practice.

APRN practice is increasingly a focus of research and a framework to understand APRN practice in the context of regulations to practice is important to understanding the roles APRNs play in providing patient care.

Existing nursing models (Elliott & Walden, 2014; Herman, 2007; Kilpatrick, Lavoie-Tremblay, Lamothe, Ritchie, & Doran, 2013; APRN Consensus Work Group, 2008; van Offenbeek & Knip, 2004) focus on the role and role enactment of nurses or nurse practitioners. The notion of formal and informal restrictions to practice is introduced in these models while highlighting the fluidity with which APRN roles are enacted. As it relates to understanding nurse practitioners' role in PICU care delivery, the biggest limitation of existing nursing frameworks is a lack of full integration of regulatory and practice concepts into a single model for evaluation. Kilpatrick et al. (2013) provides the closest attempt at integration, but the framework lacks clarity of concepts and does not adequately emphasize the complexity of the relationships among the concepts. Further conceptual clarity and incorporation of the regulatory, policy and practice concepts is needed in nursing frameworks.

Policy and economic models (Feldstein, 2004; Lomas, 2000; Lubell, 2012) have been essential to understanding how regulations influence and can change APRNs' practice. These models do not focus on components of APRNs' clinical practice specifically, but contribute to understanding how changes to regulations related to practice and role enactment should be evaluated and can be achieved. As states eliminate formal, legislative restrictions to practice, the role and influence of informal regulations become more important to evaluate relative to APRN practice and should be present in any framework for APRN practice (Kilpatrick et al., 2013; Lubell, 2012; van Offenbeek & Knip, 2004).

I propose a new framework that examines how variety in state scope-of-practice and other regulations impact hospital-based NPs' practice (Figure 1). My suggested framework's major concepts have been guided by integrating the Social Elements of a Policy System (Lubell,

2012), Lomas Policy (Lomas, 2000), the Economic Theory of Regulation (Feldstein, 2004), and Acute Care Nurse Practitioner Role Enactment, Boundary Work and Perception of Team Effectiveness (Kilpatrick, 2013) frameworks. These frameworks incorporate the central ideas of regulations on practice, factors associated with nurse practitioner care, and how policies related to regulations on practice change over time.

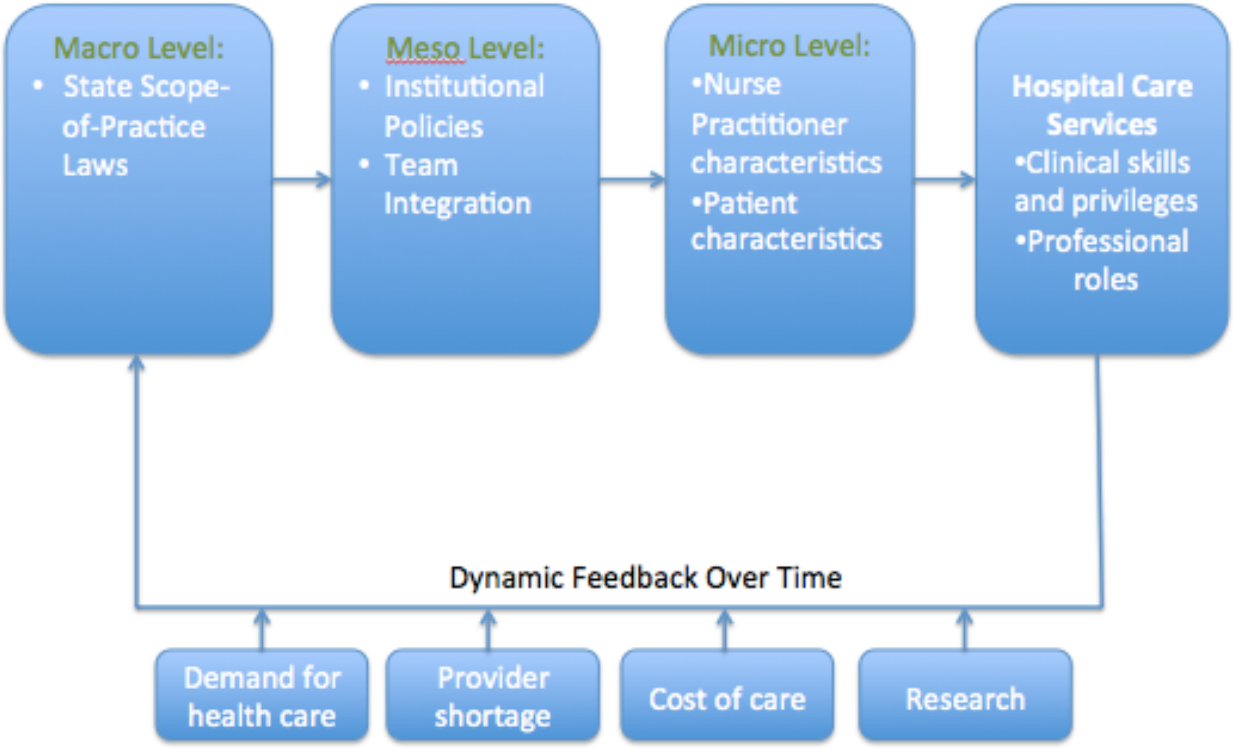


Figure 1. Synthesized Model to Describe the Impact of State Scope-of-Practice Laws and Regulations on Nurse Practitioner Practice Patterns

The concept of progressive restriction upon practice (Kleinpell, Hudspeth, et al., 2012) is demonstrated in: 1) a macro-level set of formal rules that constrain and enable behavior 2) a meso-level of institutional influences upon behavior; and 3) micro-level parameters that result from individual characteristics that influence behavior (Lubell, 2012). These cumulative restrictions result in a variety of expectations for APRNs' delivery of hospital care services.

The Kilpatrick et al. framework (2013) describes the gradations of restrictions upon the acute care nurse practitioners' clinical practice that can be inferred to pediatric intensive care unit

PNP hospital care services. State scope-of-practice regulations outline expectations related to the range of care services within a NP's practice. Individual providers can then face additional restrictions and practice oversight from institutions and hospitals for which they work and/or by physician colleagues that are part of a health care team that may have different standards for integration of PNPs into teams or delegation of components of patient care to PNPs. An individual provider's educational background and clinical experiences, along with the patient's characteristics, influence the PNP level of competence to care for specific patient populations.

The Lomas and Social Elements of a Policy System frameworks support that, over time, factors including demand for health care, provider shortages, the cost of providing care, and research on NP practice in this new framework will influence the macro-level regulations that trickle down, and ultimately result in changes to the hospital care services provided (Lomas, 2000; Lubell, 2012).

This new framework supports cross-sectional and longitudinal research. As it is used, the van Offenbeck and Kipp (2004) concepts of demand for care and division of patient care tasks will be important to monitor and will be influential in model testing. The professional roles (Elliott & Walden, 2014) related to hospital care services in proportion to clinical roles may change with time as the optimum balance of provider skills and knowledge utilization are not yet understood. A career of research designed to support NP practice will afford opportunities to assess how, over time, practice patterns influence the evolution of SSOP laws. As part of the dynamic of this long-term assessment, the use of information to influence policy/regulation, as presented in Lomas (2000), will have considerable import. With the synthesis of this new framework, concepts related to scope-of-practice and NP practice can be more clearly understood and venues for research can be readily identified.

Conceptual definitions.

In this document, definitions for all the concepts within my proposed framework will be defined. Only a portion of the overall framework will be examined in my dissertation work. Those concepts that are specifically applicable to my proposed dissertation research project will be indicated with a * following the key concept.

State scope-of-practice laws:* formal, legal regulation of APRN practice that occurs state-by-state and includes three levels of practice authority: 1) states with no scope-of-practice limitations where APRNs have full practice authority; 2) states where an APRN must collaborate in order to practice or prescribe have reduced practice authority; and 3) those who must collaborate to prescribe, diagnose, and treat patients have restricted practice authority (AANP, 2017b; Kuo, Loresto, Rounds & Goodwin, 2013; Regan & Salsberry, 2013).

Institutional policies:* hospital- or institution-based credentialing and privileging that permits APRNs to perform patient care "tasks under varying degrees of supervision, collaboration or independently" (Kleinpell, et al., 2012, p.16).

Team integration:* how NPs are incorporated into a team of care providers for a patient population in the hospital setting and includes: who does work, how many of them are doing the work, what they are able to do and tasks they are assigned – and variation in role based upon individual collaborating physicians APRN inclusion disposition, work schedules and interactions with non-physician health-care workers (Garland & Gershengorn, 2012).

Nurse practitioner characteristics: demographic characteristics of the APRN including: age, years worked as an APRN, years worked as an register nurse (RN), number of years at current job, highest educational level, APRN certification and practice specialty as an RN and APRN (Cajulis & Fitzpatrick, 2007).

Patient characteristics: acuity and complexity of a patient's condition(s) determines patient care needs and provides framework for which APRN provider, acute care versus primary care, is appropriate to provide care (National Organization of Nurse Practitioner Faculties [NONPF], 2012).

Hospital care:* care provided in an acute care setting with specially trained personnel, monitoring and support equipment for treatment of patients requiring comprehensive observation and care (American Hospital Association [AHA], 2014).

Clinical skills:* assessment, diagnosis, treatment and management with interventions for patients and their families performed by an APRN (NONPF, 2013; Verger, et al., 2005).

Clinical roles:* professional responsibilities of the APRN that include patient management, nursing and medical education, coordination of care, research, advocacy and consultation (Verger, et al., 2005).

Demand for care: a present or future need for health care by a specific patient population with specific health problems in a particular care setting by a specific individual health care professional (Health Workforce Information Center [HWIC], 2012).

Provider shortage: an inadequate supply of: physicians in all stages of training, nurse practitioners and physicians assistants who have the ability to give orders that influence patient care; to provide needed care to a patient population (HWIC, 2012).

Cost of care: total cost of health care service for an episode of illness (Mason, Leavitt & Chaffe, 2012). The cost of care also includes the influence of "concentrated interest", the effect of changes to SSoP legislation that would have a large impact on the profitability of a provider, where providers with the most at risk in terms of an economic self interest are the most likely to oppose to changes to legislation (Feldstein, 2004).

Research: systematic inquiry using a disciplined method to answer questions about care delivery and patient outcomes that develops evidence (Mason et al., 2012).

Literature Review.

History of the PNP.

The role of the NP has been integrated into health care delivery over the last 50 years. Developed in the 1960s, this new nursing role, an equivalent to today's pediatric nurse practitioner – primary care (Silver, Ford, & Stearly, 1967), offered "improved patient care, benefit to society by conservation of scarce manpower resources, increased availability of comprehensive, expert, and accessible services, and the development of the role of each health practitioner to its fullest" (Silver, Ford & Day, 1968; pg. 302). Over time the NP role has expanded to include roles for NPs as care providers to both pediatric and adult patients in primary, specialty, and acute care settings, along with other advanced practice nursing roles in nurse midwifery, clinical nursing, and anesthesia, becoming essential health-care providers (AANP, 2017c).

Pediatric nurse practitioners are increasingly assuming roles in the care of children in acute care, hospital-based settings (Allen et al., 2008; Brady & Neal, 2000; Freed et al., 2010; Freed et al., 2014; Pitts & Seimer, 1998). Nurse practitioners first transitioned into acute care settings during the 1990s (Haut & Madden, 2015). Approximately one-quarter of PNPs work in hospital-based settings today (Freed et al., 2014). Ongoing development of the acute care PNP role has resulted in national competencies for education (NONPF, 2013) and a national certification (Pediatric Nursing Certification Board [PNCB], 2017).

Nurse practitioners working in the PICU require additional post-graduate training, often provided during a formal clinical orientation (Sorce, Simone, & Madden, 2010) lasting up to a year after hiring (Verger et al., 2005). Theses PNPs are specialized providers with clinical skills and a knowledge base to provide direct patient care and care coordination to the population of critically ill pediatric patients, many with complex, chronic illness (Reuter-Rice, 2013; Verger et al., 2005). The roles and clinical privileges of acute care nurse practitioners in hospital-based

care delivery have been described, (Reuter-Rice, 2013), but roles specific to the PICU providers have not been recently evaluated (Verger et al., 2005). With regulatory and practice environments changes, nurse practitioner practice in the PICU must be reevaluated to understand role implementation and practice variations nationally.

Role recognition.

Since the NP role was created, contention has surrounded incorporating this role into the health care system. Today, APRNs complete formal, advanced-practice education in a clinical role for a specialized patient population, attain national certification, and attain state licensure before practicing (APRN Consensus Work Group, 2008). Despite national education and certification standards, the degree to which NPs may practice independently and the scope of their practice varies by state, creating legal barriers to APRN practice (National Council of State Boards of Nursing [NCSBN], 2017).

Policy barriers are used and create variation among APRN practice as well. Individual health care organizations also place limits on NP practice by imposing restrictive policies and failing to completely integrate NPs into historically physician-centric practice groups (Poghosyan, Nannini, Stone, & Smaldone, 2013). Nurse practitioners, particularly those working in the PICU, are part of an interdisciplinary team of providers (Jessup, 2007). The role of every provider on a health care team should be developed to its fullest to allow for optimal health care manpower utilization (Silver et al., 1967).

Demand for PICU NPs.

Recent enactment of the Patient Protection and Affordable Care Act (ACA) has changed the health-care delivery environment by reframing care delivery models and underscoring quality and care coordination, while altering reimbursement (Carlson, 2013; Hall & Lord, 2014). These changes occurred at a time of physician provider shortage, particularly in pediatrics and intensive care (Basco & Rimsza, 2013; Cassidy, 2012; CHA, 2012 and HRSA, 2006). Concurrently,

APRNs are being integrated into the health care delivery models and are accepted as qualified, cost-effective providers by consumers, institutions, and some policymakers (Dill, Pankow, Erikson, & Shipman, 2013; Federal Trade Commission, 2014; Lowe et al., 2012; IOM, 2011).

The alignment of these events has contributed to demand for expansion of PNP roles and utilization in the delivery of hospital-based child health care, particularly within the PICU (Freed, Dunham, Loveland-Cherry et al., 2011). Nurse practitioners are viewed as high-quality providers whose participation in patient care in the intensive care unit can supplement and extend physician-provider care (Garland & Gershengorn, 2013; Gershengorn, Johnson, & Factor, 2012). To have the greatest influence on pediatric health care delivery, PNPs must practice to the full extent of their education, certification, and licensure, and be completely and effectively integrated into the hospital-provider team. It is imperative that factors influencing PNP practice limitations in the PICU be explored to understand how and why their practice is limited. In doing so, efforts to maximize PNPs' contributions to pediatric intensive care delivery can be instituted.

Research Priorities

Nurse practitioners in the PICU have unique skills and knowledge to care for critically ill patients in various stages of development with acquired and/or congenital illnesses (Connor, LaGrasta, & Hickey, 2015). The population of PNPs is small, and those pursuing careers in the PICU represent only a portion of the total PNP population. With a need for pediatric specialists (Basco & Rimsza, 2013), it is imperative that PNPs practice to the full extent of their education and training. A combination of regulations, SSoP and hospital-based, and restrictions placed through physician supervision can limit care delivery provided by NPs in the PICU. Therefore, an evaluation of the current roles of and restriction upon PNPs' practice as they relate to pediatric health-care delivery is needed if we are to maximize NPs' contribution to pediatric care and increase children's access to critical care services.

Although knowledge of the PNP role and workforce has increased, significant gaps in knowledge of the role of NPs in care delivery within the PICU persist. Prioritization of research gaps is important to strategic advancement in the knowledge of NP roles in PICU care delivery (Table 1). Describing the phenomenon is first step to addressing gaps and enables informed decisions when considering future comparative and interventional research. Descriptive research priorities to advance the knowledge of the role of the NP in PICU care delivery are derived from two interrelated areas of study: (1) the roles and team integration of NPs on care delivery teams in the PICU and (2) the influence of regulations and restrictions on NP practice in the PICU.

Table 1. Considerations for Research Prioritization Related to Gaps in Understanding the Role of NPs in PICU Care Delivery.

Knowledge Gap	Importance of Research	Practicality of Conducting Research
PICU provider team composition	• No existing description; team models have changed to include more NPs • PICU workforce development • Influence on access to PICU care	• Supports future comparison studies • Achieved through cross-sectional descriptive design • National study can be carried out
NP role in PICU care delivery	• NP workforce development • National standard of PICU clinical care delivery • With demand for NPs it's unclear what care roles are in demand • Influence on patient access to PICU care	• Supports future comparison studies • Achieved through cross-sectional descriptive design • Can be evaluated from multiple perspectives • National study can be carried out
How practice environments influence care delivery	• Unknown relationship with workforce size and role actualization of PNPs • Do environments support recruitment and retention of NP providers • Supports evaluation of the level at which restriction to practice are placed on NPs	• Describing supports future practice environment intervention studies • Can be evaluated from multiple perspectives • Generally accepted practice environment classifications
PICU specific quality measures	• Must develop valid and reliable, accepted measures for studying PICU outcomes • Adult measures are not equivalent to pediatric measures	• Not amenable to dissertation research • Independently developed measures are submitted to national organizations (NQF, CMS) for adoption
Diverse descriptive research methods: observation, focus groups, and longitudinal studies	• Lends validity to survey research findings • Diverse descriptive methods can provide depth of knowledge • Longitudinal can evaluate causation	• Observation and focus group techniques are time intensive, but findings may not generalize • Longitudinal design is beyond dissertation scope
PICU provider outcome comparison studies	• Must demonstrate quality and safety of providers • Explores NP contribution to patient outcomes relative to other providers	• Must understand team composition and contribution of a practice environment on care prior to comparing outcomes – current knowledge does not support comparison
Practice environment intervention studies	• A set of factors may create optimum patient and provider outcomes • Environments can lead to recruitment and retention of NPs	• Must understand the environment prior to applying and studying interventions that result in a practice environment change
PICU care needs and utilization	• Supports understanding of demand for PICU workforce • Allows for resource capacity building • Shows regional disparities in care availability	• Beyond the scope of understanding NPs' role in care delivery • Data may be already be available from secondary data sources that requires analysis
Cost of PICU care annually	• Allows for cost of care comparisons to be made between providers • Efforts to reduce costs can be undertaken if costs can be measured	• Beyond the scope of understanding NPs' role in care delivery • Requires extensive economic expertise
Conceptual definitions related to PICUs and children's hospitals	• Consistent definition and measure of these concepts facilitates research • No research is needed for conceptual definition; conceptualization must be clear and intentional for my own research	• No research is necessary to address this gap, expert consensus is required to achieve a definition that can be adopted in all children's hospitals and PICU research

With a grasp of PICU team composition, identification of NP roles, and an awareness of constructive practice settings for PNPs, then strategies can be: 1) developed to encourage positive clinical practice environments for NPs across institutions; 2) instituted to result in national standardization of practice that matches national standards for both education and certification; and 3) adopted to increase patient access to the pediatric specialist workforce focused on PICU care delivery. These strategies have policy implications, but also compel additional research questions.

To compare provider outcomes, gaining an understanding of the PICU team composition and provider roles is essential. To formulate groups for comparisons, a researcher must know: (1) who the PICU providers are on a team, (2) the roles they assume in providing patient care, and (3) how much of each provider's time in the PICU is spent providing direct patient care. When these elements are understood, comparisons can be made about patient outcomes among and between these provider groupings: (a) provider groups that have varying composition (e.g. teams with and without NPs, PICUs with or without 24-hour NP coverage), (b) PICU groups that use similar NP staffing models (e.g. PICUs with 24 hour NP coverage models vs. PICUs with day time NP coverage 7 days a week), and (c) SSoP regulatory practice environments (e.g. least vs. most restrictive states). Understanding the provider-team composition and provider roles ensures comparisons are equivalent relative to a "dose of NP", across settings and studies.

A PICU practice environment results from a confluence of SSoP regulations, hospital policies incorporating supervision, and physician collaboration. Little is known about the effect of SSoP and organizational regulations, physician supervision, and work processes upon the practice and growth of this specialized PICU NP workforce (Bahouth et al., 2013; Becker, Kaplow, Muenzen, & Hartigan, 2006; Kilpatrick et al., 2012). Hospital attributes can be hypothesized as important for NP recruitment and retention and should be investigated. Hospitals that are hoping to increase PNP presence in their PICUs should be invested in

understanding professional work process and organizational characteristics as understanding this information can help them recruit and retain a desired PNP workforce with PNPs working in an optimal role (Freed et al., 2011; Freed, Dunham, Moran, & Spera, 2012).

These factors guided the development of the study-specific aims. From the aims, I identified key concepts (Table 2, columns 1-3).

Table 2. Development of Survey Concepts and Questions.

Specific Aim	Survey Concept	Survey Concept Definition	Survey Question Correlation with Concept	Question Level of Measure
Identify the roles and functions of PNPs working in PICUs within children's hospitals	Patient care and other NP roles[1]	Responsibilities related to delivering patient care and carrying out other professional and administrative roles	4	Ordinal
			5	Ordinal
			6	Ordinal
			7	Nominal
	Qualifications[3]	Education, experience and certifications of NPs	9	I/R
			20	Nominal
	Workload[3]	The volume of patients an individual provider cares for	22	I/R
	Capital[2]	Building resources, equipment and supplies that contribute to PICU care delivery	31	Nominal
Examine the PICU provider team composition within children's hospitals	Temporal conditions / schedule[1]	Shift structure and call requirements	15	Nominal
			16	I/R
			17	Nominal
	Team composition[3]	How many providers work in PICU including their professional background (MD with level of training, NP, PA…) and direct patient care coverage models.	1	Ordinal
			2	Ordinal
			3	Qualitative
			8	I/R
			18	Nominal
			19	I/R
			21	Nominal
	Demand[3]	Intent to hire NPs for PICU	23	Nominal
			24	I/R
			25	I/R
			26	Nominal
			27	Nominal
	Work processes[2]	Regulatory or supervisory requirements that influence APRN practice	10	Nominal
			11	Nominal
			12	Nominal
			13	Nominal
Identify hospital reported internal regulatory characteristics and state regulatory environments influence on the practice of PNPs	Organizational structure[2]	Institutional and unit specific factors that foster to NP presence in the PICU	7	Nominal
			10	Nominal
	Financial[2]	How workers are monetarily compensated	14	Nominal

Specific Aims Key Definitions

The definitions are organized as they occur in the specific aims:

1) Identify the roles and functions of PNPs working in PICU within children's hospitals.

2) Examine the PICU provider team composition within children's hospitals.

3) Identify hospital-reported internal regulatory characteristics and state regulatory environments' influence on the practice of PNPs.

Definitions.

Pediatric Nurse Practitioner (aims 1 and 3).

A PNP is an APRN who practices in a NP role caring for the pediatric population. Pediatric nurse practitioners are educated as primary care and/or acute care NPs (APRN Consensus Work Group, 2008; NONPF, 2013). The NP is:

> prepared to diagnose and treat patients with undifferentiated symptoms as well as those with established diagnoses…provide initial, ongoing, and comprehensive care, includes taking comprehensive histories, providing physical examinations and other health assessment and screening activities, and diagnosing, treating, and managing patients with acute and chronic illnesses and diseases. This includes ordering, performing, supervising, and interpreting laboratory and imaging studies; prescribing medication and durable medical equipment; and making appropriate referrals for patients and families…care includes health promotion, disease prevention, health education, and counseling as well as the diagnosis and management of acute and chronic diseases…(APRN Consensus Work Goup, 2008, pp. 9)

The pediatric population traditionally includes children from birth to age twenty-one. However, in certain situations the age constraint is not in the best interest of patient care.

Patients with congenital diseases who are diagnosed by prenatal testing or who survive into adulthood may be best cared for by a PNP (Lace Network, 2012).

Roles and functions (aim 1).

Professional responsibilities of the APRN that include roles in patient management, nursing and medical education, coordination of care, research, advocacy and consultation (Verger, et al., 2005) and clinical functions related to provision of patient care including: assessment, diagnosis, treatment and management with interventions for patients and their families performed by an APRN (NONPF, 2013; Verger et al., 2005).

Pediatric Intensive Care Unit (aims 1 and 2).

A PICU is a section of a hospital that "contains specialized equipment and highly trained staff to treat patients who have a serious illness or injury." (Torpy, Lynm, & Glass, 2009) Patients of multiple developmental levels with congenital and acquired diseases and illnesses comprise the PICU patient population (Connor, LaGrasta & Hickey, 2015). The size and scope of critical care services vary among PICUs, but all provide monitoring and care for patients with multiple critical conditions (*Fuhrman & Zimmerman*, 2006; Torpy et al., 2009). Care is provided by a multidisciplinary team that includes: physicians, nurses, respiratory therapists, physical therapists, nutritionists, social workers, and pastoral care staff (Furhman & Zimmerman, 2006; Torpy et al., 2009).

Children's hospitals (aims 1 and 2).

Hospitals with "inpatients predominantly age 18 or younger" are designated as children's hospitals (HRSA, nd, http://www.hrsa.gov/opa/eligibilityandregistration/hospitals/childrenshospitals/index.html). Children's hospitals can be free-standing or units within a larger, adult-based system, and recently have become more regionalized centers for advanced quality pediatric specialty care.

Provider (aim 2).

A health care worker including: physicians in all stages of training, nurse practitioners and physicians assistants who have the ability to give orders that influence patient care.

Team composition (aim 2).

The types of providers who deliver care to a patient population in the hospital setting, in this instance PICU providers, and includes: who does work, how many of them are doing the work, work schedules and interactions with non-physician health-care workers (Garland & Gershengorn, 2012).

Internal regulatory characteristic (aim 3).

Hospital- or institution-based credentialing and privileging that permits APRNs to perform patient care "tasks under varying degrees of supervision, collaboration or independently" (Kleinpell et al., 2012, p.16).

Credentialing.

Credentialing is "the process of obtaining, verifying, and assessing the qualifications of a practitioner to provide care or services in or for a health care organization. Credentials are documented evidence of licensure, education, training, experience, or other qualifications." (The Joint Commission, n.d., p. 2)

Privileging.

Privileging is the process whereby a specific scope and content of patient care services (that is clinical privileges) are authorized for a healthcare practitioner by a health care organization, based on an evaluation of the individual's credentials and performance. A "privilege" is defined as an advantage, right, or benefit that is not available to everyone; the rights and advantages enjoyed by a relatively small group of people, usually as a result of education and experience. (The Joint Commission, n.d., p. 2)

State regulatory environment (aim 3).

Formal, legal regulation of APRN practice that occurs state-by-state and consists of three levels of practice authority: 1) APRNs working in states with no scope-of-practice limitations have full practice authority; 2) those who must collaborate in order to practice or prescribe have reduced practice authority; and 3) those who must collaborate to prescribe, diagnose, and treat patients have restricted practice authority (AANP, 2017b).

Practice (aim 3).

Skills and activities permitted to be performed and consistent with a health care provider's education, competence, and responsibility related to the delivery of patient care (NONPF, 2013). Activities may overlap with the practice of other providers (NONPF, 2013).

Dissertation Chapters

Subsequent chapters of this dissertation are manuscripts, submitted for review and publication, complied to describe: a) the supply of and demand for PICU providers (Chapter II); b) the roles of PICU NPs in care delivery and interdisciplinary provider team composition in the PICU (Chapter III); and the alignment of SSOP and organizational regulation of NP practice and prescriptive authority along with organization-level regulation of PICU NP practice (Chapter IV). The final chapter, chapter V, outlines my research trajectory based upon these dissertation findings.

CHAPTER II

PEDIATRIC INTENSIVE CARE UNIT PROVIDER SUPPLY AND DEMAND

This manuscript has been submitted to the journal *Pediatric Critical Care Medicine*, is formatted to the journal specifications, and is currently under review.

Objectives: To describe physicians' and nurse practitioners' (NPs) perceptions of the national and local pediatric intensive care unit (PICU) physician and other provider supply; assess for differences in perceptions of supply; and evaluate the intent of institutions to hire NPs to work in PICUs.

Design: National, quantitative, cross-sectional descriptive study via a postal-mail survey from October 2016 to January 2017.

Setting: Institutions identified in the 2015 American Hospital Association Annual Survey with a pediatric intensive care unit.

Subjects: Pediatric intensive care unit physician medical directors and NPs.

Intervention: None

Measurements and Main Results: There were 152 respondents, representing 126 institutions. Responses were received from 93 (29%) PICU medical directors and 59 (45%) lead NPs. More than half (60%) of all subjects reported the national supply of PICU physicians is less than demand, and 55% reported the local supply of PICU providers (physicians in all stages of training, NPs, and physician assistants) is less than demand. Respondents from institutions that reported local shortages were more likely to employ PICU NPs than those that did not (p=0.03). Of the respondents from institutions that self-reported a local provider shortages (n=99), nearly three-fourths (n=60 of 81 respondents, 74%) reported plans to increase the number of PICU NPs in the next 3 years and one-third (36%) were likely to expand the NP's role in patient care.

Conclusions: Most PICU medical directors and lead NPs perceive the national and local supply of providers to be less than the demand. Where local demand is exceeded by supply, innovative models of care are being utilized. The demand for more PICU NPs with expanded roles in care delivery was reported. Further evaluation of models of care and provider roles in care delivery can contribute to aligning provider supply with demand for care delivery.
Key Words: pediatric; critical care; workforce; supply; demand; nurse practitioner

Introduction and Background

In 2012, there were more than 2 million pediatric hospital admissions in the United States (1). Although the number of admissions to children's hospitals is decreasing, the number of admissions to the pediatric intensive care unit (PICU) has been increasing since the 1990s with patients presenting with higher acuity and complexity (2, 3, 4, 5). Although national estimates of the critical care workforce predict an abundant supply of critical care providers, these estimates focus primarily on the adult critical care workforce (6). The American Academy of Pediatrics has emphasized the importance of pediatric subspecialty workforce policy and planning (7). Knowledge of the pediatric-focused critical care workforce is limited, but studies suggest that, despite recent efforts to increase the physician workforce, there may be an inadequate supply of PICU physicians (6, 8, 9).

Barriers to growing the PICU physician workforce have resulted in innovative workforce models of care to compensate for the inadequate supply of such physicians (10, 11). These models often rely on the involvement of nurse practitioners (NPs) to deliver patient care as part of the health care provider team (12, 13, 14). As NPs are increasingly used as health care providers in hospital-based settings (15, 16, 17, 18, 19), PICU physicians have shown a willingness to incorporate NPs into provider teams (20). Given the increasing size of the acute

care NP workforce and uncertainty over the adequacy of the PICU physician workforce, the current demand for NP providers in the PICU is uncertain.

The purpose of this study was to describe PICU medical director and NP perceptions of the national PICU physician supply and the local supply of providers, namely physicians, NPs and physician assistants; assess differences in perceptions of the national and local supply; and to evaluate the medical director and NPs' assessment of their institutional intent to incorporate NPs into the PICU workforce.

Materials and Methods

A national, quantitative, cross-sectional descriptive study of PICU medical directors and lead (most senior or NP serving in a supervisory role among a group of PICU NPs) PICU NPs was conducted. A novel survey instrument was developed to assess the current composition of the PICU workforce and role of NPs in providing PICU care. Concepts were operationally defined based upon literature reviews and the author's experience. A 34-item survey was developed based upon concepts derived from a synthesis of frameworks for NP participation in care delivery (Table 3); this article focuses on the concept of provider demand.

Table 3. PICU Workforce Survey Concepts, Conceptual Definitions, and Key Variables Related to Provider Demand.

Survey Concept	Conceptual Definition	Number of Survey Questions Correlating with Concept
Demand*	Need for PICU physician providers and intent to hire PICU NPs. • Perception of the supply of PICU physicians in the U.S. • Self-report of the local supply of PICU *providers* o *Provider* is defined as physicians in all stages of training, nurse practitioners and physician assistants who have the ability to give orders that influence patient care. • Likelihood to and meaningfulness of: o Increasing the number of PICU NPs, o Expanding the scope of PICU NPs' role in patient care o Expanding the number of physician training programs o Improving the work/life balance for PICU attending physicians • Strategic plan regarding the employment of PICU NPs in next 3 years	9
Team composition	How many providers work in PICU including their professional background and direct patient care coverage models.	7
Qualifications	Education, experience, and certifications of NPs	2
Patient care and other NP roles	Responsibilities related to delivering patient care and carrying out professional and administrative roles	4
Workload	The volume of patients an individual provider cares for	1
Temporal conditions / schedule	Shift structure and call requirements	3
Organizational structure	Institutional and unit-specific factors that foster to NP presence in the PICU	2
Work processes	Regulatory or supervisory requirements that influence APRN practice	4
Capital	Building resources, equipment, and supplies that contribute to PICU care delivery	1
Financial	How workers are monetarily compensated	1

Five items related to PICU provider supply and demand were included in the survey (Table 3). Questions on respondents' perceptions of the national supply of PICU physicians and

of the local provider (physicians in all stages of training, nurse practitioners and physician assistants who have the ability to give orders that influence patient care) supply were reported on a 5-point likert-like scale. This analysis reports a 4-point scale as no respondents reported that supply was much greater than demand. Interventions acknowledged to address PICU provider shortages were assessed with a 5-point likert-like scale for their likelihood to occur and meaningfulness in ability to offset a local provider shortage (6). Strategic planning regarding intentions to grow the local PICU NP workforce were also examined.

Variables that have been associated with healthcare workforce size including COTH membership status and state scope-of-practice (SSOP) regulations, were used to compare perceptions of supply and demand (8, 21). Hospital characteristics including state, hospital size, and COTH membership were obtained from the 2015 American Hospital Association Annual Survey (22). Based upon state, the American Association of Nurse Practitioners respondents were categorized into SSOP regulatory environments at the time of data collection (23). The SSOP environments are: 1) full practice authority; i.e. NPs may evaluate, diagnose, and manage treatment of patients - including prescribing medications under the authority of the board of nursing; 2) reduced practice authority; i.e. a collaborative agreement with a physician is required for at least one of the practice elements: evaluation, diagnosis, or treatment - including prescribing medications; and 3) restricted practice; i.e. there must be physician supervision, delegation or team-management to prescribe, diagnose, and/or manage patient treatment (23).

Two independent researchers conducted preliminary item validity testing using a card sort method. Each survey item was assigned to a conceptual category within the study framework with greater than 75% agreement. Seven PICU providers unrelated to the study team participated in pilot testing for reliability, readability, and acceptability (24).

Institutions identified as operating a PICU in the 2015 American Hospital Association Annual Survey (21) were contacted to confirm the continued operation of a PICU. Surveys were

sent to a medical director at each operational PICU (n = 326). Telephone calls were made to each PICU to determine the presence of a PICU NP and, if a NP was employed, the lead NP (most senior or NP serving in a supervisory role among a group of PICU NPs) was identified, an additional survey was sent to the lead PICU NP (n = 140). The Vanderbilt University Medical Center's Institutional Review Board approved this study before recruitment and distribution of any study materials.

Mailings occurred between October 2016 and January 2017. After an initial introductory postcard, three separate survey mailings were sent to eligible participants. Survey packets included a cover letter; a definition of key concepts; a paper survey, which included an electronic participation option; and a self-addressed, stamped envelope. Returning a survey served as consent. Participants (one medical director and one lead PICU NP for each PICU) who returned a completed survey were eligible for a drawing of a $250 visa gift card. Participants returned surveys electronically via a secure, web-based platform, Research Electronic Data Capture (REDCap) (n = 29, 19%) hosted at Vanderbilt University (25) or by postal-mail (n = 123, 81%). Mailed survey responses were double-entered by a study team member into REDCap.

After the survey was closed, data analysis was performed using IBM SPSS Statistics 23.0 (IBM Corporation, 2015). For institutional-level data, institutions were included in the analysis if either a medical director or a NP responded. If both providers responded from the same institution, the medical director's response was included in the analysis of institutional-level responses to have consistency in respondent roles, given most sample institutions only had eligible physician respondents.

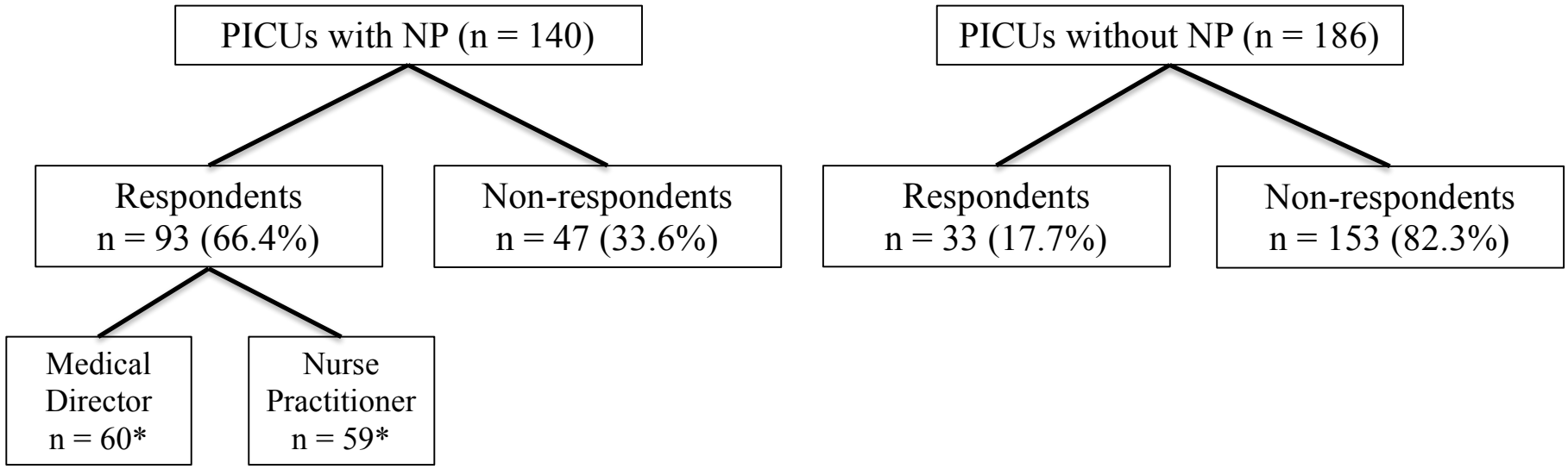
Most of the survey responses were nominal or ordinal in nature and thus were summarized using counts and percentages. Continuous data distributions were summarized using median and inter-quartile range (IQR) due to skewness. Tests of differences between groups were conducted using either Chi- Square test of independence (nominal, ordinal data) or Mann

Whitney test (continuous). An alpha of 0.05 ($p < 0.05$) was used for determining statistical significance.

Results

Survey Respondents and Response Rates.

The survey was sent to 466 potential respondents (326 PICU medical directors from 326 institutions and 140 lead PICU NPs from 140 institutions). Responses were received from a PICU medical director and/or NP working in 126 institutions (39% of all U.S. institutions with a PICU). In total, 93 (29%) medical directors responded, 59 (45%) NPs responded (n = 152). Both the medical director and the lead NP responded from 26 institutions (Figure 2).



*A Medical Director and Nurse Practitioner both responded from 26 institutions
Total Medical Director response rate 93/322 (28.9%) and Nurse Practitioner 59/132 (44.7%).

Figure 2. Institutional Response Rates from PICUs in the United States

Characteristics of the institutions with respondents (n = 126) and those not responding are summarized in Table 4. Compared to those institutions without respondents (n = 196), institutions with respondents (n = 126) were more likely to be members of the Council of Teaching Hospitals (COTH, 57% vs. 42%, p=0.007). Differences in size, region, or state regulation of nurse practitioner practice were not statistically significant ($p > 0.05$, Table 4).

Table 4. Characteristics of Institutions Identified as Having a PICU.

	Total Institutions, (n = 322)	Respondent Institutions, (n=126)	Non-Respondent Institutions (n = 196)	p-value
	N (%)	N (%)	N (%)	
American Hospital Association Region				0.438
CT, MA, ME, NH, RI, VT	13 (4.0)	8 (6.3)	5 (2.6)	
NJ, NY, PA	46 (14.3)	19 (15.1)	27 (13.8)	
DE, KY, MD, NC, VA, WV	65 (20.2)	28 (22.2)	37 (19.0)	
AL, FL, GA, MS, SC, TN	47 (14.9)	16 (12.7)	31 (15.9)	
IL, IN, MI, OH, WI	14 (4.3)	8 (6.3)	6 (3.1)	
IA, KS, MO, MN, NE, ND, SD	32 (9.9)	9 (7.1)	23 (11.8)	
AR, LA, OK, TX	41 (12.7)	14 (11.1)	27 (13.8)	
AZ, CO, ID, MT, NM, UT, WY	24 (7.5)	10 (7.9)	14 (7.2)	
AK, CA, HI, NV, OR, WA	39 (12.1)	14 (11.1)	25 (12.8)	
Hospital Size				0.380
0-200 beds	28 (8.8)	9 (7.1)	19 (9.8)	
201-300 beds	33 (10.2)	17 (13.5)	16 (8.2)	
301-400 beds	59 (18.4)	18 (14.3)	41 (21.1)	
401-500 beds	49 (15.3)	21 (16.7)	28 (14.4)	
501+ beds	151 (47.2)	61 (48.4)	90 (46.4)	
Council Of Teaching Hospitals Status				
Member	152 (47.2)	72 (57.1)[a]	80 (41.7)[b]	**0.007**
Non-Member	166 (51.6)	54 (42.9)[a]	112 (58.3)[b]	
Employ PICU Nurse Practitioners				
Yes		93 (73.8)		
Nurse Practitioner state scope-of-practice				0.725
Full Practice: AK, AZ, CO, CT, DC, HI, ID, IA, ME, MD, MN, MT, NE, NV, NH, NM, ND, OR, RI, VT, WA, WY	60 (18.7)	21 (16.7)	39 (20.0)	
Reduced Practice: AL, AR, DE, IL, IN, KS, KY, LA, MS, NJ, NY, OH, PA, SD, UT, WV, WI	113 (35.2)	46 (36.5)	67 (34.4)	
Restricted Practice: CA, FL, GA, MA, MI, MO, NC, OK, SC, TN, TX, VA	148 (46.1)	59 (46.8)	89 (45.6)	

Characteristics of the individual respondents are summarized in Table 5. Medical director and lead PICU NP respondents were predominantly white (n = 128, 90%) and employed at their current institution for 10 years. Compared to the medical directors, the PICU NPs were

more likely to be female (88% vs. 34%), younger (40 vs. 54 years old), and board-certified PICU providers for a shorter period of time (18 vs. 9 years) (all $p < 0.001$, Table 5).

Table 5. Characteristics of PICU Medical Directors and PICU NP Respondents

Respondent Characteristics	All respondents (n=152)*	Medical Director Respondents (n=93)*	Nurse Practitioner Respondents (n=59)*	p-value
	(N, %)	(N, %)	(N, %)	
Gender				**<0.001**
Male	68 (45.3)	61 (66.3)	7 (12.1)	
Female	82 (54.7)	31 (33.7)	51 (87.9)	
Race				
White	128 (84.2)	72 (77.4)	56 (94.9)	**0.004**
Other	24 (15.8)	21 (22.6)	3 (5.1)	
	Median (IQR)	Median (IQR)	Median (IQR)	
Age	50 (40, 57)	54 (46.25, 60)	40 (33.75, 50.75)	**<0.001**
Years of Board Certification as PICU provider	15 (7.5, 20)	18.0 (11.25, 25)	9 (3.5, 14.5)	**<0.001**
Years Working at Current Employer	10 (4, 18)	11.0 (6, 18.75)	10 (2, 18)	0.388

National and Local PICU Provider Supply.

Nearly three-fifths of respondents (n = 89 of 145, 60%) stated that the national supply of PICU physicians was somewhat less (n = 72, 48%) or much less (n = 17, 12%) than demand and only 6% (n = 9 of 145) reported national supply was greater than demand (Table 6). With regard to self-report of the local supply of PICU providers (defined as physicians, nurse practitioners, and physician assistants), 55% (n = 84 of 152) of respondents indicated the local supply was somewhat less or much less than demand.

Among pairs of medical directors and lead PICU NPs working in the same institution (n = 26), the self-report of the local PICU provider workforce supply was not statistically significantly different (p = 0.204) and neither were perceptions about national physician supply for those same respondents (p = 0.206). Overall, 62% (n = 32) of the physician and NP pairs indicated the national supply was less than demand and 70% (n = 35) self-reported a local PICU provider shortage.

Summaries and comparisons of reports about supply by respondents' institutional COTH membership status, employment of a PICU NP, and state NP scope-of-practice are also summarized in Table 6. Respondents from institutions that employ PICU NPs were more likely to self-report local provider shortages than institutions that do not employ PICU NPs (61% vs. 33%, p = 0.030). No other statistically significant differences in respondent perceptions of the national supply of PICU physicians in the U.S. or self-report of local provider supply were observed based on role (physician or nurse practitioners), institutional characteristics (region, hospital size, COTH membership), or NP SSOP environment (p >0.05).

Table 6. PICU Providers' Perception of the National Supply of PICU Physicians who Work in Patient Care in the United States and Self-Report of the Local Supply of PICU Providers who Work in Patient Care in Respondent Institutions in the United States.

	Total	COTH Status*		Employ PICU NP		State NP Scope-of-Practice		
Perception of the supply of PICU physicians in the U.S.	(n =145)	Member (n=85)	Non-Member (n=60)	Yes (n=114)	No (n=31)	Full Practice (n=28)	Reduced Practice (n=50)	Restricted Practice (n=67)
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Greater than demand	9 (6.2)	6 (7.1)	3 (5.0)	8 (7.0)	1 (3.2)	3 (10.7)	2 (4.0)	4 (6.0)
About equal to demand	47 (32.4)	31 (36.5)	16 (26.7)	40 (35.1)	7 (22.6)	7 (25.0)	17 (34.0)	23 (34.3)
Somewhat less than demand	72 (49.7)	43 (50.6)	29 (48.3)	53 (46.5)	19 (61.3)	13 (46.4)	28 (56.0)	31 (46.3)
Much less than demand	17 (11.7)	5 (5.9)	12 (20.0)	13 (11.4)	4 (12.9)	5 (17.9)	3 (6.0)	9 (13.4)
		p = 0.063		p = 0.413		p = 0.546		
Perception of the local supply of PICU providers	(n =152)	Member (n=90)	Non-Member (n=62)	Yes (n=119)	No (n=33)	Full Practice (n=28)	Reduced Practice (n=53)	Restricted Practice (n=71)
Greater than demand	7 (4.6)	6 (6.7)	1 (1.6)	4 (3.4)[a]	3 (9.1)[a]	3 (10.7)	3 (5.7)	1 (1.4)
About equal to demand	61 (40.1)	33 (36.7)	28 (45.2)	42 (35.3)[a]	19 (57.6)[b]	9 (32.1)	20 (37.7)	32 (45.1)
Somewhat less than demand	60 (39.5)	37 (41.1)	23 (37.1)	53 (44.5)[a]	7 (21.2)[b]	10 (35.7)	23 (43.4)	27 (38.0)
Much less than demand	24 (15.8)	14 (15.5)	10 (16.1)	20 (16.8)[a]	4 (12.1)[a]	6 (21.4)	7 (13.2)	11 (15.5)
		p = 0.415		**p = 0.030**		p = 0.416		

Intent to Employ PICU Nurse Practitioners.

Respondents from institutions with PICU NPs were more likely to increase the number of PICU NPs (57% vs. 9%, $p < 0.001$) and expand the scope of the NP's role in care than respondents from institutions without NPs (43% vs. 6%, $p < 0.001$) (Table 7). Among institutions with respondents that self-reported a local provider shortage (n = 99, 79%), more than 80% (n = 82) reported that increasing the number of NPs working in the PICU would be a meaningful change to address a local provider shortage. Two-thirds (n = 68, 69%) agreed expanding the scope of the NP role in patient care would be another meaningful change to address a local shortage. Compared to respondents from institutions not employing PICU NPs (n = 20), those from institutions employing PICU NPs (n = 79) were more likely to report that they planned to increase the number of PICU NPs and expand the scope of NPs' roles in patient care (61% vs. 15%, $p < 0.001$ and 43% vs. 10%, $p = 0.002$ respectively). Formal, strategic planning aimed at increasing the number of PICU NPs was reported by 74% (n = 60 of 81 responses) of respondents from institutions with a self-reported local shortage, 78% (n = 57) from institutions that currently employ PICU NPs, and 38% (n = 3) from those that do not currently employ PICU NPs ($p = 0.006$, Table 7).

Table 7. Intent to Employ PICU NPs For All Institutions and Among Those Institutions that Self-Report a Local Provider Shortage Compared by Current Employment of PICU Nurse Practitioners.

	Employ PICU Nurse Practitioners, N (%) N = 93*	Do Not Employ PICU Nurse Practitioners, N (%) N = 33*	p-value
Likelihood to increase the number of PICU NPs			**<0.001**
Very likely	29 (31.2)[a]	2 (6.3)[a]	
Likely	24 (25.8)[a]	1 (3.1)[b]	
Unlikely	22 (23.7)[a]	7 (21.9)[a]	
Very unlikely	18 (19.4)[a]	22 (68.8)[b]	
Likelihood to expand the scope of NP's role in patient care			**<0.001**
Very likely	10 (10.8)[a]	0 (0)[a]	
Likely	30 (32.3)[a]	2 (6.3)[b]	
Unlikely	33 (35.5)[a]	7 (21.9)[a]	
Very unlikely	20 (21.5)[a]	23 (71.9)[b]	
Among Institutions with a Self-report of Local Provider Shortages	(n = 79)*	(n = 20)*	
Likelihood to increase the number of PICU NPs			**<0.001**
Very likely	26 (32.9)[a]	2 (10.0)[b]	
Likely	22 (27.8)[a]	1 (5.0)[b]	
Unlikely	19 (24.1)	5 (25.0)	
Very unlikely	12 (15.2)[a]	12 (60.0)[b]	
Likelihood to expand the scope of NP's role in patient care			**0.002**
Very likely	9 (11.4)[a]	0 (0)[a]	
Likely	25 (31.6)[a]	2 (10)[a]	
Unlikely	30 (38.0)[a]	6 (30.0)[a]	
Very unlikely	15 (19.0)[a]	12 (60.0)[b]	
Strategic plan regarding PICU NPs in next 3 years*	(n=73)	(n=8)	**0.006**
Increase number of PICU NPs	57 (78.1)[a]	3 (37.5)[b]	
Decrease number of PICU NPs	5 (6.8)	0 (0)	
No change to number of PICU NPs	11 (15.1)[a]	5 (62.5)[b]	

Discussion

More than half of the PICU medical directors and lead PICU NP respondents believe the national and local supply of PICU providers are less than demand. There were no significant differences in PICU medial directors and lead NPs' perceptions of the national PICU physician supply. However, respondents from institutions that employ PICU NPs were statistically

significantly more likely to report a local shortage of PICU providers. A majority of the institutions that identified a local provider shortage reported plans to increase the number of PICU NPs and more than 40% indicated they planned to expand the NP roles in patient care.

National and Local PICU Provider Supply.

These findings are consistent with the limited reports of the pediatric critical care medicine workforce. A shortage of physicians in the critical care workforce has been reported (6, 26, 27) and inferred in pediatrics from practice patterns and unfilled positions (9) and is consistent with perceptions reported by a majority of respondents in this survey. However, this study diverges from the 2016 Health Resources and Services Administration critical care workforce estimates that predicted a surplus of providers. The divergence is likely related to the study's focus on the adult critical care workforce (6), which further highlights the significance of and need for pediatric workforce evaluation and planning (7).

Physicians-in-training and NPs can increase the available number of providers on a PICU team. However, prior studies have not shown a reduction in the workload of critical care attending physicians with the addition of physicians-in-training to the care team (8). The finding is consistent with this study, which found no statistically significant difference in self-reports of the local provider shortages by COTH membership status, where member institutions would have the addition of physicians-in-training to their care teams. With regard to NP SSOP regulations, fewer restrictions on NP practice have been associated with decreased provider shortages in primary care studies (21), but no similar report of improvement in provider supply was seen in this PICU study. Future studies to evaluate how the PICU provider team's size and composition can be modified to optimize effectiveness and address workforce shortages are needed given the demand for PICU providers.

In this study, NPs were statistically significantly more likely to be employed in institutions with a self-reported local provider shortage than institutions that did not self-report a

shortage. This would be expected as institutions with a provider shortage seek innovate care delivery models (12, 13, 14, 28). Inclusion of NPs and PAs on interdisciplinary care teams in the ICU has demonstrated similar quality outcomes as physician-only models (10, 29, 30). While the use of interdisciplinary teams is growing, rigorous evaluation of diverse models of interdisciplinary care is needed to understand the contribution of providers to care delivery and maximize clinical outcomes.

Nurse Practitioner Employment.

The rate of growth in the pediatric nurse practitioner workforce has been slower than other NP specialties (17). While, the contributions of NPs to PICU care may be smaller in scale than those in adult critical care medicine (6), nevertheless they are a unique and growing sector of the PICU workforce. In a 2010 pediatric workforce survey, 61% of a sample of pediatric critical care physicians reported they would increase the number of PICU NPs and 34% reported they would expand the scope of the PICU NP role (20). The current desire to increase the number of PICU NPs is comparable to this prior study of PICU physicians (60% among hospitals with provider shortages), and even greater among institutions that currently employ PICU NPs (78%). Among all institutions, the reported likelihood to expand the scope of the NP role in patient care is also similar to the prior study (33%) and slightly higher in areas of self-reported local shortage (36%) (20). No significant changes in employment of NPs and self-report of local shortage were associated with SSOP, and further evaluation of these influence of regulations on the role of NPs in the PICU should be considered. As the possibility of NP employment in the PICU increases, support for and alignment of the PICU NPs' education and certification as acute-care pediatric nurse practitioners will be important for employers to consider in making the role implementation and scope expansion successful (31).

Limitations.

The institutional response was almost 40%, but the medical director response rate approached only 30% and the NP response rate was 45%. The timing of the survey, during a U.S. general election and over winter holidays, may have contributed to the low response rate and will be considered when conducting future studies. Despite a large number of respondents from states with restricted practice, institutions were generally representative of the national distribution of institutional characteristics. There was a difference in response rate among medical directors from institutions that do and do not currently employ nurse practitioners, which limits generalizability of these findings to PICU without NPs.

Despite these limitations, this study contributes to knowledge of the national and local PICU provider supply. The role of NPs on an interdisciplinary PICU team is affirmed and is important to emphasize in NP education programs.

Conclusions

Most PICU medical directors and lead NPs perceive the national and local supply of PICU providers to be less than demand. However, in locations where the local demand is exceeded by supply, innovative models of care that include employment of nurse practitioners are being used. In institutions that self-report local provider shortages, there is a demand for more PICU NPs and an expanded scope of the NP's role in patient care. Further evaluation of innovative models of care and provider roles in care delivery can contribute to aligning PICU provider supply with demand for care delivery.

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CHAPTER III

INTERDISCIPLINARY TEAMS and the ROLE OF NURSE PRACTITIONERS in PEDIATRIC INTENSIVE CARE UNITS

This manuscript has been submitted to the journal *AACN Advanced Critical Care*, is formatted to the journal specifications, and is under review.

Objective: To describe 1) the members comprising PICU interdisciplinary provider teams and 2) PICU NP labor input, working conditions, and clinical practice.

Methods: A national, quantitative, cross-sectional descriptive postal-mail survey of PICU medical directors and nurse practitioners (NPs) to describe provider team members (physician, NP, and physician assistants), PICU NP labor inputs, working conditions (credentials, size of NP team, schedule), and clinical practice (responsibilities, procedural competencies and roles). Descriptive statistics, cross-tabulations, and Chi-square tests were used to test differences among institutional practices and provider reports of clinical practice.

Results: Responses from 97 (30%) PICU medical directors and 59 (42%) PICU NPs representing 126 institutions (39%). The types of providers on interdisciplinary PICU teams differed between institutions with and without NPs. PICUs employ, on average, three full-time NPs who work predominantly during the day, with an average NP-to-patient ratio of 1 to 5. The clinical practice reported by medical directors was consistent with NP reports and similar to prior NP-only reports.

Conclusions: NPs are being integrated into interdisciplinary PICU teams but institutional variation in team composition exists. Investigating models of care contributes to the understanding how models influence positive patient and organizational outcomes and may change future role implementation.

Keywords: Interdisciplinary team, pediatric intensive care unit, nurse practitioner roles

Introduction and Background

In 2012, more than 2 million children were admitted to United States hospitals.[1] Children are being hospitalized with increased illness severity and more chronic illness.[2-6] Although there was a nearly one percent decrease in the number of pediatric hospitalizations from 2008 to 2012, the number of admissions to the pediatric intensive care unit (PICU) has increased.[6-9]

Despite a significant demand there is a shortage of pediatric intensivists. PICU provider workforce shortages have been exacerbated by restrictions to training physician work hours.[10-13] As the role of the nurse practitioner (NP) has developed, NPs have been recognized as safe, high-quality health care providers and over the last 20 years have been increasingly employed as pediatric hospital-based providers.[13-19] As members of interdisciplinary teams, NPs who work in the PICU care for acute, chronic, and critically ill children and adults with chronic childhood illness.[20] Although PICU NPs are increasingly members of interdisciplinary care teams, the roles of PICU NPs in patient care delivery have not been widely evaluated.[21, 22]

Interdisciplinary care, teamwork, and collaboration are important components of delivering high-quality healthcare in all clinical settings.[23] Recently, health care policy has focused on interdisciplinary team care as a means to improve access to care and health outcomes.[24] Successful interdisciplinary teams maximize the contributions of each team members' knowledge, skills and professional expertise.[23] In critical care, interdisciplinary teams that include NPs have demonstrated improvements in patient safety, guideline adherence, and quality outcomes, along with lower patient mortality.[25-29] However, most interdisciplinary studies exclude pediatric teams.[27]

In the PICU, interdisciplinary teams are comprised of members from diverse educational backgrounds, including: medicine, nursing, pharmacy, rehabilitative therapies, nutrition, and

social work, among others. To understand how interdisciplinary PICU teams influence patient outcomes, attributes of the team and healthcare professionals' roles must be described first. This study describes one portion of the PICU interdisciplinary team, "the providers" - PICU attending physicians (intensivists, pulmonologists and/or anesthesiologists), physicians in all stages of training (critical care fellows, pediatric and non-pediatric residents, and medical students), and advanced practice providers (nurse practitioners and physician assistants) who serve as leaders on interdisciplinary PICU teams. These providers may have similar roles and have been granted institutional privileges to diagnose, manage, and treat PICU patients.[19, 30] Yet a paucity of information exists regarding the composition of PICU interdisciplinary provider teams and providers' roles in patient care.

The purposes of this study paper are: 1) to describe the two chief members of the PICU interdisciplinary provider teams, physicians and advanced practice providers; and 2) to describe PICU NP labor input, working conditions, and clinical practice roles and responsibilities.

Methods

Participants.

A national, quantitative, cross-sectional descriptive survey of PICU medical directors and lead (most senior or NP serving in a supervisory role among a group of PICU NPs) PICU NPs was conducted. Using the 2015 American Hospital Association Annual Survey Database, institutions that reported a PICU were identified.[31] The study primary investigator placed telephone calls to each institution in the Summer of 2016 to confirm the continued operation of the PICU and determine the presence of a PICU NP. If a PICU NP was employed, an attempt to identify a lead NP (most senior or NP serving in a supervisory role among a group of PICU NPs) was made. Surveys were sent to the medical director at each operational PICU (n = 326), and a survey was sent to lead PICU NPs (n = 140).

Procedures.

The development of a 34-item survey instrument was based upon concepts derived from a synthesis of frameworks that examine the role of NPs in care delivery. The Vanderbilt University Medical Center's Institutional Review Board approved this study before the recruitment and distribution of study materials.

An introductory postcard and three separate survey mailings were sent via U.S. postal mail between October 2016 and January 2017. Survey mailings included a cover letter; a definition of key concepts; a paper survey, which included an electronic participation option; and a self-addressed, stamped return envelope. Participants (one medical director and one lead PICU NP) who returned a completed survey were eligible for a drawing of a $250 visa gift card.

Surveys were returned electronically (n = 29, 19%) or by mail (n = 123, 81%). A secure, web-based platform, Research Electronic Data Capture (REDCap), hosted at Vanderbilt University, was used to capture responses. Participants recorded their own responses electronically or mailed survey responses were double-entered by the primary investigator into the REDCap system. Returning a survey indicated participant consent.

Variables.

To assess team composition, the survey instrument included the pediatric attending physicians (intensivists, pulmonologists and/or anesthesiologists), physicians in all stages of training (critical care fellows, pediatric and non-pediatric residents, and medical students), and advanced practice providers (nurse practitioners and physician assistants). Respondents were asked to indicate the presence of a provider, but not the number of providers on the interdisciplinary provider team. Respondents were also asked to report the number of PICU interdisciplinary teams that work each day in the PICU.

Variables were included that described PICU NP labor inputs, working conditions, and patient care roles. PICU NP labor inputs included measures of labor quantity and descriptive

attributes.[32] The labor quantity variables included in this study were: number of full-time, part-time, and per-diem PICU NPs employed in the PICU; full-time equivalents were not measured. The PICU NP clinical certifications as primary or acute care pediatric nurse practitioners or family nurse practitioners were reported as the descriptive attribute.

Working conditions included: work schedules, shift length, and workload.[33] The routine presence or absence of PICU NPs was assessed on day and night shifts during the weekdays and on weekends. A typical patient workload on day and night shifts, during the week, and on weekends was reported. The predominant shift length was reported for weekday and weekend-day shifts. For institutions that did not have NP presence 24/7, in the absence of PICU NPs, the provider who was primarily responsible for the care of the NP's patients was ascertained.

Clinical practice is guided by and should be consistent with the PICU NP's education, competence, and responsibilities related to the delivery of patient care.[34] For this study, major areas of clinical practice were assessed: 1) clinical responsibilities: day-to-day patient management, providing education and training, and leading quality improvement; 2) requirement to maintain procedural competency; and 3) clinical roles as respondents to acute patient-care situations within and outside of the PICU. [15, 34, 35]

Data Analysis.

Data analyses were performed using IBM SPSS Statistics 23.0 (IBM Corporation, 2015). Frequency distributions were used to summarize the nominal and ordinal data distributions; median and inter-quartile range (IQR) were used for the continuous data due to skewness. Differences in response distributions among institutional practices and provider reports of clinical practice were tested using Chi-Square Tests of Independence. An alpha of 0.05 ($p < 0.05$) was used for determining statistical significance.

Results

Responses were received from 97 (30%) PICU medical directors and 59 (42%) lead

PICU NPs representing 126 unique institutions (39%). Paired responses, one from the medical director and another from the lead NP, were received from 26 institutions. For institutional-level data, the physician response was included in the analyses for consistency in respondent roles.

Interdisciplinary Team Composition.

Nearly three-fourths of respondents were PICU medical directors or lead PICU NPs from institutions that employ PICU NPs (n = 93) (Table 8). Institutions that employed PICU NPs had larger PICUs than those that did not employ PICU NPs (median = 20 licensed beds with average daily census of 14 patients vs. median = 10 licensed beds with an average daily census of 6 patients, both $p < 0.001$). Compared to institutions that employed PICU NPs, institutions that did not employ NPs were more likely to report having only one PICU provider team working in the PICU each day (73% vs. 44%, $p = 0.017$) and as many as four PICU provider teams were reported to work daily in PICUs with NPs. The institutions without PICU NPs were also less likely to have a separate pediatric cardiac intensive care unit (15% vs. 47%) or offer pediatric cardiothoracic surgery (23% vs. 67%) than those institutions that employ PICU NPs ($p < 0.001$). (Table 8).

Table 8. PICU Interdisciplinary Provider Team Composition in PICUs as Reported by Institutions that Employ PICU NPs and Those Without PICU NPs in the United States

	Total PICUs N (%)	**Employ Nurse Practitioners**, N (%)	**Do Not Employ PICU Nurse Practitioners** N (%)	p-value
	N = 126	**N=93**	**N = 33**	
Number of Licensed PICU Beds, Median, (IQR)		20 (14, 28)	10 (8, 12)	**< 0.001**
Average PICU Daily Census, Median, (IQR)		14 (10, 20)	6 (4, 8)	**< 0.001**
Separate PICU and Pediatric Cardiac ICU				**< 0.001**
Yes	49 (38.9)	44 (47.3)[a]	5 (15.2)[b]	
Number of Licensed Beds Median, (IQR)		15 (12, 24)	16 (7, 18)	
No, but care for cardiac patients in the PICU	34 (27.0)	28 (30.1)[a]	6 (18.2)[a]	
No, the institution does not offer cardiac surgery	43 (34.1)	21 (22.6)[a]	22 (66.7)[b]	
Admission Policy*				0.097
Open Unit	18 (14.8)	17 (18.5)[a]	1 (3.3)[b]	
Semi-Open Unit	34 (27.9)	23 (25.0)[a]	11 (36.7)[a]	
Closed Unit	70 (57.3)	52 (56.5)[a]	18 (60.0)[a]	
Number of ICU teams in PICU each day				
1 team	65 (51.6)	41 (44.1)[a]	24 (72.7)[b]	**0.017**
2 teams	36 (28.6)	30 (32.3)[a]	6 (18.2)[a]	
3+ teams	25 (19.8)	22 (23.7)[a]	3 (9.1)[a]	

* Open Unit: a PICU where patients receive care primarily from physicians with responsibilities outside the ICU. Critical care specialists are often available on a consultation basis. Semi-open Unit: a PICU where patients receive care primarily from a physician with responsibilities outside the ICU or exclusively by critical-care specialists or teams based upon the nature of the illness necessitating PICU admission; e.g. surgical patient. Closed Unit: a PICU where patients are cared for exclusively by critical-care specialists or teams.

The composition of the interdisciplinary PICU provider team is summarized in Table 9. All respondents (n = 125) reported that pediatric intensivists were members of the PICU attending physician team, while only 29% (n = 37) reported that the team included a pediatric pulmonologist and 19% (n = 24) a pediatric anesthesiologist. If an institution employed PICU NPs, it was statistically significantly more likely to also have pediatric critical care fellows, non-pediatric residents, and physician assistants (PAs) working on its interdisciplinary PICU provider team than institutions who did not employ PICU NPs ($p < 0.05$). (Table 9)

Table 9. PICU Interdisciplinary Provider Team Composition as Reported by Institutions that Employ PICU NPs and Those Without PICU NPs in the United States

	Total PICUs N (%)	**Employ PICU Nurse Practitioners** N (%)	**Do Not Employ PICU Nurse Practitioners** N (%)	p-value
Team Composition	**N = 125**	**N=91**	**N = 34**	
Pediatric Pulmonologists	37 (29.6)	27 (29.8)	10 (29.4)	0.753
Pediatric Anesthesiologists	24 (19.2)	16 (17.6)	8 (23.5)	0.825
Pediatric Critical Care Fellows	46 (37.7)	44 (48.4)	2 (6.5)	**<0.001**
Pediatric Residents	95 (76.0)	73 (80.2)	22 (64.7)	0.076
Non-Pediatric Residents	68 (54.9)	55 (60.4)	13 (38.2)	**0.036**
Medical Students	84 (67.2)	63 (69.2)	21 (61.7)	0.627
Physician Assistants	34 (27.9)	31 (34.1)	3 (9.7)	**0.009**

Labor Inputs and Working Conditions.

Institutional-level responses, from a PICU medical director or lead PICU NP (n = 93), regarding PICU NP labor inputs and working conditions are summarized in Table 10. Although most (90%) respondents indicated that the institution hired PICU NPs that were certified as acute care pediatric nurse practitioners, only 44% reported that acute care certification was required for PICU NPs. Institutions also employed primary care certified pediatric nurse practitioners (26%) and family nurse practitioners (17%) that comprise the remaining PICU NP workforce. (Table 10)

Table 10. Labor Inputs and Working Conditions Reported for NPs Employed in PICUs within the United States.

	N (%) N=93
Nurse Practitioner Certification	
PNP-Acute Care	84 (90.3)
Require AC certification	41 (44.1)
PNP-Primary Care	24 (25.8)
Family Nurse Practitioner	16 (17.2)
	Median, (IQR), (range)
Number of Nurse Practitioners	
Full time	3 (1,5) (0-23)
Part time	0 (0,1) (0-8)
Per diem	0 (0,0) (0-4)
	Median, (IQR)
Number of patients NP is responsible for:	
Week day	5 (4,8)
Week night	4.25 (0,12.5)
Weekend day	5 (3.5, 10)
Weekend night	5 (0,12)
	N (%)
Times NPs routinely provide care	
24/7 NP Staffing*	22 (23.7)
Week days	67 (72.0)
Week nights	26 (28.0)
Weekend days	47 (50.5)
Weekend nights	13 (14.0)
	Median, (IQR) (range)
Typical Shift Length	
Week day	12 (10,12) (8-24)
Weekend day	12 (8,12) (3-24)
	N (%)
Provider who is responsible for patients when NPs are not working	
Resident physicians	46 (37.1)
Critical care fellows	19 (15.3)
Attending physician	52 (41.9)

Respondents from institutions that employed PICU NPs indicated a median of three full-time PICU NPs (range = 0 to 23). Employment of part-time and per-diem PICU NPs was much

lower (part-time: median = 0, range = 0-8; per-diem, median = 0, range = 0-4). When adjusted for PICU census, the median ratio of NP to patient was one to four (IQR 1:2, 1:8). When adjusted for the number of licensed beds the median NP to bed ratio was one to five (IQR 1:4, 1:10).

PICU NPs were responsible for a median 4-5 patients per shift (IQR 2-8 patients with shift variation, range 1-20 patients) (Table 10). If an institution did not have round-the-clock PICU NP presence, the PICU attending physicians (42%) most frequently assumed management responsibility for PICU NPs' patients when no NP was working.

In a quarter of institutions, respondents reported PICU NPs provide care round-the-clock (24%). If NP staffing allowed, an additional 14% of PICUs reported increasing their PICU NP coverage to round-the-clock. In those institutions that did not have round-the-clock PICU NP presence, a majority of respondents reported that a PICU NP is present during week day shifts (72%) and fewer reported they are present during weekend-day shifts (50%). Two institutions employed PICU NPs to provide overnight coverage only. Median PICU NP shift length was 12 hours, with some institutions operating 24-hour NP shifts (29%).

Nurse Practitioner Clinical Practice.

Within institutions that employ PICU NPs (n = 93) expectations of major clinical responsibilities, procedural competency, and clinical roles are presented. Expectations of the medical directors who worked at institutions employing PICU NPs (n = 68) and lead NP (n = 59) were compared. No statistically significant differences in expectations of PICU NPs' clinical responsibilities, need for procedural competency, or roles were identified between PICU medial directors and lead NPs ($p > 0.05$). Therefore, overall responses will be described by institution and illustrated in Figure 3-6.

Nearly all respondents reported PICU NPs participated in the delivery of direct patient care (98%). Pediatric ICU NPs participated in educating NPs (89%) and were largely viewed as having a role in the training and education of physicians (75% and 74% respectively). (Figure 3).

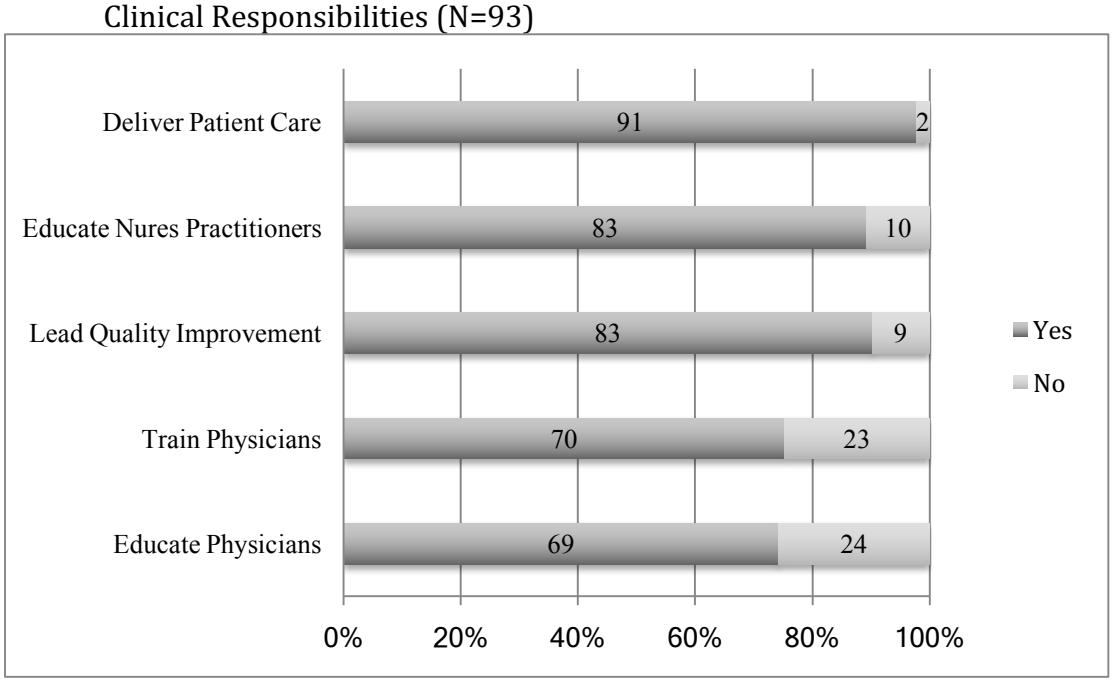

Figure 3. Clinical Responsibilities Reported by PICU Medical Directors and Lead NPs As Part of Clinical Practice of PICU NPs Employed in the United States

The procedural competencies expected of PICU NPs are summarized in Figure 4Figure 5. A majority of respondents reported institutional requirements for procedural competency among PICU NPs as part of the provision of day-to-day patient care. Lumbar puncture was reported as a required competency most often (90%) and chest tube insertion was reported least often (68%) (Figure 4). Medical directors consistently reported that procedural competency was required less often for the lead PICU NPs (Figure 5).

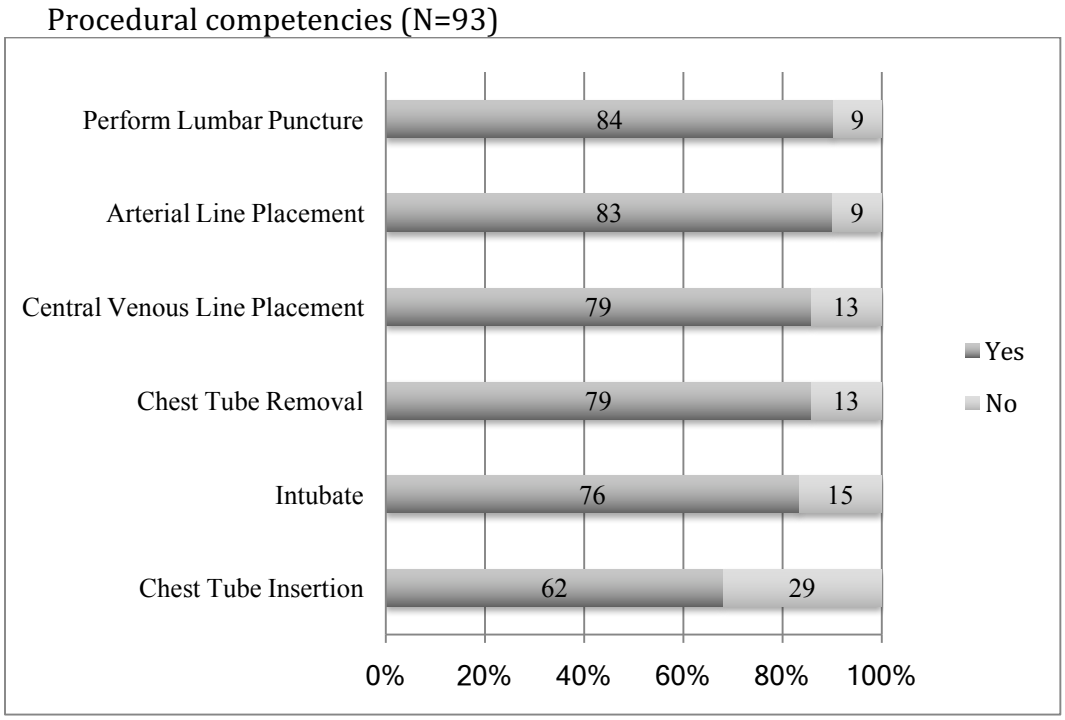

Figure 4. Procedural Competencies Expected of PICU NPs by PICU Medical Directors and Lead PICU NPs as part of Clinical Practice in the United States

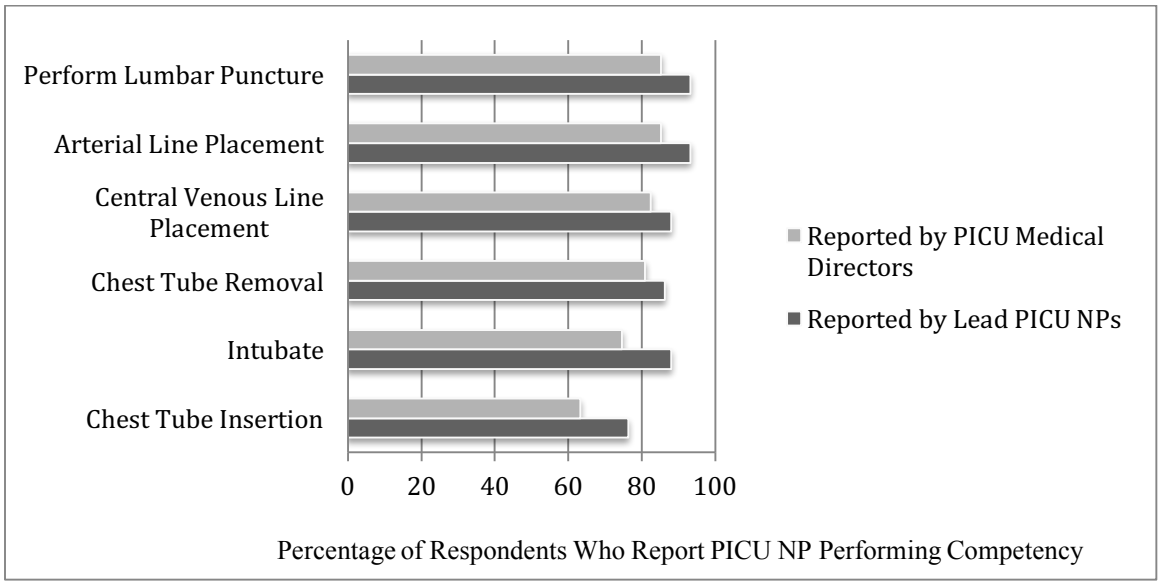

Figure 5. Differences in Expectations of PICU NPs' Procedural Competencies by Report of PICU Medical Directors (n=68) and Lead PICU NPs (n=59)

The roles of PICU NPs as team members who respond to acute patient care situations within and outside of the PICU are summarized in Figure 6. The most commonly reported roles NPs were expected to play in responding to acute patient situations were as members of the code and rapid response teams (75% and 65% respectively). PICU NPs were reported to lead those teams only approximately 45% of the time (Figure 6). Rarely were PICU NPs required to respond to a trauma stat situation (28%).

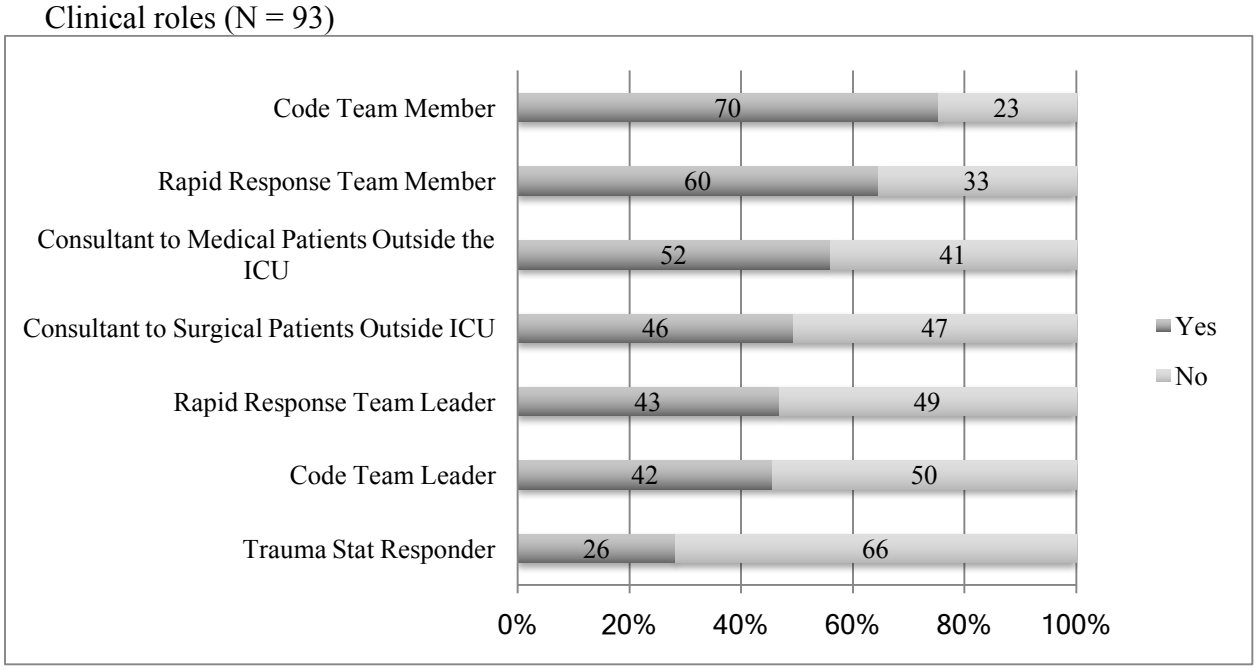

Figure 6. Clinical Roles in Acute Patient Care Situations Reported by PICU Medical Directors and Lead NPs as Part of the Clinical Practice of PICU NPs Employed in the United States

Discussion

This national study of physicians and advanced practice provider members of the PICU interdisciplinary care teams, as well as PICU NP labor input, working conditions, and clinical practice roles and responsibilities on the care team, is a first step toward evaluating the interdisciplinary PICU provider workforce.[23] The study also examined ways NPs contribute to the care of PICU patients. As PICU NPs are integrated into interdisciplinary PICU provider care

teams, knowledge of their role has implications for standardization of NP integration and utilization on PICU care teams, NP educational preparation, and assessing NPs' influence on patient outcomes.

Interdisciplinary Teams.

Institutions where respondents reported PICU NP employment have more licensed beds and a higher average daily census in the PICU than those that do not employ PICU NPs. In larger PICUs, more patients require more providers and, as seen in adult ICU care, the PICU NP's presence can be part of an innovative model of care delivery.[36] The institutions that employ PICU NPs are statistically significantly more likely to have a separate pediatric cardiac ICU. Assessment of the role of pediatric cardiac ICU NPs has not been reported and should be considered in future studies of the NP role in the delivery of care to children in critical care settings.

Institutional variation exists in the composition of the interdisciplinary PICU provider team. Compared with adult intensive care provider teams, interdisciplinary PICU teams report fewer attending pulmonologists and anesthesiologists in direct PICU patient care.[10] In adult critical care, they make up a significant portion of the workforce and, given the relatively recent addition of pediatric critical care medicine as a specialty, the small numbers of pulmonologists and anesthesiologists in the PICU is an important finding for forecasts of the PICU physician workforce.

More respondents reported critical care fellowship programs at institutions that employ PICU NPs, than institutions without PICU NPs ($p < 0.001$). These may be institutions in academic medical centers, which are more likely to have medical and nursing schools and thus have more critical care fellows and NP representation on the interdisciplinary team.[37] The relationships between critical care fellows and PICU NPs could shape future interdisciplinary collaboration as fellows go on to work in positions as attending PICU physicians. Evaluation of

the relationships between these providers as they interact in training, education, and patient-care delivery should be the target of future studies.[38]

Consistent with prior PICU workforce studies, the presence of PAs on PICU interdisciplinary teams is less common than PICU NPs.[19, 26] While reasons for the smaller presence of PAs on PICU interdisciplinary teams is unknown, the greater use of PAs may be an alternative way to grow the PICU workforce. Developing knowledge of the PA roles and experiences in PICU care relative to NPs would a useful area for future research.

Other interdisciplinary team members including bedside nurses, respiratory therapists, pharmacists, among others were not included in this study, even though they contribute to positive patient outcomes in the PICU.[39] Future studies of these healthcare professionals' roles and their potential influence on PICU physician, NP, and PA roles are needed to more comprehensively understand PICU team dynamics.

Labor Inputs and Working Conditions.

While a majority of respondents reported that PICU NPs are acute care pediatric NPs, not all PICU providers are, and less than half of institutions require PICU NPs to have acute care certification. Efforts to align NP education, certification, licensure and practice encourage the use of acute care pediatric NPs in this practice setting.[40, 41] The expansion of graduate-level educational opportunities to obtain an acute care pediatric NP education may support the demand for more PICU NPs.[42] Employers who hire new PICU NPs to join their interdisciplinary teams should be aware that practice in a PICU is considered acute and critical care and requires acute care educated and certified pediatric nurse practitioners.[15]

A "dose of nurse practitioner" has been described as a combination of labor inputs and working conditions that determine how providers influence chronic management of pediatric patient care.[43] This study, describes the factors that contribute to a "dose of NP care" in a novel setting, the PICU. This study provides information that may be useful for future studies assessing

the "dose of NP" care as part of the interdisciplinary provider team. Similarly, studies are also needed to assess the adequacy of the available PICU NP workforce to meet the "dose" demands and determine future workforce development needs. Future efforts to associate patient and organizational outcomes with the presence of PICU NPs will require intentional assessment of the "dose of NP," particularly as a majority of PICUs do not have a continuous NP coverage model. A description of other non-NP provider member roles and contributions to patient care should be examined and are important to understand when considering patient outcomes. Ultimately, efforts to integrate PICU NPs into the interdisciplinary provider team should seek to optimize the contributions of all team members' clinical skills, knowledge, roles and responsibilities to optimize the workforce and pediatric outcomes.

Nurse Practitioner Clinical Practice.

The clinical practice expectations reported for PICU NPs were similar to findings in prior study.[21] The PICU NP is primarily responsible for the day-to-day provision of direct patient care. Development of more specific knowledge of NP roles associated with the day-to-day care of PICU patients including: ventilator management, titration of vasoactive medications, and care coordination among others, and professional roles in research, leadership and education will allow for PICU NP clinical practice patterns and variations in practice to be examined.[21] Trends in professional role opportunities for PICU NPs should be monitored as provider shortages may necessitate more clinical time dedicated to the provision of day-to-day patient care. Examination of PICU NPs' participation in professional roles and the implications for PICU NP role actualization, role satisfaction, and retention may support the clinically focused PICU NP to have opportunities to engage in professional development activities.

Patient to NP ratios should also be further evaluated in future focused NP role studies. Factors including expectations of the PICU NP role in care delivery, patient acuity, provider team composition, and patient census may contribute to the wide range in the patient to NP ratios

reported in this study.[44] Given a wide range of reported ratios, no conclusions about optimal ratios of patients to PICU NPs can be drawn from this study.

Medical director- and lead PICU NP-reported expectations for PICU NP roles in the response to acute patient care situations (codes, rapid response, consultations outside of the PICU) showed less standardized practice expectations for NPs across respondent institutions. Reasons for variations in practice and expectations were not explored in this study. However, institutional culture should be considered.[45] Future qualitative studies can contribute to the knowledge of factors associated with variations in PICU NP practice reported between institutions.

This is the first study that has compared medical director and lead PICU NP expectations for PICU NPs' clinical practice. While not statistically significant, discrepancy in reports of expectations for procedural competency between the medical directors and lead PICU NPs and variation in PICU NP role expectations were noted between institutions. Future studies that evaluate variation in PICU NP clinical practice may elicit the physicians' perceptions of the value PICU NPs bring to patient care. Physicians in the PICU report a desire to hire additional PICU NPs and expand the role of those providers.[11] Future studies of the aspects of the NP role they would like to expand are necessary and have implications for PICU NP workforce planning and education.

Other Considerations for Future Work.

This study focuses on the clinical practice of the PICU NP. Future research on the detailed care PICU NPs provide including specific patient management and treatment roles along with professional role expectations will build knowledge of the contributions of PICU NPs to patient and organizational outcomes. Comparison studies that examine similarities and differences between PICU NP and other hospital-based, acute care pediatric NP roles are needed.

These studies have potential implications for the education, training and institutional orientation for all hospital-based, pediatric NPs.

This analysis was limited to examining NP clinical practice only in institutions that currently employ PICU NPs. Future studies should examine the expectations for NP practice among PICU medical directors from institutions who do not currently but plan to have NPs join their interdisciplinary provider team. Comparisons of the expectations of medical directors who desire to work with PICU NPs and those who currently work with PICU NPs may highlight the value physicians view NP team members bring to patient care and the findings may have implications for future role development of the PICU NPs.

Limitations.

In describing the interdisciplinary teams, this study is limited in report of presence or absence of a provider on the PICU interdisciplinary team. More meaningful descriptions of the interdisciplinary provider team composition could have been created through more detailed reports of labor input and working conditions for each member of the provider team. Additionally, understanding practice expectations for all team members would support additional comparisons of other PICU providers' clinical practice expectations to that of the PICU NP.

Findings regarding PICU NP roles and responsibilities and patient to NP ratios are limited by self-report, rather than observation, and may not be accurate. This study only examined the major clinical roles of the PICU NP, not specific patient management responsibilities. As a result, factors that influence institutional expectations of the PICU provider to patient ratios are not able to be determined from this study. In addition, institutional culture and individual provider characteristics including level of experience were not accounted for in this study and may contribute to a PICU NPs role and integration into an interdisciplinary PICU care team.

Conclusions

The intent of this study was to describe the physician and advanced practice provider members of the PICU interdisciplinary care team, as well as PICU NP labor input, working conditions, and clinical practice roles and responsibilities on the care team. Interdisciplinary PICU provider teams will become more common as the PICU physician shortage continues. PICU NPs are members of interdisciplinary PICU teams, active in providing patient care and educating team members. Assessing the "dose of NP" on the interdisciplinary care team will support future measurement of PICU NP contribution to patient and organizational outcomes. Utilizing PICU NP labor inputs and working conditions, and applying that to future inquiry of other interdisciplinary care team members can clarify how provider teams function to deliver care to PICU patients.

The clinical practice of PICU NPs is consistent with prior study.[21] In the PICU, NPs have a roles in contributing to patient care. Detailed descriptions of the aspects of patient care and professional roles expectations of PICU NPs will allow for comparisons of the role to other pediatric hospital-based NP and build understanding of the unique aspects of the PICU NP role. Determining the aspects of the PICU NP practice that are most valuable to physicians and have a positive influence on patient care outcomes may change the way the role is implemented in the future and deserves consideration. With an interdisciplinary care team, the team composition and all providers' practice should be further evaluated to assess how models of care contribute to patient care outcomes. With ongoing examination and future interventional studies, research can assist in determining how to optimize the integration of PICU NPs into the interdisciplinary PICU provider teams.

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CHAPTER IV

REGULATION OF NURSE PRACTITIONER PRACTICE IN PEDIATRIC INTENSIVE CARE UNITS

This manuscript has been submitted to the journal the *Journal of the American Association of Nurse Practitioners*, is formatted to the journal specifications, and is under review.

Purpose: The purposes of this paper are to: describe the extent to which organizational regulation of pediatric intensive care unit (PICU) nurse practitioner (NP) practice and prescriptive authority aligns with state scope-of-practice (SSOP) regulations; examine differences between PICU medical directors' and NPs' report of regulation; and describe organizational-level restriction of PICU NP practice.

Data source: A 34-item survey of United States PICU medical directors and NPs included demographic, institutional characteristics, and PICU NP regulation and role-related questions. Invitations to participate were sent between October 2016 and January 2017.

Results: Respondents (n=121, 60 PICU NPs and 61 PICU medical directors) reported 30% of PICU NPs have additional organizational restrictions beyond their SSOP practice authority and 11% have prescriptive authority regulations that exceed those required by the SSOP regulations. Medical directors and lead NPs showed agreement in reports of NP practice regulation. Variation in organizational-level restrictions of privileging, billing, and reporting structure practices were identified.

Implications for practice: As more states move to full SSOP regulatory environments, organizational regulation of NP practice can impede attainment of full practice authority.

Future research is needed to determine if variations in regulation of PICU NP practice influence patient outcomes, interdisciplinary collaboration, and NP role actualization.

Introduction and Background

Nurse practitioners (NPs) are a growing source of health care providers in the United States. In pediatric acute care settings, the NP role has its origin in pediatric critical care where the role has developed over the last 20 years (Allen, Fennie, & Jalkut, 2008; Freed et al., 2010; Pitts & Seimer, 1998; Reuter-Rice, 2013; Teicher, Crawford, Williams, Nelson, & Andrews, 2001). In response to critical care physician shortages (Health Resources and Services Administration, 2006), training physician work hour restrictions (Accreditation Council for Graduate Medical Education, 2011), and increased recognition of NPs as safe, high-quality health care providers (Dill, Pankow, Erikson, & Shipman, 2013; Institute of Medicine, 2010; Newhouse et al., 2011), pediatric intensivists have reported they intend to increase employment of and expand the roles for NP providers in the pediatric intensive care unit (PICU) (Freed, Dunham, Loveland-Cherry, Martyn, & Moote, 2011). However, the intent to expand PICU NP employment and roles must be considered within the context of regulation of PICU NP practice.

Regulations that unnecessarily limit NP contributions to care in a time when, according to the Institute of Medicine, every provider's role on the health care team should be developed to its fullest extent (Institute of Medicine, 2010). The practice of PICU NPs is subject legally defined to state scope-of-practice (SSOP) regulations. Organizational-level regulations can also impose barriers to NP practice through the processes of credentialing, privileging of NPs to provide patient care, prescribe medications, and bill, and complex management structure (Jalloh et al., 2016; Kleinpell, Hravnak et al, 2008; Kleinpell, Hudspeth, Scordo & Magdic, 2012; Lowe, Plumber, O'Brien & Boyd, 2012; Munro, 2013; Verger, Marcoux, Madden, Bojko, & Barnsteiner, 2005). States with restrictions on NP SSOP have smaller NP populations per capita

(10 per 100,000 population less) and 25% slower rates of growth in the NP population compared to states that have full SSOP regulation (Reagan & Salsberry, 2013). Differences in SSOP and organizational-level regulations such as inability to practice to the full extend of one's education, an inability to identify NP care in medical and billing records, a lack of centralized organizational NP leadership structure, and physician concerns about integrating NPs into an interdisciplinary team, have been shown to create barriers to NP practice, result in variations in NP practice, and may have implications for patient care outcomes (Bahouth et al., 2013; Reagan & Salsberry, 2013; Poghosyan, Nannini, Stone & Smaldone, 2013; Verger et al., 2005). In the PICU, the SSOP and orgnizational-level regulations that shape the NP practice environment have not been reported in the literature.

The purposes of this paper are to: 1) describe the extent to which organizational regulations of PICU NP practice, including prescribing medications, align with SSOP regulations; 2) describe the differences, if any, between PICU medical directors and lead PICU NPs reports of the alignment of the organizational regulations of PICU NP practice and prescribing with SSOP regulations; and 3) describe organizational-level restrictions on PICU NP practice.

Frameworks for NP Practice and the Regulation of Practice.

Frameworks describing NP practice focus on the patient care roles and suggest that formal and informal regulations of NP practice result in difference practice environments. (APRN Consensus Workgroup, 2008; Elliott & Walden, 2014; Kilpatrick, Lavoie-Tremblay, Lamothe, Ritchie & Doran, 2013; Safriet, 2002; van Offenbeek & Knip, 2004). Multiple sources of NP practice regulation, from SSOP regulations, organizational-level policies, and those faced as NP's attempt to integrate into a team of providers, have a cumulative effect and create barriers to NP practice, and result in a variety of practice norms and diverse PICU practice environments. These factors can affect patient care delivery and outcomes. A synthesis of frameworks that

consider NP roles and the regulation of NP practice was used to guide this study, the purpose of this study was not to test the frameworks.

Regulations.

The justification of SSOP regulations are to protect the public and give state regulatory boards power to ensure practitioners are safe and competent (National Council of State Boards of Nursing [NCSBN] 2017). Each state's legal SSOP regulation of NP practice is governed by a practice act that differs by state. Three levels of SSOP regulations have been used to categorize the different NP practice environments. According to the American Association of Nurse Practitioners (AANP), states are classified as: 1) full practice authority; i.e. NPs may evaluate, diagnose, and manage treatment of patients - including prescribing medications under the authority of the board of nursing; 2) reduced practice authority; i.e. a collaborative agreement with a physician is required for at least one of the practice elements: evaluation, diagnosis, or treatment - including prescribing medications; and 3) restricted practice; i.e. there must be physician supervision, delegation or team-management to prescribe, diagnose, and/or manage patient treatment (AANP, 2017). Requirements for NPs to collaborate with physicians to obtain prescriptive authority are particularly pervasive across the spectrum of state regulations enacted to limit NPs (Cassidy, 2012). As a result, the regulation of prescribing is examined separately from the more general regulation of NP practice - evaluation, diagnosis and treatment in this study.

Health care organizations also regulate NP practice through credentialing and privileging of NPs and a variety of other policies. Credentialing is the process institutions use to verify providers' qualifications, e.g. education, professional certifications, and licensure (The Joint Commission, n.d.). Privileging grants a NP the right to perform a specific clinical activities and procedures within the scope-of-patient care based upon their qualifications/credentials (The Joint Commission, n.d.). Through the processes of credentialing and privileging, institutions determine

the degree to which a physician is required to supervise a NP when performing various aspects of their clinical practice including prescribing medications. This process of credentialing and privileging is also where the various sources of public and private regulation of NP practice may or may not align. Organizational-level regulations can be consistent with or more restrictive than SSOP regulations with regards to practice or prescribing (Jalloh et al., 2016; Kleinpell, Hravnak et al., 2008; Kleinpell, Hudspeth, Scordo, & Magdic, 2012; Poghosyan et al., 2013). In studies of primary care settings, organizational-level regulations that support NPs have been attributed to improved patient care delivery, NPs' ability to practice to the full extent of their licensure, and decreased work related stress (Poghosyan et al., 2013). The alignment between organizational regulation of NP practice and prescriptive authority and SSOP regulations through credentialing and privileging has not been examined. Consequently, little is know about the extent to which organizations place limits on PICU NPs' practice and prescriptive authority. Additionally, comparisons between PICU physician and NP reports of NP regulation at the organizational or state level have not been assessed.

Organizational-level policies governing billing practices and supervisory, reporting structures can restrict NP practice (Jalloh et al., 2016; Munro, 2013; Moote et al., 2011; Verger et al., 2005). Some institutions enable PICU NPs to submit bills for services or procedures as part of their role (Kleinpell, Hravnak et al., 2008). Billing can enable measurement of NP productivity and contributions to patient care. Billing is being reported with increasing frequency in inpatient adult NP care (Kapu, Kleinpell & Pilon, 2014; Munro, 2013). This study gathers data regarding the prevalence of PICU NP billing that will, in part, aid future studies using billing data.

Hospital reporting structures also vary. In some institutions, NPs report to multiple supervisors, often a physician and a nurse or another APRN (Bryant-Lukosius & DiCenso, 2004; Lowe, et al., 2012; Verger et al., 2005). When a NP reports to multiple supervisors, competing

expectations and increased regulation of the NP's practice have been reported (Bryant-Lukosius & DiCenso, 2004; Kilpatrick et al., 2013). The occurrence of PICU NPs reporting to multiple supervisors is not known and may have consequences for practice.

Methods

Design.

A national, quantitative, cross-sectional descriptive survey of PICU medical directors and lead PICU NPs was conducted to evaluate: 1) PICU provider team composition and provider supply, 2) NP roles in PICU care, and 3) regulatory influence on the PICU NP practice environments. The development of a 34-item survey instrument used in this study was based upon concepts derived from a synthesis of frameworks for NP participation in care delivery and practice regulations. The influence of regulation on PICU NP practice is the focus of this article.

Participants.

Institutions identified as operating a PICU in the 2015 American Hospital Association Annual Survey were contacted to confirm the continued operation of a PICU. Surveys were sent to a medical director at each operational PICU (n = 326). Telephone calls were made to each PICU to determine if a PICU NP was employed and, if a NP was employed, an additional survey was sent to the lead (most senior or NP serving in a supervisory role among a group of PICU NPs) PICU NP (n = 140).

Data Collection/Procedures.

An introductory postcard and three separate survey mailings were conducted between October 2016 and January 2017. Survey mailings included a cover letter; a definition of key concepts; a hard copy paper survey, which included an electronic participation option; and a self-addressed, stamped return envelope. Returning a survey indicated participant consent. Participants (one medical director and one lead PICU NP) who returned a completed survey were eligible for a drawing for a $250 visa gift card. Surveys were returned electronically (n = 29,

19%) by participants or by postal-mail (n = 123, 81%). A secure, web-based platform, Research Electronic Data Capture (REDCap) hosted at Vanderbilt University was used to capture data (Harris, et al., 2009). Participants recorded their own responses electronically or mailed survey responses were double-entered by a study team member into the REDCap system. The Vanderbilt University Medical Center's Institutional Review Board approved this study before recruitment and distribution of any study materials.

Study Variables.

Guided by study aims and previous research on NP regulation, the survey included seven variables related to PICU NP regulation. Questions asked about NP practice authority, prescriptive authority, and organizational-level regulations (Irvine et al., 2000; Kilpatrick et al., 2013; Kleinpell, Hravnak, 2008; Kuo, Loresto, Rounds, & Goodwin, 2013; Moote et al., 2011; Verger et al., 2005). Each respondent's state was identified and categorized using the AANP State Practice Environment classification at the time of data collection (AANP, 2017). Two survey questions asked about the alignment of SSOP and organizational-level regulations and whether institutional policies regarding 1) practice and 2) prescriptive authority were consistent with or more restrictive that SSOP regulations. Multiple-choice questions were asked to determine: a) what organizational entities credentialed NPs within the institution, b) who employs and supervises PICU NPs, and c) what are the billing practices for procedures and services performed by the PICU NP.

Data Analysis.

Data analyses were performed using IBM SPSS Statistics 23.0 (IBM Corporation, 2015). Frequency distributions summarized the nominal and ordinal study data; median and IQR were used for summarizing continuous data. Cross-tabulations and Chi square tests of independence were used to assess differences among the distributions of nominal and ordinal distributions. An alpha of 0.05 ($p < 0.05$) determined statistical significance.

Results

Survey Respondents and Response Rates.

Responses were received from 97 (30%) PICU medical directors and 60 (45%) lead PICU NPs. For the purposes of this paper, gauging the knowledge of the regulatory environment by providers familiar with PICU NP practice, only respondents from institutions that currently employ PICU NPs were used in the analysis (n = 93, 66% of the U.S. institutions with an operational PICU identified as having employed PICU NPs). The sample included 61 physicians (63% of respondent medical directors) and all respondent NPs (n = 60). For institutional-level data, institutions were included in the analysis if either a medical director or NP responded; if both providers responded from the same institution, the physician response was included in the analyses of institutional-level responses for a consistent institutional-level respondent. Paired responses from both the medical director and the lead NP were received from 26 institutions.

Respondent characteristics are summarized in Table 11. Medical director and lead PICU NPs were employed at their current institution for similar lengths of time (11 vs. 10 years respectively, $p > 0.05$). Compared to medical directors, PICU NPs were more likely to be female (88% vs. 36%), younger (40 vs. 54 years old), and board certified PICU providers for a shorter period of time (9 vs. 18.5 years) (all $p < 0.01$). (Table 11)

Table 11. Respondent Demographic Characteristics of PICU NPs and Medical Directors Who Work in Institutions with NPs in the United States.

Respondent Characteristics	All respondents from institutions with PICU NPs (n=121)*	Nurse Practitioner Respondents (n=60)*	Medical Directors at institutions with PICU NPs (n=61)*	p-value
	(n, %)	(n, %)	(n, %)	
Gender				
Male	46 (38.3)	7 (11.9)[a]	39 (63.9)[b]	**<0.001**
Female	74 (61.7)	52 (88.1)[a]	22(36.1)[b]	
Race				
White	104 (86.0)	57 (95.0)[a]	47 (77.0)[b]	**0.004**
Other	17 (14.0)	3 (5.0)[a]	14 (23.0)[b]	
	Median (IQR)	Median (IQR)	Median (IQR)	
Age	49 (40, 56)	40 (33.75, 50.75)	53.5 (47.75, 58)	**<0.001**
Years of Board Certification as PICU provider	14 (7, 20)	9 (3.5, 14.5)	18.5 (14, 25)	**<0.001**
Years Working at Current Employer	10 (4.5, 18)	10 (2, 18)	11.0 (6, 19.25)	0.161

* Totals do not always add up to *n* because of variation in response rate per item.

Superscripts in cells indicate pairwise statistically significant differences (Bonferroni-adjusted, $p < 0.05$)

Alignment of State Scope-of-Practice Regulations and Organizational Policies.

Summaries of the organizational regulation of NP practice and prescribing authority alignment with SSOP regulations and are presented in Table 12. Nearly one-third of respondents (30%) reported that organizational policy imposes more restrictions on PICU NP practice than required by SSOP regulations. Of respondents located in full practice authority states, over 60% reported having full practice authority and no organizational-level restrictions to practice in their institution. With regard to prescriptive authority, nearly three-fourths of respondents (74%) reported that organizational regulation of PICU NP prescriptive authority was consistent with SSOP regulation. Differences in reported alignment of organizational regulation of NP practice and prescriptive authority with SSOP regulations were not statistically significant by SSOP environment ($p > 0.05$).

Table 12. Reported Alignment of Organizational Policies that Regulate PICU NP Practice and Prescriptive Authority with State Scope-of-practice Regulations within Institutions in the United States.

	Total Respondents	Full Practice States	Reduced Practice States	Restricted Practice States	p-value
	N (%)	N (%)	N (%)	N (%)	
Organizational Policy					
	N = 112	N = 22	N = 39	N = 51	
NPs Have Full Practice Authority					0.080
Yes	55 (49.1)	14 (63.6)	21 (53.8)	20 (39.2)	
No, because of institutional policy	33 (29.5)	7 (31.8)	12 (30.8)	14 (27.5)	
No, because of state law	24 (21.4)	1 (4.5)	6 (15.4)	17 (33.3)	
	N = 120	N = 23	N = 42	N = 56	
Institutional Prescriptive Authority					0.415
In line with state laws	89 (73.6)	18 (83.3)	33 (78.6)	38 (67.8)	
More restrictive than state laws	14 (11.5)	3 (16.7)	2 (4.8)	9 (16.1)	
Do not know	18 (14.9)	2 (0)	7 (16.6)	9 (16.1)	

Report of SSOP and Organizational Regulation Alignment by Role.

Summaries of the alignment of organizational regulation of NP practice and prescribing with SSOP regulations of NP practice reported by medical director and lead PICU NP are shown in Table 12 Table 13. Although reports of the alignment of organizational regulation of PICU NP practice with SSOP regulations were not statically significantly different, a greater percentage of medical directors described organizational policies pertaining to practice authority were more restrictive than state laws (33% vs. 26%). At the same time, medical directors were more likely than the lead PICU NPs (25% vs. 5%, p = 0.009, Table 13) to report not knowing how organizational regulation NP prescriptive authority aligned with SSOP prescribing regulations.

Table 13. Medical Directors and PICU NPs' Report of the Alignment of Organizational Policies that Regulate PICU NP Practice and Prescriptive Authority with State Scope-of-Practice Regulations within Institutions in the United States.

Organizational Policy	Total N = 112 N (%)	Nurse Practitioner N = 57 N (%)	Physician N = 55 N (%)	P-value
NPs Have Full Practice Authority				0.862
Yes	55 (49.1)	29 (50.9)	26 (47.3)	
No, because of institutional policy	33 (29.5)	15 (26.3)	18 (32.7)	
No, because of state law	24 (21.4)	13 (22.8)	11 (20.0)	
	N = 121	N = 60	N = 61	
Institutional Prescriptive Authority				**0.009**
In line with state laws	89 (73.6)	50 (83.3)[a]	39 (63.9)[b]	
More restrictive than state laws	14 (11.5)	7 (11.7)	7 (11.5)	
Do not know	18 (14.9)	3 (5.0)[a]	15 (24.6)[b]	

Superscripts in cells indicate pairwise statistically significant differences (Bonferroni-adjusted, $p < 0.05$)

Responses from the lead PICU NP and the medical directors were analyzed separately (Table 14Table 15). There were no statistically significant differences in PICU NP or medical

director reports of the alignment of organizational regulation of NP practice or prescriptive authority among the varying SSOP regulation categories ($p > 0.05$).

Among pairs of medical directors and lead PICU NPs working in the same institution ($n = 26$), alignment of organizational regulation of practice with SSOP regulation was not statistically significantly different ($p = 0.49$) and neither were perceptions of the alignment of organizational regulation of prescribing and SSOP regulation ($p = 0.096$). Overall, 52% ($n = 26$) of the physician and NP pairs indicated the organizational regulation of PICU NP practice were aligned with SSOP regulations and 84% ($n = 42$) indicated the organizational regulation of PICU NP prescribing was in alignment with SSOP regulations.

Table 14. PICU NPs' Reports of the Alignment of Organizational Policies that Regulate PICU NP Practice and Prescriptive Authority with State Scope-of-practice Regulations within Institutions in the United States.

	Total Respondents	Full Practice States	Reduced Practice States	Restricted Practice States	p-value
	N = 57	N = 11	N = 20	N = 26	
Organizational Policy					
NPs Have Full Practice Authority					0.060
Yes	29 (50.9)	9 (81.8)	10 (50.0)	10 (38.5)	
No, because of institutional policy	15 (26.3)	2 (18.2)	7 (35.0)	6 (23.1)	
No, because of state law	13 (22.8)	0 (0)	3 (15.0)	10 (38.5)	
	N = 60	N = 12	N = 22	N = 26	
Institutional Prescriptive Authority					0.782
In line with state laws	50 (83.3)	10 (83.3)	18 (81.8)	22 (84.6)	
More restrictive than state laws	7 (11.7)	2 (16.7)	2 (9.1)	3 (11.5)	
Do not know	3 (5.0)	0 (0)	2 (9.1)	1 (3.8)	

Table 15. PICU Medical Director's Report of the Alignment of Organizational Policies that Regulate PICU NP Practice and Prescriptive Authority with State Scope-of-Practice Regulations within Institutions in the United States.

	Total Respondents	Full Practice States	Reduced Practice States	Restricted Practice States	p-value
	N = 55	N = 11	N = 19	N = 25	
Organizational Policy					
NPs Have Full Practice Authority					0.450
Yes	26 (47.3)	5 (45.5)	11 (57.9)	10 (40.0)	
No, because of organizational policy	18 (32.7)	5 (45.5)	5 (26.3)	8 (32.0)	
No, because of state law	11 (20.0)	1 (9.1)	3 (15.8)	7 (28.0)	
	N = 61	N = 11	N = 20	N = 30	
Institutional Prescriptive Authority					0.261
In line with state laws	39 (63.9)	8 (72.7)	15 (75.0)	16 (53.3)	
More restrictive than state laws	7 (11.5)	1 (9.1)	0 (0)	6 (20.0)	
Do not know	15 (24.6)	2 (18.2)	5 (25.0)	8 (26.7)	

Organizational-level Restrictions.

Descriptive summaries of organizational-level restrictions to PICU NP practice are presented in Table 16. Most respondents reported PICU NPs are credentialed and received practice privileges through the institution's medical staffing committee (90%). However, nearly one quarter of PICU NPs are also credentialed by an allied health staffing (25%) and/or nursing staffing (24%) committees. Only 40% (n = 33 of 84) of respondents indicated that PICU NPs bill for services or procedures, while just over a quarter (27%) of PICU NPs bill using a personal National Provider Identification.

Nearly 80% of respondents (n = 74 of 93 institutions) indicated that the PICU NPs are employed by the hospital; 4 institutions have both hospital and non-hospital employed PICU NPs working in the PICU. One-third of respondents (38%) describe that PICU NPs report to multiple supervisors. PICU NPs most frequently reported to a PICU medical director (72%), with half (51%) reporting to an advanced practice provider.

Table 16. Organizational-level Supervision of and Privileging for PICU NPs.

	N (%)
Credentialing entity	
N=93*	
Medical Staffing Organization	84 (90.3)
Allied Health Staffing Organization	23 (24.7)
Nursing Staffing Organization	22 (23.7)
Bill for Services of Procedures	
N=84	
Yes, using a personal NPI number	23 (27.4)
Yes, using a hospital NPO number	6 (7.1)
Yes, as incident-to	4 (4.8)
No	51 (60.7)
Hospital Employed	
N=93*	
Yes	74 (79.6)
No	23 (24.7)
Report to a:	
N=93*	
Unit Manager	14 (15.1)
Advanced Practice Manager	30 (32.3)
Director of Advanced Practice	17 (18.3)
Medical Director	67 (72.0)

* Respondents allowed to choose >1 response

Discussion

The key findings of this study include: 1) a majority of respondents reported that institutions do not over-regulate PICU NP practice and prescribing with additional organizational regulations beyond the SSOP regulations; 2) PICU medical directors and lead PICU NPs are generally in agreement with regard to the alignment of organizational regulations of NP practice and prescribing with of SSOP regulations; and 3) organizational-level restrictions on PICU NPs can introduce redundant oversight and limit visibility of PICU NPs' practice with billing policies. These findings have implications for clinical practice and should be the focus of future research on regulation of the PICU NP.

Alignment of Organizational Policies and SSOP Regulations.

PICU NP Practice and Prescribing.

In this initial study of the regulation of NPs in PICUs, nearly a third of respondents (30%) reported organizational regulation of PICU NP practice authority is more stringent than required by SSOP regulations. In studies of the primary care workforce, increased regulation of NP practice was associated with reduced patient access to care (Kuo et al., 2013) and a smaller NP workforce (Reagan & Salsberry, 2013). Given the current demand for PICU care and the PICU provider shortage (Freed et al., 2011), over-regulation should be minimized and NPs should be allowed to practice to the full extent of their education and certification (IOM, 2010). Additionally, as some PICU physicians desire to increase the role of PICU NPs in patient care, alginment of the orgnaizational regulation of NP practice and prescribing with the SSOP regulations should provide a framework for organizations.

One approach would be implementation of the Consensus Model for APRN Regulation (the Consensus Model). The Consensus Model supports alginment of the NPs' education, certification, and licensure, and can guide policy change that may result in more standard national PICU NP practice environments (APRN Consensus Workgroup, 2008). However, as long as variations in the PICU practice environment persist, future research is needed to determine how PICU practice environments influence patient, family, and organizational outcomes (Bahouth et al., 2013; Kleinpell, Hravnak et al., 2008; Lowe et al., 2013).

Prior studies have demonstrated safe prescribing, with low error rates, among NPs in adult ICUs (Carberry, Connelly & Murphy, 2012) and higher rates of NP prescribing when physicians are present at a practice site (Kaplan & Brown, 2004). In the PICU, only 11% of respondents reported more organizational restrictions on prescribing than required by SSOP

regulations. In prior study, the presence of physicians resulted in more provider consultation and fewer barriers to prescribing for NPs (Kaplan & Brown, 2004), this affects the context with which PICU NP prescribing should be evaluated. With physician presence in the PICU increasingly around-the-clock (Pronovost, 2011), changes in NP prescribing patterns should be monitored and evaluated in future studies, particularly comparisons among multidisciplinary provider roles in medication prescribing, patient safety outcomes, and NPs' perception of role actualization (Lowe et al., 2012).

Physician and PICU NP Report.

Differences in reports of the alignment of organizational regulation of NP practice and prescribing with SSOP regulations were not statistically significantly different among PICU medical directors and lead PICU NPs. The finding of a shared perspective among respondents is encouraging to those who seek to develop the role of NPs in PICU care delivery. Nevertheless, provider collaboration, teamwork, NP autonomy, and role actualization should be examined in studies of organizational regulation of NP practice and PICU climate (Kilpatrick, et al., 2013; Lowery, Scott & Swanson, 2015; Peterson & Way, 2016; Poghosyan et al., 2013). Future research that focuses on providers who report similar and contradictory perspectives of NP practice regulation may highlight how regulations influence clinical practice and NP role actualization.

Overall, PICU medical directors were more likely to report uncertainty about how regulations influenced NP prescribing than were PICU NPs (25% vs. 5%, $p = 0.009$). This finding reinforces the importance of NPs' educating physician colleagues and hospital administration on NP SSOP regulations (Kleinpell, Hravnak, et al., 2008) and assisting medical directors' in envisioning expanded roles for PICU NPs. Well informed physicians may become

partners with NPs in advocating for organizational-level and SSOP regulations that support full NP practice and prescriptive authority.

Organizational-level Restrictions.

Within organizations, credentialing and reporting through multiple organizations and supervisors, as described by respondents in this study, represents unnecessary duplication and competing expectations reported in prior studies (Bryant-Lukosius & DiCenso, 2004; Kilpatrick, et al., 2013). Streamlining credentialing and reporting structures can optimize the use of organizational resources. Studies to understand how credentialing bodies perceive their role and to what extent they intervene to restrict NP practice can help foster approaches to limit organizational regulations that have been identified as being more restrictive than SSOP regulations (Kleinpell & Hudspeth, 2013). Additionally, APRN-led reporting structures have been associated with improved NP satisfaction, retention, and accountability (Elliott & Walden, 2014; Metzger & Rivers, 2014). The significance of the provider type (nurse, NP or physician) and number of supervisors should be considered, as PICU NP programs desire to grow in size.

Billing is often used to assess NP productivity and their contributions to patient care. However, with 60% of respondents reporting that PICU NPs do not bill, and with the development of value-based and bundled payment systems, use of billing as a marker of productivity and involvement in patient care will have limited utility in future studies of PICU NP practice. Additionally, in a fee for service environment, limits on PICU billing restrict NPs' ability to contribute to their organizations financial health and has implications for evaluating the cost of providing PICU care. As trends in inpatient NP billing change (Kapu et al., 2014; Munro, 2013), continued assessment of practices in and prevalence of PICU NP billing will be important to understand. In the meantime, with only 25% of PICU NPs billing using a personal

NPI, additional markers to measure NP utilization and productivity are needed to allow for a more comprehensive assessment of their contributions to patient and financial outcomes (Moote et al., 2011; Riley, Poss & Wheeler, 2013).

Limitations.

This study may be limited by respondents' knowledge of NP practice and prescribing regulations. Further work to elucidate providers' knowledge of these regulations can guide future evaluation of their perspective on the regulation of NP practice.

Questions regarding organizational-level regulation of PICU NP practice were limited in the scope of the question. Practices related to billing for services and procedures were addressed as a single item and more detailed knowledge surrounding practices would have been generated with separate questions. The addition of a question about parties responsible for a PICU NP's salary would increase the understanding of NP reporting structures in situations where there are multiple supervisors.

Additionally, this sample examined PICU medical directors and lead NPs reports on the alignment of organizational regulations on practice and prescribing with SSOP and in the PICU. These findings are not generalizable to all ICUs that employ NPs.

Implications

The regulation of NP practice results in barriers to and variations in practice that have been shown to decrease access to care and have no association with quality of care (Bahouth et al., 2013; Loresto, Jupiter, Kuo, 2017; Reagan & Salsberry, 2013; Poghosyan et al., 2013; Timmons, 2017). Respondents report that PICU NPs generally have practice and prescriptive authority that align with SSOP regulations, which varies in degree of restriction by state. As more states move to full SSOP regulatory environments, the assessment of organizational-level

restrictions on practice will become important to evaluate attainment of full practice for NPs in their PICU, clinical practice environment (Kleinpell, Hravnak, et al., 2008; Lowe et al., 2012). Studies examining how various degrees of PICU NP practice regulation, up to and including full practice, influence patient outcomes are important for understanding the clinical implications (intended and unintended) for regulating NPs in general and PICU NPs specifically.

Within institutions, organizational-level regulations also shape clinical practice environments. Organizational regulations related to granting clinical privileges of PICU NPs should align with SSOP regulations. If the organizational regulations are redundant or more stringent than SSOP regulations, institutions should undertake efforts to eliminate undue regulation (Kleinpell, et al., 2012; Kleinpell & Hudspeth, 2013) and facilitate the development of each health care provider's role to its fullest to allow for optimal health care manpower utilization (Institutie of Medicine, 2010; Silver, Ford, & Stearly, 1967).

Conclusions

While PICU NPs have been integrated into multidisciplinary health care teams, regulation of their practice is inconsistent. Findings from this study indicate that a majority of institutions allow PICU NPs to practice and prescribe at the level of their SSOP without additional restrictions from the institution. The PICU medical directors and lead PICU NPs are also generally in agreement with regard to the extent to which organizational regulation of PICU NP practice and prescriptive authority align with SSOP regulations. However, organizational-level restrictions to practice can introduce redundant oversight with multiple credentialing and supervisory pathways. Additionally, billing policies limit the visibility of PICU NPs' practice; additional measures of utilization and productivity are needed. Ongoing evaluation of variations in SSOP and organizational-level regulations should continue to ensure that the regulations on

practice are enacted in a way that optimizes PICU NPs' contribution to patient care and result in desired patient, family, and organizational outcomes.

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CHAPTER V

IMPLICATIONS FOR FUTURE RESEARCH

Background

In 2012, there were more than 2 million pediatric hospital admissions in the United States (AHRQ, 2012). Although the number of children admitted to the hospital decreased 1% from 2008-2012, the number of admissions to the PICU has increased as children are admitted with increased severity of illness and complexity (Goh & Mok, 2001; Miller, Gebremariam, Odetola, 2001; Randolph, Gonzales, Cortellini, & Yeh, 2004; Watson & Hartman, 2014).

Despite a demand for pediatric providers and an increase in the size of the critical care workforce, the pediatric workforce is inadequate to meet the current health care needs of children (CHA, 2012; HRSA, 2006; HRSA 2016). Barriers to growing the ICU physician workforce resulted in an evolution of workforce models of care, which include the employment of APRNs part of an interdisciplinary health care team of care providers (Basco & Rimsza, 2013; Garland & Gershengorn, 2013; Kleinpell et al., 2015; Shugerman et al., 2013).

Pediatric Nurse Practitioners, a subspecialty of APRNs, are increasingly employed in hospital-based settings (Allen, Fennie, & Jalkut, 2008; Brady & Neal, 2000; Freed, Dunham, Lamarand et al., 2010; Freed et al., 2014; Pitts & Seimer, 1998). The demand for PNPs is strongest among PICU-based, pediatric intensivist physicians (Freed, Dunham, Loveland-Cherry et al., 2011). The roles PICU NPs perform are not well known (Verger et al., 2005; Brown et al., 2012) and may vary according to practice location (Kleinpell, Hudspeth et al., 2012). Although knowledge of PNP roles and characteristics of the PNP workforce has increased, significant gaps remain in understanding the role NPs perform providing care within the PICU.

Describing a phenomenon is the first step to addressing gaps in knowledge; it also informs decisions when considering future comparative and interventional research. Gaps in knowledge of the NP's role in PICUs were identified and prioritized (Table 1). A framework, The Synthesized Model to Describe the Impact of State Scope-of-Practice Laws and Regulations on Nurse Practitioner Practice Patterns (Figure 1) combines elements of existing frameworks that described NP roles and those that described practice regulations. This model suggests regulations, including SSOP regulations, organizational-level regulations, and NP integration onto multidisciplinary teams; influence the NP role in patient care delivery. The synthesized framework guided this initial descriptive research. A 34-item survey instrument was developed to assess the current composition of the PICU workforce and role of NPs in providing PICU care. A national, quantitative, cross-sectional descriptive postal-mail study of PICU medical directors and lead (most senior or NP serving in a supervisory role among a group of PICU NPs) PICU NPs was conducted. The purposes of the study were to:

1) Identify the roles and functions of NPs working in PICUs;
2) Examine the PICU provider team composition and workforce supply; and
3) Identify hospital-reported internal regulatory characteristics and state regulatory environments' influence on the practice of PICU NPs.

Summary of Key Findings

The methods, findings, and implications of this study are reported in detail in the three dissertation manuscripts. Findings lay a foundation for and will influence research on the PICU workforce, PICU provider roles, and patient and organizational outcomes. A summary of the findings will be presented for each aim 1) PICU NPs roles and functions; 2) PICU provider workforce and team composition; and 3) the affect of regulations on PICU NP practice.

PICU NP Roles.

Pediatric Intensive Care Unit medical directors and lead NP reported similar expectations of PICU NP clinical roles, responsibilities and need for procedural competencies. Among institutions that employ PICU NPs, the PICU NP is primarily responsible for the day-to-day provision of direct patient care (n = 91 of 93 institutions, 97.8%). Respondents also reported an expectation that PICU NPs participate in the education of NPs (n = 83, 89.2%) and the training of physicians (n = 70, 75.3%). Although a majority of respondents reported institutional requirements for procedural competencies among PICU NPs, medical directors were less likely to report that procedural competency was required than lead PICU NPs.

Respondents from institutions that employ PICU NPs reported a median of three full-time PICU NPs were employed (range = 0 to 23). When adjusted for PICU census the median ratio of NPs to patients was one to four (IQR 1:2, 1:8). When adjusted for the number of licensed beds the median NP to bed ratio was one to five (IQR 1:4, 1:10). PICU NPs were responsible for a median 4-5 patients per shift (IQR 2-8 patients, range 1-20 patients).

PICU Workforce and Team Composition.

A majority (n = 89 of 145, 61.3%) of all respondents reported the national supply of PICU physicians was less than demand, and 55.3% (n = 84 of 152) self-reported the local supply of PICU providers (physicians in all stages of training, NPs, and physician assistants) was less than demand. Institutions that self-reported local shortages were more likely to employ PICU NPs than those institutions that did not report shortages (p=0.030). Nearly two-thirds (n=60 of 81, 65%) of institutions with self-reported local provider shortages reported plans to increase the number of PICU NPs in the next 3 years and one-third (n = 34, 36%) were likely to expand the NP's role in patient care.

Institutions that employed PICU NPs had larger PICUs than those that did not employ PICU NPs (median = 20 licensed beds with average daily census of 14 patients vs. median = 10 licensed beds with an average daily census of 6 patients, both $p < 0.001$). Institutions that did not employ PICU NPs were more likely to have only one PICU provider team working in the PICU each day as compared to institutions that employed PICU NPs (79% vs. 44%, $p = 0.017$) and had a broader range (1 to 4 teams) of PICU teams working each day. Additionally, if an institution employed PICU NPs, it was more likely to also have pediatric critical care fellows, non-pediatric residents, and physician assistants working on its interdisciplinary PICU provider team than institutions who did not employ PICU NPs ($p < 0.05$).

Regulations Affecting PICU NP Practice.

Nearly 30% (n = 33 of 112) of respondents from institutions that employed PICU NPs reported that institutional restrictions placed on PICU NP practice are more restrictive than SSOP regulations. Respondents from 12% (n = 14 of 120) of institutions with a PICU reported prescriptive authority regulations that exceed those required by the SSOP. No statistically significant differences were identified in PICU medical directors and lead NPs' report of the alignment organizational regulations on NP practice and prescriptive authority and SSOP regulations ($p > 0.05$).

This study identified variations in organizational-level restrictions. One-quarter of PICU NPs were credentialed through multiple organizations: medical staffing, allied health, or nurse staffing. One-third of respondents reported PICU NPs report to multiple supervisors, nurses, advanced practice providers, and/or physicians. In a majority of institutions (n = 51 of 84, 60%), respondents reported that PICU NPs do not bill for services or procedures.

Dissemination of Findings

The results of this research are expected to be of interest to clinicians, policy makers, and workforce researchers who are concerned with the pediatric workforce and the use of NPs in addressing shortages of PICU providers. Journal submissions and conference abstracts will describe the study aims, methods, analysis, discuss study findings and implications.

I have written three manuscripts for submission to peer-reviewed journals. Each manuscript was written to the specifications of the journal to which I submitted my work. The manuscript focused on the interdisciplinary provider team composition and PICU NP clinical roles and has been submitted to *Advanced Critical Care*. This journal focuses on publication of articles that are relevant to clinicians in critical care including articles on professional roles and published the last major study of PICU NP roles (Verger et al., 2005). Given a focus on physician and provider supply in the PICU, the workforce supply and demand manuscript has been submitted for consideration by *Pediatric Critical Care Medicine*, the official journal of the Society of Critical Care Medicine, the World Federation of Pediatric Intensive and Critical Care Societies – with a large physician membership. The third manuscript focuses on the regulation of PICU NP practice. The AANP is active in the monitoring practice regulations and this journal includes articles on policies relevant to NP practice. As a result, I submitted this article to the *Journal of the American Association of Nurse Practitioners (JAANP)*. If needed, submission to additional journals with health services, nursing, and medicine audiences including: *Pediatrics, Journal of Pediatric Healthcare, Critical Care Nurse, Research in Nursing and Health,* and *Health Policy* will be considered to achieve dissemination goals.

I also plan to disseminate the findings of this research project at professional meetings. Abstracts will be submitted with pertinent findings that align with the interests of individual

organizations. Meetings I am considering include: the National Association of Pediatric Nurse Practitioners, Society of Critical Care Medicine, the American Association of Critical-Care Nurses National Teaching Institute, and the National Organization of Nurse Practitioner Faculties annual conferences along with AcademyHealth and Sigma Theta Tau International research meetings.

Addressing Future Gaps

My dissertation research aimed to address descriptive deficiencies in understanding the role of role of NPs in care delivery in the PICU. My findings contribute to the body of knowledge surrounding the role of PICU NPs however additional research questions remain and were generated (

Table 17). The scope of my dissertation work has laid the foundation for a career of research on the role of NPs in PICU care delivery. I will continue to prioritize research gaps and build on new findings to strategically advance the knowledge of NP roles in PICU care delivery.

Table 17. Knowledge Gained and Questions Developed from Dissertation Study of PICU NP Roles.

Knowledge Gap	Knowledge Gained in Dissertation	New Avenues to Explore
PICU provider team composition	• Physician, NP, and PAs presence on the team • Night time PICU coverage models; most NP models provide daytime coverage	• What is the "dose" of each provider role; how does that influence outcomes • What is the role of non-providers on PICU teams; do providers roles change when other professionals are on the team • What influences interdisciplinary roles, collaboration and autonomy on PICU teams
NP role in PICU care delivery	• Clinical roles, responsibilities and procedural competency expectations of PICU NPs • Comparisons of MD and NP perspective of expectations for the role of PICU NPs	• More in depth analysis of the patient care and non-clinical roles of PICU NPs • What factors contribute to NP : patient ratios • What aspects of a PICU NP's role are valued by attending PICU physicians • How does PICU NP's role compare with other hospital-based NPs, most closely related pediatric cardiac ICU • How are PICU NPs prepared for their role: graduate education,

		orientation, ongoing education
How practice environments influence care delivery	• Most institutions do not add additional organizational restrictions to PICU NP practice and prescribing beyond SSOP requirements • Physicians and NPs generally agree on degree of restriction to practice • Organizational structures result in multiple credentialing organizations and supervisors for PICU NPs • Majority of NPs are not privileged to bill as individual providers	• How do regulations relate to the size of and demand for a local PICU NP workforce • How does regulation influence NP perception of role actualization • How does PICU NP practice, team work, or autonomy change if the NP and MD have similar or different perspective of regulation • As more states have full SSOP, how does that change institutional regulation of practice and prescribing • How are practice regulations related to roles, patient and organizational outcomes
PICU specific quality measures	• These will be important to develop and allow for NP accountability given low rates of billing among PICU NPs	• What makes a good PICU quality measure • What organizations/mechanisms support the development of measures • How can NPs contribute to value of care best be measured
Diverse descriptive research methods	• Not addressed in this descriptive, cross-sectional, survey study design	• Qualitative study of PICU physicians to assess the value of PICU NP role • Observational studies of collaboration and role actualization in different practice environments and variety of team members • Longitudinal assessment regulation of PICU NP practice
PICU provider outcome comparison studies	• Have developed some measures to support a "dose of NP" care	• Construct "dose" calculation for all PICU provider roles • Additional studies of role are needed to fully understand the clinical and non-clinical roles of the PICU NP • Must determine what outcomes are meaningful and can reliably be measures in a interdisciplinary environment
Practice environment intervention studies	• Multiple organizational entities may credential a PICU NP • NPs have a variety of supervisors and employers	• What role do credentialing organizations feel they play in regulating practice, how do they decide to limit practice • What role does the supervisor have on the NP practice environment, satisfaction and role actualization
PICU care needs and utilization	• Updated knowledge of currently active PICU sites	• Are there more reliable, updated sources for this data • Can year-to-year admissions, ICU days be reliably monitored, is there an existing data source
Cost of PICU care annually	• Not reflective of the role NPs play in care delivery - NP care is not seen in most billing for PICU care	• How can we best measure PICU care and how does that represent actual cost when NP not visible in billing • How changes to reimbursement influence the cost of care
Conceptual definitions r/t PICU, workforce and care delivery	• Consistent, clear definition and measure of these concept will facilitate continued, replicable research	• No research is necessary to address this gap, expert consensus is required to achieve a definition that can be adopted in all children's hospitals and PICU research

My career trajectory will support this research. I would like to conduct additional studies on the role of PICU providers in achieving optimal patient, family and organizational outcomes. In prioritizing next steps, research questions should focus on the roles of PICU providers along with elements of teamwork and interdisciplinary provider collaboration designed specifically to

advance knowledge relative to each provider's role and integration in the PICU team. I envision three studies focused on different populations of PICU team members: PICU NPs, PICU attending physicians and the broad interdisciplinary team.

The aims of the PICU NP study are: 1) to describe the day-to-day roles of PICU NPs in the provision of patient care and 2) to examine the NP's perception of preparedness for a role as a PICU NP. In the dissertation study, patient care delivery was identified as the most common clinical responsibility. Looking ahead, I intend to further explore the full range of clinical responsibilities. Non-clinical roles such as education, research, and leadership should also be evaluated along with the time PICU NPs have to fulfill non-clinical roles and outcomes that result from non-clinical time. A NP is often prepared for the role with bedside nursing experience, formal graduate education, and a hospital orientation. With an anticipated increase in the size of the PICU NP workforce in the coming years, the influence of these experiences in preparing a NP to work in the PICU has not been assessed and may contribute to a successful role transition and attainment of role actualization. It may also provide useful information for nursing educators.

Pediatric Intensive Care Unit medical directors reported a desire to increase the number of and expand the role for PICU NPs. An important unknown is what NP roles they hope to expand, how they would integrate additional NPs into the interdisciplinary care team, and what value they perceive in having a NP on the care team. I believe the best approach to begin to answer these questions is with a qualitative study where I can develop a sense of the language physician use to describe the PICU NP role. With a better understanding of what the desired role expansion may be and how the physicians describe NP value, a more informed descriptive survey can be designed to elucidate widespread physician perceptions of the value of PICU NP

care. I would like to target physicians from institutions that currently employ PICU NPs and those that do not currently employ NPs but in this study reported a desire to employ PICU NPs in the future to examine differences in perceptions of the PICU NP role.

The interdisciplinary care team is important in PICU care delivery but much remains unknown about the team. This study examined the provider membership (physicians, NPs and physician assistants) of the PICU team. The next interdisciplinary PICU team study aims are: 1) to describe the labor input and working conditions for all providers on the PICU care team; 2) to examine other professionals (pharmacist, dietitian, respiratory therapist, social worker, child life specialist…) involvement on the team and determine if these members involvement changes the provider workload; and 3) to identify key components of collaboration, teamwork, and knowledge of team members' attitudes toward other's involvement on the interdisciplinary team. This study will allow for determination of a "dose" of each provider. It also builds an understanding of how PICU team composition, collaboration and the interdependence of team members may relate to patient care outcomes.

Simultaneous efforts to establish PICU quality measures are an important component of future research on PICU outcomes and for the evaluation of providers' influence on care. Currently there are few PICU specific outcome measures (National Quality Forum, 2017). Researchers must play a role in developing valid and reliable PICU outcome measures that are appropriate for pediatric care and can be accepted and integrated into PICU research. High-quality outcome measures can be used to facilitate comparisons among provider groups and establish standards for PICU care. Most important, these measures must assess the NPs' clinical role and contributions to healthcare value (outcomes and costs).

These questions are next steps to furthering the knowledge of NPs' role in the delivery of PICU care. Advancing the descriptive understanding of the PICU provider teams and NP roles supports ongoing assessment of the variation in practices across the country. With knowledge of PICU teams, provider roles, and practice environments, comparisons among providers and patient outcomes assessed along with the identification of "best practices". After evaluating outcomes, interventions can be designed to modify roles and regulations of NP practice that influence PNPs' ability to provide PICU care. The long-term goal of this research will be to realize interventions that achieve optimal integration of PNPs into interdisciplinary PICU health care teams, ultimately producing positive child, family, and organizational outcomes.

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