DIFFUSION OF INNOVATION: DESCRIPTIVE ANALYSIS OF PEDIATRIC PREPAREDNESS IN EMERGENCY DEPARTMENTS

by

Kathi C. Huddleston

A Dissertation
Submitted to the
Graduate Faculty
of
George Mason University
In Partial Fulfillment of
The Requirements for the Degree
of
Doctor of Philosophy
Nursing

Committee:

_____	Dr. P.J. Maddox, Chair
_____	Dr. Loretta Normile, 1st Reader
_____	Dr. Daniel Barbara, 2nd Reader
_____	Director, PhD Program in Nursing
_____	Dean, College of Health and Human Services

Date: 2/28/08

Spring Semester 2008
George Mason University
Fairfax, Virginia

Diffusion of Innovation: A Descriptive Analysis of Pediatric Preparedness in Emergency Departments

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

By

Kathi C. Huddleston
Master of Science Nursing
California State University Fresno, 1982

Director: Dr. P. J. Maddox
College of Health and Human Services

Spring Semester 2008
George Mason University
Fairfax, VA

DEDICATION

To my Mother and Father…who always encouraged me to follow my dreams, and the hope that my children will pursue their dreams with abandon….

ACKNOWLEDGEMENTS

First and foremost I must thank my chair, P.J. Maddox; her mentorship provided a vision of health service research and its effect on health care. She had the patience to allow me to venture, and wander a bit, into new areas of research. Her support and guidance provided an opportunity for me to grow as a researcher and a health policy analyst and for that I am ever grateful.

My committee members and nursing faculty have provided me a rich graduate education. I thank the University and the College for their economic support and the chance to participate as a research assistant.

I gratefully acknowledge the institutional support that I received from the National Center for Health Statistics; without the support of Dr. Cathy Burt this study could not have taken place.

My studies would not have been the same without the academic and social support of friends and colleagues. The stress of school and work and life would have been too great had it not been for the diversions along the way provided by Mary Ann, Nancy, Odette, and Edith. Life goes on, even during graduate studies, and the richness of our chaotic lives forged a bond that will last forever. This all added to my education and many milestones have occurred with our ability to laugh and cry together.

I thank my husband for his unwavering faith in me, his continuing love and his timely nudges to complete this task. I thank my children. They unknowingly inspired me to go back to school; they have supported and loved me throughout this arduous process even at times when I was tired and overwhelmed! Most of all, I thank my mother who was there for my family every day of this journey.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

DIFFUSION OF INNOVATION: A DESCRIPTIVE ANALYSIS OF PEDIATRIC PREPAREDNESS IN EMERGENCY DEPARTMENTS

Kathi C. Huddleston, Ph.D.

George Mason University, 2007

Dissertation Director: Dr. P.J. Maddox

The purpose of this study was twofold: First, to identify essential pediatric resuscitative equipment gaps in the nation's emergency departments; second, to identify associations among and between the domains of *community* and *health care organizational structure* as they related to hospital emergency departments' (EDs) adoption of the 2001 "Care of the Child in the Emergency Department: Guidelines for Preparedness" (*Guidelines for Preparedness*) published by the American Academy of Pediatrics (AAP) and the American College of Emergency Physicians (ACEP). Diffusion of Innovation (DOI) is the theoretical concept by which multiple characteristics within the domains of health care structure and community were examined. The study was conducted using extant data from the Center for Disease Control and Prevention (CDC) branch of the National Center for Health Statistics (CDC/NCHS). This descriptive study examined the relationships regarding the organizational and community characteristics of emergency departments with the adoption of the *Guidelines for Preparedness*. Characteristics of pediatric

patient volume, pediatric subspecialty services, per capita income, urbanicity, and region were associated with the availability of pediatric emergency care essential equipment and services. Logistic regression was used to further explore variable relationships. The study identified hospital and community characteristics associated with pediatric emergency readiness and emergency medical care services essential for the care of critically ill or injured children. The study's community variables of per capita income and metropolitan status were significant, as were the structure variables of pediatric ED volume (size), pediatric trauma service, the presence of pediatric emergency medicine, and being a pediatric hospital. The DOI concepts of complexity and interconnectedness were drivers in both the adoption of the *Guidelines for Preparedness* and the compliance with pediatric essential emergency equipment. This study affirms that pediatric emergency equipment availability is a problem. Pediatrics continues to be an afterthought in emergency and disaster management, and as a nation we are not prepared for pediatric emergencies or pediatric disaster care.

I. INTRODUCTION

Today's emergency departments (EDs) are the entry doors to a complex health care system. They are an integral part of the community, providing primary health care, urgent care, high technology diagnostics, and treatments in addition to providing a medical safety net for the uninsured and a surveillance station for public health. Since 2001, the nation's EDs have been assigned the additional task of disaster planning and response. These multiple tasks have overwhelmed the health care system, leaving emergency departments that are described as "in crisis" and "at the breaking point" (Institute of Medicine & Committee of the Future of Emergency Care in the U.S. Health System, 2006). Numerous studies and media reports have described an emergency care system that is under-capacitated and lacks the basic items necessary to respond to a local crisis.

In 2003, 114 million visits were made to these complex care centers. Over the past decade more people are going to the EDs for care, with an increase in visits by 26% across the nation (McCaig & Burt, 2005). Emergency departments are being tasked with caring for larger numbers of critically ill patients and many EDs find it difficult to maintain the resources to provide quality care. Whether the ED is urban or rural, large or small, within a community of affluence or poverty, the task of rendering specialized

health care in an on-demand delivery system is challenging. Yet, recently there have been numerous ED closures, resulting in 12% fewer EDs over the past decade (McCaig & Burt, 2005). Increased patient care demands and decreases in facilities will continue, in turn leading to a decrease in capacity for disaster emergency response.

Of the 114 million visits in 2003, 30 million visits (27%) to EDs were pediatric emergency visits (McCaig & Burt, 2005). The challenge of providing children emergency care is more complex because of their different care needs requiring specialty trained personnel, as well as different supplies and equipment for diagnosis and treatment (Gausche-Hill & Wiebe, 2001; McCaig & Burt, 2004, 2005). Although studies have revealed a lack of emergency care equipment and supplies for children in the ED, few studies have systematically evaluated equipment and supplies for children. It was in response to these readiness gaps that, in spring of 2001, the "Care of the Child in the Emergency Department: Guidelines for Preparedness" (*Guidelines for Preparedness*) were published by two professional governing bodies, the American Academy of Pediatrics (AAP) and the American College of Emergency Physicians (ACEP). The *Guidelines for Preparedness* were developed to provide the ED with an essential list of emergency equipment necessary to care for critically ill or injured children. They were disseminated by publication in both lead professional journals (*Pediatrics* and *Annals of Emergency Medicine*) and also by direct mailing to emergency departments. These *Guidelines* were the first professional mandate to establish pediatric emergency service and equipment standards, and provided an innovative emergency care standard for children.

Soon after disseminating the *Guidelines for Preparedness* in the spring of 2001, the events of September 11, 2001 changed the nation. The terrorist attacks and subsequent anthrax attacks propelled the national health focus to emergency and disaster response. Specifically, in time of disaster, the *Guidelines for Preparedness* would assist in disaster readiness for the pediatric population. Yet much of the focus in health care's emergency and disaster response was centered on adult readiness, with little to no attention on pediatrics. The increasing public health role ascribed to the community hospital emergency department to be "all hazards" prepared for the community poses additional concerns regarding hospital emergency departments' abilities to provide adequate supplies, equipment, and supportive care for children in times of emergency and disaster (Krug & Kuppermann, 2005; Moody-Williams et al., 2002).

Purpose of the Study

The purpose of this descriptive study was twofold; first, to identify essential pediatric resuscitative equipment gaps in the nation's emergency departments to provide emergency care for children of all ages, and second, to identify associations among and between the domains of *community* and *health care organizational structure* as they related to hospital emergency departments' (EDs) adoption of the "2001 Care of the Child in the Emergency Department: Guidelines for Preparedness" (*Guidelines for Preparedness*) published by the American Academy of Pediatrics (AAP) and the American College of Emergency Physicians (ACEP). The ability to identify hospital and community characteristics associated with compliance with these *Guidelines* will benefit

planning and coordinating emergency medical care services for critically ill or injured children.

Diffusion of Innovation (DOI) is the theoretical concept by which multiple characteristics within the domains of health care structure and community were examined. The relationships that exist between and among the concepts of complexity and interconnectedness, as operationalized by the characteristics of pediatric patient volume, pediatric subspecialty services, per capita income, urbanicity, and region, were associated with the availability of pediatric emergency care essential equipment and services.

Background

The emergency care required by children is different from that of adults because they suffer from different illnesses, disease processes, and patterns of injuries. Children can not be treated with adult equipment, disease guidelines, or standards of care. Though 25-30% of ED encounters are children, they often present unique diagnostic challenges (Athey, Dean, Ball, & Weibe, 2001). Providing pediatric emergency care is complicated by children's unique physiological, developmental, and psychological needs. Small children are not able to communicate what hurts or why they feel sick, making their triage more difficult. Assessing and recognizing serious illness in children requires specially trained and educated health care providers. Yet, even in the hands of an experienced clinician, there is an additional need of varied sizes of essential equipment to appropriately assess and treat the child.

Pediatric emergency care requires a different set of skills and equipment from adult care. Numerous tasks such as vascular access and airway management are much more technically challenging skills in children. The ability to access a vein in a small infant is a technical skill that requires experience, but it also requires the availability of a smaller intravenous catheter. Numerous sizes of airway adjuncts are essential to care for children from infancy through adolescence, whereas adult airway management requires few pieces of equipment. Medication is another challenge in pediatric emergency care as doses must be carefully calculated specific to the child's weight. Children have a smaller range of error in medication administration because of differences in renal and hepatic function as well as dosing by weight (MacLean, Dacsy, Juarez, Perhats, & Gacki-Smith, 2006; White, Henretig, & Dukes, 2002a).

Whereas the first hour after injury (the golden hour) is the trauma standard for adult care resuscitation, the trauma standard for children is a half-an-hour (the platinum half-an-hour) because a child progresses from injury or illness to death faster than an adult; the smaller the child, the more quickly he or she progresses from serious illness and injury to death. Thus, children's emergency care requires not only specialized training and equipment but also requires efficiency in the emergency system to ensure that the proper level of emergency care can be provided efficiently in an organized and timely manner (Haller, 2002; Ramenofsky, Luterman, Quindlen, Riddick, & Curreri, 1984; Seidel et al., 1999; Seidel & Gausche-Hill, 2001; Surpure & Walker, 1992; Young, Gausche-Hill, McClung, & Lewis, 2004).

There have been numerous studies that reveal an emergency care system that is inadequately prepared for children and postulate that every year children die needlessly due to the lack of simple resources and equipment. This is a serious problem. Children represent 25% of the population (McCaig & Burt, 2005) and although usually healthy, when ill, children lack the reserves to compensate, succumbing to illness quicker than their adult counterparts. The National Hospital Ambulatory Medical Care Survey (NHAMCS) estimates that of the 114 million patients who visit the over 4800 emergency departments of our nation's hospitals annually, 30 million are children (McCaig & Burt, 2005). The emergency department must be able to care for all people in the community who require acute health care services. Additionally, there is the assumption that emergency departments be the focal point of disaster planning efforts, ready to care for the community in times of crisis. The challenge to health policy makers and health care delivery systems, politicians, administrators and clinicians is to ensure emergency care services provide coordinated care for children who arrive ill or injured to the emergency department for any reason and under any circumstance (Chaloupka & Johnston, 2007; Hohenhaus, 2005a; Holahan, Weil, & Wiener, 2003).

Problem Statement

There is a substantial need for well-equipped and -staffed emergency departments (EDs) adequately prepared to provide emergency care to children of all ages in all communities. The problem is twofold; first, the availability of essential pediatric equipment and supplies—particularly resuscitative equipment—are highly variable in emergency departments. It is not known whether a specific age group of children may be

at greater risk for lack of essential resuscitative equipment. Secondly, it is not known if community or health care characteristics are associated with the availability of pediatric services, essential equipment and supplies. Though studies document the lack of essential resuscitative equipment for children in emergency departments, few systematic evaluations have ascertained how widespread the problem is or what other deficiencies may be associated with this lack.

Further, although studies document inadequate pediatric resuscitative equipment in EDs, these studies have not attempted to group or categorize the equipment to identify a potential at-risk age group. Patient data often refer to a mean age or an average ED encounter, neither of which relate in any way to the equipment essential for actually delivering care. Specialized equipment for children is required according to their age, length, and weight; different equipment is required for an infant, a preschool, or a school-age child. Thus, there is a need to explore the availability of resuscitative equipment grouped appropriately into the categories of infant, preschool, or school-age children in order to identify potential gaps (Gausche-Hill, 2007; Gebbie, Rosenstock, & Hernandez, 2003; Hohenhaus, 2006b; Seidel & Gausche-Hill, 2001; Szilagyi et al., 2002).

While there are few standards of care in pediatrics, the *Guidelines for Preparedness* do provide information on essential pediatric emergency equipment and services (Gausche-Hill & Wiebe, 2001; Isaacman, 1990). Yet, as of this research, the adoption of the *Guidelines for Preparedness* into clinical practice had not been documented or studied (Burt & Middleton, 2007; Gausche-Hill, Schmitz, & Lewis, 2007). It is important to understand what contributes to the persistent gaps in pediatric

emergency equipment availability in order to resolve this quandary. Although there is interest in the process of adopting research- or evidence-based practice models into clinical practice, there has been little research on what influences adopting these standards, or clinical guidelines into pediatric emergency and disaster care. The influence of community and health care organizational characteristics outside of the emergency department is one of the most important components of standards adoption. Identifying relations, if any, among and between the domains of organization and community may identify problem-solving interventions other than those associated with a lack of awareness or other human factors (Richardson, Babcock Irvin, & Tamayo-Sarver, 2003).

Need for Study

There is a need to identify children and hospitals at risk for lack of emergency equipment, services, and supplies. This study sought to evaluate the availability of essential equipment for infant, preschool, and school-age children so as to demonstrate the gaps in emergency care practice patterns, as well as identify the associations between the availability of essential pediatric emergency equipment and supplies and the health care organizational structure and community characteristics. There is a related need to identify hospital and community characteristics associated with adopting the *Guidelines for Preparedness* to benefit planning and coordinating emergency medical care services regarding critically ill or injured children. Finally, there is a need for disaster management teams to understand the practice patterns of emergency departments as related to pediatric emergency services and equipment availability.

The study sought to assess the domains of health care organizational and community characteristics associated with adopting the "Care of the Child in the Emergency Department: Guidelines for Preparedness." It examined the links between these domains and the associations between and among characteristics such as emergency care patterns, pediatric specialty services, community economics, and geography, to pediatric preparedness. Further, community and organizational structure that was considered exemplary was analyzed in an attempt to establish factors related to higher levels of hospital and ED preparedness. Specific factors related to pediatric emergency preparedness gaps were identified so health care administrators, federal and state policy makers and disaster planners may address these issues (Burkle, 2003; Butler, Panzer, & Goldfrank, 2003; Phillips, 2003). The efficiency and quality of the nation's disaster care response cannot be separated from the structure, capacity, and utilization of pediatric emergency care facilities (Bravata et al., 2004; Clements & Evans, 2004; "Health Departments," 2004).

Research Questions

This study examined the differences in the availability of resuscitative equipment essential for infants, preschoolers, and school-age children. It also examined the associations between various characteristics in the domains of organization, geography, and community with the availability of essential pediatric resuscitative equipment. The following questions were examined.

Research Question One: What is the gap in the availability of essential pediatric resuscitative equipment, and are there differences by pediatric age category? What is the

state of equipment available for children, and are there differences in equipment availability by pediatric age category (infants, preschool, and school-age children) in U.S. emergency departments?

Research Question Two: Is a hospital's designation as a pediatric hospital associated with increased availability of essential pediatric resuscitative equipment? Are there differences in the availability of essential pediatric resuscitative equipment in the emergency departments of pediatric hospitals as compared to the emergency departments in community hospitals?

Research Question Three: Within the domain of *Community*, are characteristics such as region, metropolitan service area, and per capita income associated with the increased availability of essential pediatric resuscitative equipment in emergency departments?

Research Question Four: Within the domain of *Structure* are hospital organizational characteristics, such as the presence of a pediatric trauma service, a pediatric emergency care physician, or the volume of pediatric patients seen in the ED, associated with increased availability of essential pediatric resuscitative equipment in emergency departments?

Definitions of Terms and Variables

Table 1 provides definitions of terms used throughout this study. Table 2 defines the study's variables.

Table 1

Definitions of Terms

Term	Definition
Child	Person under the age of 18 years.
Emergency Medical System (EMS)	Services developed and used for delivering emergency care from pre-hospital to hospital care; highly variable in different regions.
Standards for Care	Evidence-based practice recommendations that are research derived and driven. To be used as a benchmark for quality assurance or to develop quality control measures. Usually presented by professional organizations involved in promoting and evaluating quality care.
Guidelines for Preparedness	"Care of Children in the Emergency Department: Guidelines for Preparedness" (2001) publication developed by the American Academy of Pediatrics (AAP) Committee on Emergency Care and the American College of Emergency Physicians (ACEP), Pediatric Committee, establishing the "necessary resources to ensure that children receive quality emergency care." These Guidelines took 3 years and multiple revisions to develop; they were endorsed by 17 professional organizations. These guidelines recommended equipment, supplies, and services.
Adoption of the *Guidelines for Preparedness*	In compliance with the American Academy of Pediatrics (AAP) and American College of Emergency Physicians (ACEP) "Care of Children in the Emergency Department: Guidelines for Preparedness" (2001), specific to the availability of pediatric essential equipment for emergency care.
American Hospital Association (AHA)	The national proprietary organization representing approximately 5,000 member hospitals. The mission stresses leadership in public policy, representation and advocacy, and services (AHA, n.d.).
National Association of Children's Hospitals and Related Institutions (NACHRI)	The not-for-profit organization of children's hospitals, large pediatric units of medical centers and related health systems. It offers a database of over 160 member institutions (NACHRI, n.d.).
Children's Hospital	A facility that is thus designated by either the American Hospital Association (AHA) (personal communication, AHA, June 2006) or the membership of the National Association of Children's Health Related Institutions (NACHRI).
Community Hospital	For the purpose of this research, any hospital that is not deemed a pediatric hospital (for purpose of ED assignment).

Table 2

Definition of Variables

Term	Conceptual Definition	Operational Definition	Data
Per Capita Income (PCI)	Per Capita Income is defined by the regional economic information system (REIS) from the Bureau of Economic Analysis (BEA division of Department of Commerce).	PCI was divided into three categories: PCI less than $25,000, $25,000 to $34,000, greater than $34,000, defining per capita income per county.	National Hospital Ambulatory Medical Care Survey (NHAMCS) – Area Resource File (ARF). Data is: Categorical and Applied.
Region	Grouping of the states and District of Columbia for the purpose of census data; the four regions are relatively homogeneous. The last revision by the U.S. Census was 1950.	The regions are four distinct areas: Northeast, South, Midwest and West.	Hospital Sample File: Region 1 = Northeast 2 = Midwest 3 = South and 4 = West. Data is: Categorical and Applied.
Metropolitan Service Area (MSA)	A geographic entity designated by the federal Office of Management and Budget for use by federal agencies. A metropolitan statistical area is a statistical entity division of community size by the U.S. Census Bureau.	Defining a metropolitan statistical area as a statistical entity; division of community size to delineate rural from urban areas.	SMG File (MSA) – Metropolitan Service Area label for urbanicity 1 = Urban 2 = Rural. Data is: Categorical and Applied.

Term	Conceptual Definition	Operational Definition	Data
Pediatric Intensive Care Unit (PICU)	Specialty care inpatient unit dedicated to children who have pediatric intensivists available. These units provide the most complex care to children. Not a clear definition or accreditation, but studies report between 375-480 in the nation.	Unit of care that would be capable of providing children the required intensive care such as brain injury, multiple severe traumatic injuries, meningitis, and respiratory failure requiring intubation.	NHAMCS – Section 1 Question 7. Pediatric patients requiring intensive care (such as brain injury, multiple severe traumatic injuries, meningitis, and respiratory failure requiring intubation would be cared for: 1 = in PICU 2 = in adult ICU 3 = in another hospital. Data is: Categorical and Self-Reported.
Pediatric Trauma Service (PTS)	Trauma service is state defined with regulatory and accreditation processes that use trauma (adult) guidelines and recommendations; not all states operate under trauma system regulations and not all regulated "trauma centers" have pediatric criteria or services.	System of trauma care that provides specialty care for children from emergency department encounter to discharge, providing coordinated trauma care for a pediatric patient from admission to discharge; a higher level of provider care, thus a higher level of institutional commitment to pediatrics.	NHAMCS – Section 1 Question 4. Does your institution have a pediatric trauma service, that is, coordinated trauma care for a pediatric patient from admission to discharge? 1 = yes 2 = no Data is: Categorical and Self-Reported.

Term	Conceptual Definition	Operational Definition	Data
Pediatric Emergency Medicine	Emergency Medicine Subspecialty recently established the American College of Emergency Physicians (ACEP) in 1999; providing specialty pediatric emergency care in the emergency department.	The access/availability of 24 hour/7 days a week access to a Board Certified Pediatric Emergency Medicine Attending Physician, providing a higher level of provider care thus a higher level of institutional commitment to pediatrics.	NHAMCS – Section 1 Question 10b. Does your emergency department have 24 hour, 7 days a week access to a Board Certified Pediatric Emergency Medicine Attending Physician on call? 1 = yes 2 = no Data is: Categorical and Self-Reported.
Pediatric Visit Volume	Pediatric Annual emergency department visit volume; number of pediatric patients seen in the emergency department.	Pediatric volume in annual number of Pediatric emergency department visits, as volume can be a marker for quality and readiness of supplies and services.	NHAMCS – created file by National Center for Health Statistics (NCHS). Emergency department visit volume multiplied by percent of pediatrics patients in the emergency department. Data is: Categorical and Self-Reported.
Pediatric Hospital	A hospital that is a major participant in a pediatric residency program, according to the Accreditation Council for Graduate Medical Education (ACGME, n.d.).	Major commitment to pediatrics as evidenced by greater than one month commitment to pediatric education as recognized and accredited by (ACGME).	Recoded data of matches for ACGME and NHAMCS hospitals – To establish a subset of "pediatric hospitals" in the data set. Data is: Dichotomous and Applied.
Emergency Pediatric Services and Equipment Supplement (EPSES) Weight	Hospital weights for emergency departments with a responding EPSES for national weighting of the data.	SUDAAN statistical weighting used for NHAMCS data and sampling frame.	SUDAAN statistical weighting used for NHAMCS data and sampling frame. Data is: Dichotomous and Applied.

Term	Conceptual Definition	Operational Definition	Data
Infant Resuscitation (INFRESUS)	Equipment listed from the Guidelines for Preparedness and EPSES necessary for infants, children under one year and 12 kg. to include the Broselow color coding of pink, red, and purple.	List of 53 items from the Guidelines for Preparedness and the EPSES, size-specific according Broselow coding and further verified with expert opinion.	Recoded variable that contains 53 items – all items must be present for meeting criteria. Data is: Dichotomous.
Preschool Age Resuscitation (PRSRESUS)	Equipment listed from the Guidelines for Preparedness and EPSES necessary for preschool age children, generally 1 - 4 years and/or 12 - 18 kg. Broselow color coding of yellow and white.	List of 54 items from the Guidelines for Preparedness and the EPSES, size-specific according Broselow coding and further verified with expert opinion.	Recoded variable that contains 54 items – all items must be present for meeting criteria. Data is: Dichotomous.
School Age Resuscitation (SCHAGERESUS)	Equipment listed from the Guidelines for Preparedness and EPSES necessary for school-age children, 5 - 10 years, and/or 19 - 28 kg. Broselow color coding of blue and orange.	List of 59 items from the Guidelines for Preparedness and the EPSES, size-specific according Broselow coding and further verified with expert opinion.	Recoded variable that contains 59 items – all items must be present for meeting criteria. Data is: Dichotomous.

Study Assumptions

One assumption of this study is that the two national ED surveys, the National Hospital Ambulatory Medical Care Survey (NHAMCS) and the Emergency Pediatric Services and Equipment Supplement (EPSES), adequately reflect actual and current hospital conditions, as the surveys rely on some self-reporting. It is further assumed that the data collected on site, by members of the U.S. Census Bureau, is reflective of care practices and does present a picture of national emergency care through the snapshots of data collection.

Another assumption for this research is that the "Care for the Child in the Emergency Department: Guidelines for Preparedness" (American Academy of Pediatrics, 2001) is an appropriate guideline for the scope and purpose of the research study. Availability of the essential resuscitative equipment does not, per se, indicate quality pediatric emergency care—but does provide a minimal standard of care.

Significance of the Study

Emergency care is an essential public health service that ensures equal and adequate care for all community members, including children. This study adds to the body of research documenting the lack of pediatric essential emergency equipment, and provides details about disparities in ED pediatric preparedness as associated with health care structure and community characteristics by examining the social connectedness of health care organization and community characteristics to emergency departments' compliance with the *Guidelines for Preparedness.* This knowledge assists in both everyday emergency responses and disaster mitigation and response planning by identifying the gaps in equipment and identifying hospitals with a social networking pattern associated with compliance to the *Guidelines for Preparedness*.

This information is useful to establish equipment par levels for both daily emergencies and disaster response. Disaster preparedness further requires identifying optimal resource facilities for treatment and staging areas. Identification of "best practice" pediatric hospitals associated with certain health care organizational and community characteristics enables emergency planners to identify primary and secondary pediatric disaster response sites.

Summary

This chapter introduced the current crisis in emergency care and that crisis's potential effects on pediatric emergency care. It described the noted gaps in pediatric emergency care and discussed the potential of the domains of organizational structure and community characteristics influencing pediatric emergency care. Characteristics to be examined are pediatric patient volume, pediatric subspecialty services, per capita income, urbanicity and region—characteristics associated with the availability of pediatric emergency care essential equipment and services. The desired impact of this study, to influence current emergency department readiness and disaster preparedness, was stated, and terms were conceptually and operationally defined. The next chapter discusses using Diffusion of Innovation as theory and explains the rationale for the theoretical framework. A review of the literature also includes pertinent information regarding emergency and disaster care trends in the U.S.

II. REVIEW OF LITERATURE

Introduction

Diffusion of Innovation (DOI) was utilized as the theoretical construct for this study of pediatric emergency care and preparedness as associated with community and organizational characteristics. DOI supported examining how pediatric emergency care adopted the *Guidelines of Preparedness* and facilitated identifying gaps in the adoption process. The literature review also delves into the background of emergency and disaster medicine as it applies to current trends in emergency care, pediatric emergency care and the availability of essential pediatric emergency equipment and services as well as disaster care preparedness. To understand the deficiencies in pediatric emergency care it is necessary to understand the differences in standards and care delivery patterns for adult emergency care as compared to children's.

Diffusion of Innovation Theory

The theory of Diffusion of Innovation (DOI) by Rogers (2003), first published in 1962, has been used to study innovation in areas as diverse as education, agriculture, communication and health care. Thus, the theory's versatility has been established because it allows innovation to be examined through a variety of "lenses."

There has been interest in how organizations adopt innovation, but although numerous publications present and discuss an organization's pattern of adoption of innovation, there has been little systematic research in emergency health care (Lansisalmi, Kivimaki, & Ruoranen, 2006; Rogers, 2003).

Diffusion is the process by which the innovation is communicated and shared among members of a social network. *Innovation* is "an idea, practice, or object that is perceived as new by an individual" or organization (Rogers, 2003). The perceived "newness" of an innovation may be expressed in terms of the knowledge, persuasion, or decision to adopt the innovation by the individual or organization. Adopting an innovation is accepting the innovation into the culture, workplace, or system. A majority of the diffusion research studies have examined technology innovations because technology and innovation have become synonymous. There has been interest regarding factors that promote or slow diffusion of an innovation in areas as diverse as farming practices to new pharmaceutical distribution patterns (Coleman, Katz, & Menzel, 1966; Ryan & Gross, 1943). Diffusion of practice standards or guidelines is currently popular as health care attempts to provide evidence for best practices and to minimize variance in clinical practice standards (Feifer et al., 2006; Lansisalmi et al., 2006; Meakins, 2006).

This theory has been used repeatedly in areas from agriculture to zoology, which adds to the methodology's robustness. Exploring the innovation decision process in organizations involves assessing the innovation, the organization's characteristics and the larger community environment, according to Rogers (1995, 2003). DOI research illustrates the social network of components that are integral to organizational diffusion

of innovation. Rogers further describes the variables in organization innovativeness as internal organizational structure, and external community and system characteristics (2003). New ideas, such as the *Guidelines* or standards, even when clearly advantageous, are difficult for individuals or organizations to adopt. DOI examines the interconnectedness of the individual, the organization, and the community in adopting innovation. By exploring an innovation's adoption or non-adoption, DOI provides a framework to evaluate the various characteristics and how they affect the adoption process.

By examining the adoption decision process, DOI explores the way an innovation is "communicated through certain channels over time among members of a social system" (Rogers, 1995). Diffusion is the process of social change, initiated by communication and a convergence of thoughts, based on the interplay and interactions of the following elements: (a) the innovation, (b) the organization structural characteristics, (c) the social capital characteristics, and (d) the larger community characteristics (Rogers, 2003). Accordingly, innovativeness is related to organizational size, geographical location, socioeconomic status, level of education and social networking (Rogers, 1995).

Theoretical Framework

This study sought to examine the adoption process of the *Guidelines for Preparedness* in regard to the domains of community and organizational structure through the lens of DOI. Studies have demonstrated that characteristics of the culture, social context, and community in which the organization functions need be taken into account (Fleuren, Wiefferink, & Paulussen, 2004). Though the adoption process can be

analyzed by innovation, individual, or institutional characteristics, this study looks at the associations among and between these characteristics and adopting the *Guidelines for Preparedness*. The study explores the organizational structure; the hospital, the ED, and pediatric specialty services, along with the community domains; and the characteristics of region, economic markers, and urbanicity, as the innovation's adoption is influenced by these organizational, geographical, and community characteristics (Rogers, 1995).

The organization's characteristics have an impact on the innovation-decision process and influence the choice of whether or not to adopt an innovation. Qualities such as complexity and interconnectedness are central concepts to DOI and create the environment for adoption. An organization's type, organizational structure, and size are related to organizational innovativeness (Rogers, 2003). Numerous scholarly studies of organizations' innovativeness demonstrate the positive relationship of these variables (Coleman, Katz, & Menzel, 1959; Goes & Park, 1997; Greer, 1995; Rogers, 2003). Structural characteristics establish the influences of interconnectedness and complexity; subspecialties such as pediatric trauma services or pediatric intensive care units influence the complexity, interconnectedness, and hierarchal patterns within the system.

In this study, a broad definition of community is used as organizations reflect the values, standards, and ethics of the community in which they are housed. Community also includes channels of communication which create the webbing of social networks. Characteristics such as income, poverty, growth patterns, and education are taken into consideration along with the community's innovativeness and "cosmopoliteness" (Aday, 2005; Kissoon, 2006; Rogers, 1995). Social capital plays a significant role in diffusion

research. Education, affluence and the "cosmopoliteness" are community characteristics associated with adopting innovation, including the factors of community economics and urbanicity. The organization's interconnectedness organization is evidenced by its membership in professional groups and organizations that have an effect on social communication patterns (Aday, 2005; Budrys, 2003).

Because the role of the ED is to provide 24-hours-a-day, 7-days-a-week care, it becomes integral to both the health care organization and the community, it is valuable to identify the characteristics that drive or impede adoption of innovation in health care (Fleuren et al., 2004). The influence of interpersonal communications, connectedness, and complexity appear to be strong values in diffusion of innovation among health care professionals and physicians (Coleman et al., 1959)—thus studying the role of pediatric subspecialty services is of value. The size and purpose of the health care organization will influence the social capital: The mission of an academic health center would focus on communications with professional organizations, whereas a small rural hospital would more likely emphasize community relationships. This study identifies the organizational and community characteristics that influence EDs in adopting the *Guidelines for Preparedness.* These guidelines will be used to identify characteristics of the exemplars and best practices associated with compliance. As depicted in Figure 1, the framework is devised using Rogers' Theory of Diffusion of Innovation (2003) and the *Guidelines for Preparedness*.

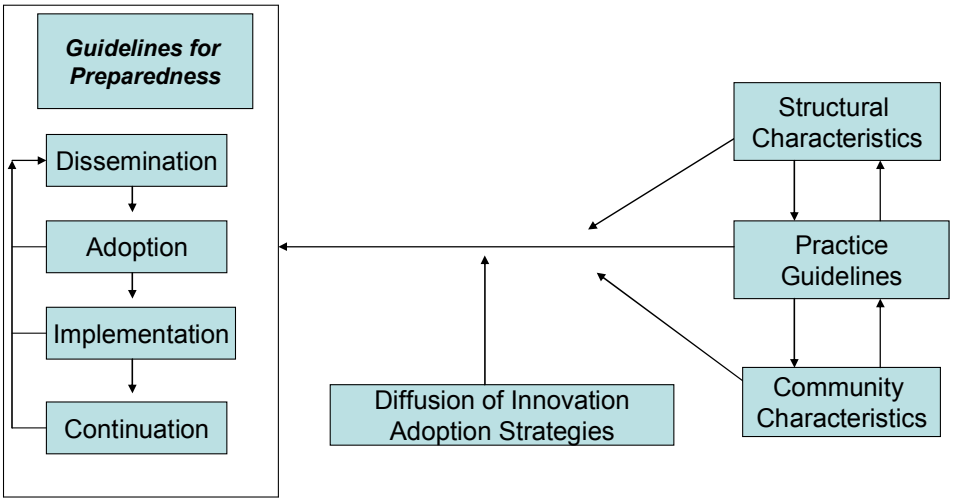

Figure 1. Diffusion of Innovation and pediatric preparedness.

Innovation and Health Care

There are three types of innovation-decisions:

- optional innovation-decisions are choices made to adopt or to reject an innovation made by an individual, and are independent from other people or the organization;
- collective innovation-decisions are choices made to adopt or to reject an innovation made by consensus of the system or by a representative committee;
- authority innovation-decisions are made by a small group of people who possess the power, position, or expertise. (Rogers, 2003)

The consequences of the innovation-decision are powerful influences on the diffusion reaction within the social system. How the system responds to the innovation and the changes that occur to the individual, unit or system exerts a powerful influence on future

diffusion patterns. Of interest, there are also affects of diffusion clustering and repeat performances. Such patterns become established and the system follows the pattern set by another more innovative system within in the same business, state, or established social network (Rogers, 2003; Walker, 1966). If one institution or region were to adopt a practice or guidelines, then theory suggests other institutions that share a common characteristic would cluster.

Health care is a dynamic and innovative environment; in fact, parts of the health care system depend on introducing innovation, including new drug therapies, new surgical techniques, new system technologies and regulatory practices. However, another part of the system is vested in maintaining the status quo, including privacy and security issues thwarting electronic records, certificates of need, and regulatory pressures to reduce costs (Lansisalmi et al., 2006). New technology, drug therapies, and practice guidelines form part of an effort to keep the health care environment competitive and competent. Guidelines of practice are being researched as innovations designed to minimize variance of practice in delivering health care (Dharshi, 2006; Handel, Sklar, Hollander, Asplin, & Hedges, 2007; Moody-Williams et al., 2002). Consistent practice facilitates collecting data and modifying treatment guidelines based on research. Therefore, the adoption of innovations such as guidelines and practice standards requires systematic analysis and evaluation to promote quality care. Hence, the DOI was utilized for this study.

Diffusion of Innovation is the framework of many quality and performance measurement organizations, and the Agency for Healthcare Research and Quality

(AHRQ) (as cited in Clancy, 2003) remarked as such in Congressional Committee, highlighting the problems of achieving "research to practice." In defending AHRQ's commitment to the research of Diffusion of Innovation, Clancy stated that the research-to-practice process was prolonged and ineffective, illustrating the point: "a research grant that ultimately yielded useful findings to the widespread diffusion and adoption of those results was at least 17 years" (Clancy, 2003). Innovation research is a method through which to identify effective characteristics of innovations and organizations in order to speed the pace of their diffusion throughout health care organizations (Lansisalmi et al., 2006; Phillips, 2003).

The diffusion of innovation is particularly slow in pediatric health care, due in part to the continuing concerns and difficulties of translating adult care to pediatrics. Supplies, equipment, medicines, and practice protocols are difficult to transfer. Many drugs, some used routinely in practice, are considered "off label" because research has not been done to justify its use in children. The barriers to pediatric drug research are difficult (Osuntokun, 2006). Equipment is difficult to "size down" and often requires different materials or styling due to developmental concerns. In particular, emergency care and clinical protocols regarding resuscitative efforts are difficult to research due in part to the additional challenge of informed consent, assent, and the ethical concerns of working with a fragile and vulnerable population (IOM, 2006).

This review of pediatric emergency care is based on references from nursing-, medicine-, health policy-, and health care services-related literature. Limited nursing and health science literature exists in the area of pediatric emergency readiness, whether in

emergency care or in the concept of disaster planning. Pediatric emergency literature largely focuses on injury prevention, pre-hospital care, and emergency care. But pediatric emergency medicine models of care have begun to develop in support of evidence-based practice and standards of care. Federally supported organizations such as the Institute of Medicine (IOM), the Agency for Healthcare Research and Quality (AHRQ), the Center for Disease Control and Prevention (CDC), and the National Center for Disaster Planning at Columbia Mailman's School of Public Health, along with other private and philanthropic foundations such as Trust in America, the Kaiser Foundation, Robert Wood Johnson Foundation, and The Children's Fund have supported much of the work regarding the emergency and disaster readiness and concerns of pediatric emergency care (Bekemeier, Riley, & Berkowitz, 2007; Bekemeier, Riley, Padgett, & Berkowitz, 2007; Chaloupka & Johnston, 2007; Chien, Tai, Chu, Ko, & Chiu, 2007; Croen, Najjar, Ray, Lotspeich, & Bernal, 2006; Falk, Klang, Paavonen, & von Wendt, 2007; Khan et al., 2007; Richardson et al., 2003).

Trends in Emergency Care

Background

The concept of emergency care, as well as disaster care, has been derived from wartime experience. Ancient Greeks and the Romans recognized the importance of transporting their wounded soldiers in chariots to areas for treatment. The American Civil War birthed the concepts of emergency services in the late 1860s. After World War II, the value of prompt pre-hospital treatment was again recognized. The initial development of our civilian trauma care system was influenced greatly by the wars in Korea and

Vietnam. These wars' physicians returned home and recognized that field emergency care services surpassed anything available stateside. Thus, emergency response, trauma, and disaster care developed and were centered on adult experiences, concepts, standards of care, and equipment (for more information on disaster care and children, see Appendix A).

Today's emergency departments are an entry door to the health care system. They are available 24 hours a day, 7 days a week, and are an integral part of the health care system, providing both primary care and highly complex care. Media reports have revealed an overwhelmed EMS system that has slow response times, ambulance diversions delaying treatment, failure to deliver adequate care issues and emergency department closures. These emergency care system problems have, in turn, affected the coordination of emergency care services at every point in care and have stretched the emergency care system to the breaking point. The financial burden of providing primary medical care to the uninsured as well as specialty care and life-saving therapies to the critically ill has caused many hospitals to reconsider the cost/benefit ratio of an ED. Numerous emergency departments have closed because of financial and economic pressures, yet the quantity of patients requiring care has not decreased; to the contrary, the number of ED visits has increased.

Emergency Department Overcrowding and Closures

The influx of patients is a multifaceted problem. A great number of uninsured and underinsured use the ED for their health care due to access and system difficulties. Emergency departments are the "safety net" of the health care system—and that "net" has

been noted by many to be unraveling, thread by thread (Holahan, Dubay, & Kenney, 2003; Holahan, Weil et al., 2003; Isaacman, 1990; Surpure & Walker, 1992), The ED has also become an adjunct to primary care physicians and for patients, with or without insurance, who choose to use the ED for convenience and access to advanced diagnostics. Over the past decade there has been an increase in patient volume of 20%; meanwhile 12 - 15% of the nation's emergency departments have closed because of financial constraints. ED overcrowding partially reflects an increase in patient load, but other factors also apply, such as the increasing care associated with chronic illness, the growing number of under- and uninsured, the lack of primary care access, and fragmentation of the emergency care system (Cappiello, 2002; Government Accountability Office (GAO), 2003; McCaig & Burt, 2005). Emergency department and trauma center overcrowding is considered a national epidemic.

In the most recent related IOM report, *Hospital-Based Emergency Care at the Breaking Point*, the greatest challenge to emergency care was identified as the overwhelming patient loads (IOM, 2006). This problem has garnered national media attention as well as investigations from numerous federal agencies, among them the U.S. Congress, the CDC, AHRQ, and the Government Accountability Office (GAO). Safety and quality care concerns have been discussed on the pages of the *New England Journal of Medicine* and the *Wall Street Journal*. The emergency department is a high-risk area and exposes patients to a number of threats to patient safety by its nature—care is often chaotic and done in haste with little or no knowledge of the patient's history (Leape et al., 1991). This crisis directly affects emergency care, hospital disaster preparedness,

availability of specialists, and support for emergency and trauma care. Research is needed to improve clinical practice but is difficult in this already vulnerable system of emergency care (Gausche-Hill, 2003, 2006; Holahan, Weil et al., 2003; IOM, 2006; Seidel et al., 1999). Studies and reports from the preceding health care researchers reveal

1. the number of ED visits is increasing;
2. the complexity of care and procedures performed in the ED is also increasing; and
3. the length of time that a patient waits in the ED to see a physician is increasing exponentially.

These ED trends are affecting the delivery of quality emergency care—and have even greater potential to impact the quality of pediatric emergency care (Gausche-Hill & Johnson, 2003; Kellerman, 2007).

Emergency Medical System for Children

Background

One-hundred-fifty years ago the first children's hospital was established in Philadelphia, Pennsylvania. Initially, children's hospitals were financed by philanthropic organizations and located in poor urban communities. The mission of the children's hospital was to provide medical care to poor children. These hospitals were centered on primary medical care. In the '60s when subspecialties of pediatrics blossomed, an interest in caring for critically ill children followed the innovations of pediatric surgery.

It was also in the 1960s that cardiopulmonary resuscitation (CPR) was shown to be effective to restore breathing and circulation and the value of emergency care was

established. Thus, over the past 50 years there have been opportunities for the care of critically ill children and the development of the emergency medical services (EMS) system to intertwine and grow together. Both health care services have matured and advanced, but emergency care for children emerged fragmented. The nation's emergency care system was designed to care for adults—children were an afterthought.

Care of the Child

Most young children visit the emergency department (ED) with complaints that are related to the respiratory system. Therefore, a large focus is needed on pre-hospital care and equipment requirements to include vascular access and respiratory adjuncts (Gausche-Hill, 2000). Children not only have smaller systems, they have very different respiratory systems and are at greater risk of respiratory failure. Respiratory distress is the most common reason for children to be seen in the ED and admitted to the hospital, and is the most common cause of death in young children. The ability to stabilize the airway and circulatory systems in the field is the cornerstone of pre-hospital care and it is a most challenging task in children (Beitel, Olson, Reis, & Mandl, 2004; Lipski et al, 2006, Surpure & Walker, 1992). Whereas medical complaints are more common in the younger child, the older child is more likely to be in the ED due to an injury. There are also a growing number of children with chronic illness. Over 20% of children suffer from a chronic illness; not surprisingly, many of these children seek emergency care related to chronic illnesses such as asthma and diabetes (Henderson, 2002). As the overall ED visits for chronic illness rise, with over 2 million asthmatics are seen annually (Akinbami, 2006) and diabetes presenting a growing role in ED encounters (Goyder, 1997), factors

such as health insurance, access to care, and medical compliance issues will soon be pediatric emergency care problems.

More children are seeking care in the ED today, with an increase from 18% to nearly 26% from 1999 to 2003, with over 30 million children seek care at EDs every year. Studies concur and validate increasing trends in the pediatric ED due multiple reasons: chronic health care needs are rising, lack of adequate insurance continues, and the special needs population presents unique challenges to emergency care. Though the majority of pediatric visits are for children over the age of five, infants make up a disproportionately large number of pediatric visits. In the first year of life infants have a visit rate of 96.2 visits per 100 persons (McCaig & Burt, 2003, 2004, 2005; McCaig & Nghi, 2002). ED usage is highly dependent on age, yet there is also research that describes factors of race, insurance coverage, geographical, and access barriers, as well as family resources playing a role in ED usage (James, Bourgeois, & Shannon, 2005; Szilagyi et al., 2002; Taylor, 2006). Little work has been done on evaluating the role of community in relationship with pediatric emergency care (Fifield, Magnuson, Carr, & Deinard, 1984).

Pediatric Emergency Care

In the 1970s, studies began to analyze the differences in pediatric emergency care. These studies revealed illness and injury patterns different from those of adults and pediatric patient outcomes different from adult outcomes (Seidel et al., 1984). Studies identified pediatric deaths as nearly twice as common as adult deaths with similar injury patterns, that pre-hospital care was lacking, and that appropriate equipment needed to

treat children was missing (Fifield et al., 1984; Ramenofsky et al., 1984; Seidel et al., 1984). Ramenofsky identified that half of pediatric trauma deaths were avoidable if appropriate medical treatment had been provided (Ramenofsky et al., 1984; Seidel et al., 1999). Studies, such as those by Seidel et al. (1984, 1986, 1999), Seidel and Gausche-Hill (2001) and Zaritsky, French, Schafermeyr, and Morton (1994), noted that pre-hospital caregivers lacked experience and expertise with children, the EMS curriculum under-represented pediatrics, and only 10% of the ambulance calls involved children. Soon, multiple studies verified the gap between adult and pediatric emergency care and outcomes. These studies changed the Emergency Medical Services (EMS) in that they stirred interest in research and stimulated funding for pediatric emergency care.

In 1984, Congress created the Emergency Medical Services for Children (EMS-C) to address the special emergency care needs of children. The EMS-C was a grant program to provide states with funding to address deficiencies in pediatric emergency care (Institute of Medicine [IOM], 1993; Moody-Williams et al., 2002). The purpose of the EMS-C is broadly stated to reduce morbidity and mortality by various community-based injury prevention programs as well as education and outreach interventions to improve emergency medical care for children (Kotagal et al., 2002; Pitetti, Glustein, & Bhende, 2002). It is the only federal agency to have children's emergency care as its sole focus. Yet pediatric emergency care is in danger of being forgotten again: As the EMS-C approaches its 20-year anniversary, it may not be re-appropriated by Congress (Huddleston, 2006; Krug & Kuppermann, 2005). It is this very agency that questioned the

availability of pediatric equipment and requested the CDC/NCHS to survey the nation's EDs compliance with the *Guidelines for Preparedness* by funding the EPSES.

The IOM has published numerous reports on children's health and specifically two reports on pediatric emergency care in the last 15 years . The landmark report of 1993, *Emergency Medical Services for Children*, outlined pediatric deficiencies in the emergency care system. This comprehensive report made numerous recommendations, some of which were adapted but most remain unaddressed. By the time of this IOM report, there was recognition of the EMS-C's work and the need to improve pediatric emergency and trauma services (IOM, 1993). The report noted a fragmented system of emergency services for children and devoted a section of the report to the gaps in equipment necessary to care for children. It pointed to particular weaknesses for pediatric emergency care, equipment, and guidelines. It concurred, "adequate supplies and equipment appropriate for children (across the entire pediatric age range) would significantly improve the capacity" to care for pediatric emergency needs. Although the committee did not create a list of items, it called on the health care providers to create such lists for their agencies. It also called on state regulatory agencies to require that ambulances and hospitals have equipment and supplies appropriate for children. Since then, 12 states have adopted pediatric guidelines that address pediatric emergency equipment, personnel, and facilities, and 48 states require that all advanced cardiac life support (ACLS) ambulances have EMS-C essential equipment (Advocates for EMS, n.d.; IOM, 2006).

Partially thanks to the EMS-C, there have been great strides in the pre-hospital area, yet there remain concerns regarding the lack of necessary equipment to properly care for children. Current studies reveal that little has changed in emergency care for children over the past 50 years (Gausche-Hill, 2000; Gausche-Hill & Wiebe, 2001; Institute of Medicine & Committee of the Future of Emergency Care in the U.S. Health System, 2006; Middleton, 2005; Middleton & Burt, 2006). Studies continue to note a lack of essential pediatric equipment; a recent study by the NCHS/CDC and another follow-up regarding the *Guidelines for Preparedness*, utilizing different methodologies, surveyed national EDs and found similar results: fewer than 10% of the nation's EDs have the essential pediatric equipment (Gausche-Hill, 2003, 2006; McGillivray, Nijssen-Jordan, Kramer, Yang, & Platt, 2001; Middleton & Burt, 2006; Seidel et al., 1999). Although there are the 2001 *Guidelines for Preparedness*, there is still a lack of nationally recognized accreditation standards on pediatric emergency equipment (American Academy of Pediatrics & Committee on Pediatric Emergency Medicine, 1995; Moody-Williams et al., 2002).

The 2006 IOM report *Emergency Care for Children: Growing Pains* states that although children rely on the emergency department for care, there is little systematic review of care and pediatric emergency care is highly uneven. Children's unique needs require a special set of skills and equipment. Though the policy makers have acknowledged these needs, the emergency and trauma system has been slow to develop, in part due to the larger emergency medical care system's inadequacies. State and local regulations, as well as the lack of pediatric emergency care guidelines, are reasons for

such variation in practice. Not all hospitals within a community can or should have the highest level of pediatric emergency care, so critically ill and injured children should be directly triaged to those facilities, or stabilized and referred to those facilities. There is substantial evidence that using regionalized care models reduces costs and improves patient outcomes. But the cornerstone to regionalization is standardizing the basics of pediatric emergency care, with all EDs capable of stabilizing a critically ill or injured child for transfer. The vision of emergency care centers on three goals: coordination, regionalization, and accountability (IOM, 2006). The goal of accountability will be addressed by this research in the efforts to identify compliance with and adoption of the *Guidelines for Preparedness*, and to assist in having essential equipment available to all providers.

The recognition of differences in caring for children has been acknowledged by the development of an accredited subspecialty of pediatric emergency medicine (PEM) and the certification of pediatrics within the Emergency Nurses Association (ENA) in the past two decades. Although the emergency care for critically ill and injured children is in its relative infancy, there is a development of certification and specialty pediatric care. The past decade has begun a renewed research interest in the outcomes and performance measures of pediatric emergency care, in some degree due to the presence of advanced clinicians. Yet compliance with existing guidelines and persistent gaps in equipment and supply availability continue. While the IOM (2006) report did not dedicate a section to equipment availability, it did state that the committee was concerned by reports that emergency providers did not have adequate equipment, and again it recommended that

pediatric supplies and equipment be made more readily available. Though there is scant evidence of essential equipment being associated with patient outcomes, adequate and appropriate equipment is necessary to stabilize a critically ill or injured child.

Pre-Hospital Treatment, Triage, Transport

Many ED encounters start with a pre-hospital intervention, yet there are wide variations in pre-hospital practice. There are over 6,000 public safety answering points or 9-1-1 call centers—and probably that many different models of emergency care services. Multiple models have evolved with the existence of state-run systems, hospital-based programs, and fire department-based or other public- or private-based systems which may even overlap. It is not unusual for one county to have numerous EMS systems and various models of delivering pre-hospital care (Institute of Medicine & Committee of the Future of Emergency Care in the U.S. Health System, 2006). Access to the EMS system provides the first step into the emergency care system and thus begins a patient's triage.

Of the 114 million emergency visits a year, 14% of these patients (15 million) arrive by an ambulance (Burt, McCaig, & Valverde, 2006). Much of the EMS's function is to triage and deliver "the right patient to the right place at the right time," ensuring the delivery of patients to specialty care hospitals such as cardiac, trauma, or pediatrics. EMS systems work differently in different regions, but regardless of the system model, EMS's role in pediatric triage is marginalized by the very nature of children's emergency care (Foltin et al., 2002). Yet studies show that 4% to 12% of pediatric emergency department admissions (1 to 2 million) involve advanced life support and are brought to the ED by EMS (Burt et al., 2006; Seidel et al., 1999; Zaritsky et al., 1994). This hinders pre-

hospital personnel's familiarity with the care of ill and injured children and their ability to deliver the "right child to the right place" for emergency care. Furthermore, most young children are easily transported and parents often bring their sick or injured child to the nearest ED for medical care, unaware of a regionalization plan. Therefore, many critically ill children enter the system as ED "walk-ins," bypassing the EMS and the regionalized routing system (Haller, 2002; Sacchetti, Brennan, Kelly-Goodstein, & Graff, 2000; van Amerongen, Fine, Tunik, Young, & Foltin, 1993).

Of the pediatric emergency medical system dispatches involving advanced life support (ALS) interventions half are for injury and half are for medical reasons. The admission rate from ED to hospital is fairly constant, with the last three years of data remaining stable at 21.7% to 21.9% of pediatric ED admissions. The NHAMCS data reports only 1% of children who are seen in the ED are transferred to another presumably more specialized hospital (McCaig & Burt, 2003, 2004; McCaig & Nghi, 2002). That small number of transports suggests that some children who should be referred may not be being transported to a regional pediatric facility. Because of the relatively small numbers of seriously ill children and multiple models of emergency care access, few data are available regarding the proportion and availability of pediatric emergency services at hospitals or the utilization of those services (Sacchetti et al., 2000; McManus, Long, Cooper, & Litvak, 2004).

In addition, with only 150 children's hospitals nationwide, the uneven distribution of pediatric care resources raises questions about children's emergency access and treatment (Odetola, Miller, & Davis, 2005; Randolph, Gonzales, Cortellini, & Yeh, 2004;

Rubinson & O'Toole, 2005). Children's hospitals are referral centers for complex care needs, such as cardiac and oncology services, but emergency care can not wait for deliberate care. Therefore, many times children are brought to the closest ED to receive care. Although major academic centers and children's hospitals may have the expertise, 90% of pediatric emergency visits are to the community hospital emergency departments (IOM, 2006; Middleton & Burt, 2006). According to the National Association of Children's Health Related Institutions (NACHRI), only 5% to 10% of hospitals are children's hospitals—yet they see 7% to 18% of pediatric emergency department visits (Gausche-Hill, et al., 2007; Middleton, 2005; Middleton & Burt, 2006). This statistic demonstrates the need for every ED to provide pediatric care; an ill child seen in an ED should be stabilized and referred to a pediatric critical care facility as needed (Hohenhaus, 2001, ; Lancaster, 2005; Sacchetti et al., 2000).

Guidelines and Evidence-Based Practice

With the continuing concern over health care costs and growth of managed care programs, children's hospitals and specialized pediatric service providers find it necessary to define their practice to present outcome and performance measures (Cone, Richardson, Todd, Betancourt, & Lowe, 2003; Holahan, Weil et al., 2003; Richardson et al., 2003). There were major efforts in the 1980s to prepare pre-hospital providers to intubate children—as respiratory failure is the number one killer of children—yet five decades later there is not a consensus regarding out-of-hospital intubations. In fact, there is a lack of evidence-based practice guidelines for many pediatric emergency care areas (Gausche-Hill, 2003). Guidelines usually flourish due to their impact on patient

outcomes. Yet, because of the limited number of pediatric emergency care patients and the barriers that exist in pediatric research, outcome research is difficult.

Although increased patient volume in some subspecialties, such as cardiac care, have been documented to affect the patient outcomes (Berry, Lieu, Forbes, & Goldmann, 2007), it is not known whether the volume of pediatric emergency care affects the quality of care a child receives in the ED. There have been no studies that associate quality pediatric emergency care to patient volume, or inpatient pediatric volume, or structure to patient care outcomes. Though the association with quality care can not be established, the availability of equipment, services, and experts suggests that starting with basic quality markers and personnel to care for children is paramount. The 2006 IOM report suggested emergency care and patient outcomes be benchmarked with basic quality indicators such as accurate weights on every patient, proper medication dosing, and pain assessment (Hohenhaus, 2006a). Another logical quality care marker would be essential pediatric emergency equipment according to the *Guidelines for Preparedness* (Gausche-Hill et al., 2004; IOM, 2006; Seidel & Gausche-Hill, 2001).

Gaps in Emergency Care for Children

Emergency Pediatric Services and Equipment Supplement (EPSES)

In response to the 1993 IOM report, the AAP and the ACEP jointly published guidelines in 2001. "Care of Children in the Emergency Department: Guidelines for Preparedness," which listed the essential services, supplies, and equipment to care for a child in the emergency department (American College of Emergency Physicians, 2001; American Academy of Pediatrics, Committee on Pediatric Emergency Medicine,

American College of Emergency Physicians, & Pediatric Committee, 2001; Gausche-Hill & Wiebe, 2001; Wiebe et al., 2001). The joint committee took over 3 years and multiple revisions to develop these *Guidelines*, and they are supported by 17 professional and health care organizations. The *Guidelines* were sent to every emergency department in the nation and published in both agencies' professional journals to assist in disseminating this important information to help in the care of critically ill children (ACEP, 2001; Seidel & Gausche-Hill, 2001). The *Guidelines* were developed with support from the Department of Health and Human Services (HHS) and EMS-C, and were produced by 30 members and liaison members utilizing a Delphi approach for consensus. These *Guidelines* included recommendations in the areas of emergency department physician staffing, quality improvement, policies and procedures, supportive services, coordination of care, and lastly, specific guidelines for supplies, equipment, and medication for children in the ED. They list some 160 items that are essential to have in the ED to adequately care for children in emergencies (American Academy of Pediatrics et al., 2001; American College of Emergency Physicians & American Academy of Pediatrics, 2001). Together, these items are the list of essential items on the EPSES.

The *Guidelines for Preparedness*, though well-credentialed, are not part of any federal, state, or regulatory accreditation process. At present, two states have a special designation for emergency department approved for pediatrics (EDAP): California and Illinois (Illinois, n.d.; State of California, n.d.); Tennessee has begun the process. California and Illinois state regulatory processes were in process before the *Guidelines for Preparedness* were created, thus they were not used as emergency department

criteria; and though these state EDs have not been studied separately, the process of state accreditation includes mandated essential equipment (Gausche-Hill et al., 2004; IOM, 2006; Seidel & Gausche-Hill, 2001).

Though various sizes of pediatric equipment are necessary to care for children, little research has been conducted to investigate the gaps within pediatric equipment. There is scant literature that compares and contrasts the essential pediatric equipment into age/size/weight/length categories. Yet, much of the equipment essential to care for a three-month-old will not work for an eight-year-old. It is well recognized that the most common pediatric medical conditions are related to the respiratory system, and respiratory failure is the most common cause for death in a pediatric patient. Yet, there was a significant lack of essential respiratory equipment as reported by the EPSES (Kotagal et al., 2002; Middleton & Burt, 2006; Pitetti et al., 2002). Although there was no analysis to evaluate whether the lack of equipment affected infants more than children, or if items that required greater expertise, such as endotracheal tubes, were missing more frequently than more basic respiratory items such as facemasks, the results of the survey appear counterintuitive. Emergency respiratory care represents the greatest volume for pediatric patients, and yet still the EPSES revealed that respiratory equipment was the area of greatest deficiency (Middleton & Burt, 2006).

McGillivray et al. (2001) reported a study involving over 700 EDs in Canada, stating that the lack of essential equipment was in a "disturbingly high number" of EDs. That study revealed that basic items for pediatric resuscitative care such as intraosseus needles, drug dose guidelines, and pediatric pulse oximetry probes were missing in 7 -

18% of the hospitals surveyed. Perhaps more disturbing, when the EDs were investigated to validate the survey results, the availability of equipment was even lower than the self-report. Athey and colleagues reported similar findings in the United States: appropriately sized equipment for children was more likely to be missing than that of adults, and actual inventory was lower than the self-report (Athey et al., 2001).

Essential equipment for pediatric resuscitation recommendations have been listed in the course handbooks for Pediatric Advanced Life Support by the American Heart Association (PALS) and Advanced Pediatric Life Support (APLS) by the Red Cross that are attended by hundreds of thousands every year (Sorrentino, Monroe, & King, 2003). But since there is little change in the availability of pediatric resuscitative equipment since first reported in the National Electronic Information Surveillance Survey (NEISS) 1998 results (as cited in Athey, 2001; as cited in Middleton, 2005), this suggests there is more to the adoption of *Guidelines for Preparedness* than simply knowledge or awareness.

It has been suggested that the cost of pediatric essential equipment has been a barrier to compliance (McGillivray et al., 2001), but this claim does not appear to have credibility. Hospitals have the major equipment items like the defibrillator, and the additional cost of pediatric defibrillation paddles is a minimal expenditure. It was estimated that most of the essential pediatric equipment could be purchased for less than $1,000 Canadian dollars (McGillivray et al., 2001). Another recent study stated the cost to be less than $1200 dollars, but author Gausche-Hill did add that there would be some slight indirect costs to inventory and monitor these items, yet again cost is not great and

thus not deemed to be a major barrier to compliance (Gausche-Hill, 2007). Repeatedly studies have shown that essential equipment for pediatrics is missing and although the *Guidelines for Preparedness* was widely disseminated in various modes, Gausche-Hill asserts that many emergency professionals (59%) are simply not aware of them (Gausche-Hill, 2007). And while it is disturbing that in everyday emergency care essential pediatric items are not available, it is of grave concern that such equipment will not be available during a mass casualty event or disaster requiring the treatment of numerous children.

Pediatric Disaster Planning

Soon after the *Guidelines for Preparedness* were published in spring 2001, the events of 9/11 occurred and the country was awakened to the understaffed, overcrowded, uncoordinated, and fragmented emergency medical system. It is ironic that the cover story of the September 10, 2001 *U.S. News & World Report* "Crisis in the ER: Turnaways and Delays are a Surefire Recipe for Disaster" by Shute and Marcus (as cited in IOM, 2006), described an emergency care system that was in crisis and was functioning far beyond the capacity of the emergency medical system. In response to the attacks of 9/11, federal and state monies were made available to assess the situation. The Health Resources and Services Administration (HRSA) provided funding to address specific needs as related to disaster response but did little to address the deficits in emergency care. Overcrowding in the nation's emergency departments was at a crisis level; additional bioterrorism assessments further verified the lack of coordination, communication, and surge capacity to care for a mass casualty event or infectious disease

outbreak. In the 1993 IOM report there was one sentence mentioning the need for disaster planning; the related latest IOM report has an entire section on children and disasters and how to improve disaster response (IOM, 2006).

In 2003 and again in 2005, through funding from the AHRQ, The Children's Fund and EMS-C, experts convened to develop the report *Pediatric Preparedness for Disasters and Terrorism: A National Consensus Conference*, prepared by the Columbia University Mailman School of Public Health and National Center for Disaster Preparedness (Markenson & Redlener, 2003a). The Executive Summary highlighted the gaps in disaster planning for children and special needs populations. It was structured to assist local, state, and federal disaster planning efforts to ensure that children's needs were met in planning and preparing for disasters. There were multiple assessments of the problems in disaster response that identified gaps and concerns. The report addressed the need for adaptations in using the National Disaster Medical System and the Strategic National Stockpile, both of which lacked basic items to care for children (Mace & Bern, 2007; Markenson & Redlener, 2003, 2004). The international experiences demonstrated that during a disaster children will arrive at general care hospitals, "therefore all hospitals must be prepared for increased pediatric needs" (Markenson & Redlener, 2005).

Little research has been done to document community capacity for pediatric disaster response with centers on emergency care (Chung & Shannon, 2007). Community demographics such as region, metropolitan status, and economic factors relate to emergency preparedness, which in turn is a cornerstone in disaster preparedness. Hospital characteristics such as ED type, structure, and pediatric volume may also serve as

markers to identify hospital preparedness in pediatric emergency and disaster care. Specifically identifying the characteristics of community hospital EDs with less gaps and more capacity, through adopting the *Guidelines for Preparedness*, can inform policy makers and communities which priorities assist in capacity building and locating centers of pediatric readiness. The emergency departments that have the necessary services and supplies to care for children in emergencies could be used as exemplars in disaster mitigation and response planning.

Because the initial development of the nation's emergency care system was created and directed by adult health care experts, the pediatric system did not advance as quickly, with performance measures and outcomes data lagging behind those of adult emergency care recipients (IOM, 2006). That the wide variation in pediatric emergency and disaster care is dependent on the hospital, economic status, and availability of specialty services assures that a child's chance of survival from an accident depends more on his zip code than on his genetic code (MacLean et al., 2006; Sacchetti et al., 2000; Taylor, 2006). To this end, the Department of Health and Human Services (DHHS) and the EMS-C requested that the nation's EDs be evaluated for pediatric readiness. NCHS develop a supplement to the NHAMCS to evaluate concerns addressed in the *Guidelines for Pediatric Preparedness*. In 2002 and 2003 the EPSES was administered. This information was requested by DHHS to ascertain the progress of pediatric emergency readiness since the National Electronic Information Surveillance Survey (NEISS) conducted in 1998, and to determine pediatric emergency and disaster preparedness.

Summary

This chapter outlined the use of Diffusion of Innovation as a framework to explore the relationships among and between organization, community, and preparedness, in addition to identifying the gaps in pediatric essential equipment. It discussed the developing crisis in our nation's emergency departments and introduced the lack of preparation for pediatric emergencies as well as the lack of emergency equipment and supplies available for children. The problems of disaster response for adults and children were discussed, and rationale was provided for the choice of study variables to explore the impact of community and organizational structure on pediatric preparedness.

III. METHODOLOGY

This chapter explains the study's research design and methodology. Methods are provided to ensure protection of human subjects, privacy in data collection and handling procedures, and the statistical analysis methods used to explore the data are described.

Introduction

The purpose of this descriptive study was first to identify gaps in essential emergency resuscitative equipment availability, and second, to examine the relationships among and between the organizational and community characteristics with the adoption of pediatric emergency care guidelines necessary for pediatric emergency and disaster care, utilizing Diffusion of Innovation (DOI) as the framework. The ability to identify hospital and community characteristics associated with adopting emergency readiness guidelines may benefit planning and coordinating emergency medical care services and disaster response for critically ill or injured children. The study design was a non-experimental, exploratory, retrospective descriptive analysis of a national secondary extant data set.

Verifying the Conceptual Framework

The first step in this study's research process involved verifying the application of the DOI framework in the analysis of essential pediatric supplies and equipment. To

validate and operationalize the Diffusion of Innovation concepts to study parameters using the EPSES, a panel of experts in disaster, pediatric emergency, and critical care services was asked to link Diffusion of Innovation concepts to each EPSES variable. A modified Delphi process (Hasson, Keeney, & McKenna, 2000) was conducted wherein the experts from emergency medicine and nursing reviewed the EPSES items and were asked to assign each item to either the Diffusion of Innovation concept of complexity or interconnectedness, or to state non-applicable. Items on the NHAMCS and EPSES describing hospital and emergency department characteristics, as well as community characteristics, were evaluated by the panel. See Appendix B for more information. To see that actual survey, visit the CDC-NCHS website (National Center for Health Statistics, 2008) at http://www.cdc.gov/nchs/about/major/ahcd/nhamcsds.htm. Survey items such as emergency department pediatric specialty coverage, pediatric critical care availability, and the presence of a pediatric trauma center, as well as items relating to written protocols and transfer agreements, were categorized by the panel into the DOI concept variables of interconnectedness or complexity.

The expert panel was comprised of eight experts in pediatric emergency and critical care: four physicians and four nurses. A letter of introduction briefly described the theory of Diffusion of Innovation and a concept definition for interconnectedness and complexity (Appendix C). The 10 items from the EPSES survey were provided under a heading asking "Do the following questions from the EPSES represent a concept definition of complexity or interconnectedness?" The EPSES items were then evaluated and as previously set by the researcher; if the items had an agreement of at least 75%,

they could be deemed as reflective of the diffusion of innovation theoretical concepts of interconnectedness and complexity. The expert panel verified using Diffusion of Innovation as a meaningful framework to analyze the study variables from the EPSES. The assessment scores were then linked to the DOI components by the expert panel. The experts read the EPSES, examined the 10 questions regarding organizational structure, and assigned each question with the concept of interconnectedness, complexity or none/unsure. For all questions the panel found agreement (>85%) for the theoretical concepts as related to the Diffusion of Innovation process (Appendix D). Thus the panel found, theoretically, interconnectedness and complexity to be positively related to the EPSES questions, and the theory of DOI finds the concepts positively related to the diffusion of innovation. These findings verified the conceptual frame of Diffusion of Innovation to study the EPSES organization and structural variables.

Research Design

The research design of this study is descriptive and exploratory, using extant data from the national sampling frame of the CDC/NCHS NHAMCS and EPSES data sets. Data from these surveys was recoded to identify associations between and among health care organizational and community characteristics associated with adopting the *Guidelines for Preparedness*.

Study Sample

The hospitals that participated in the NHAMCS and completed the EPSES supplement during 2002 and 2003 were subjects comprising the dataset utilized for this study. NHAMCS hospitals were eligible for the EPSES survey if they had an emergency

department open for service 24 hours a day and 7 days a week, and saw children. For more information on the national sampling methodology of the NHAMCS and the EPSES see Appendix B.

Nearly 400 hospitals participated in the NHAMCS, providing patient visit data for approximately 114 million visits to the EDs. The NHAMCS hospital sample participation rate was 95% and the EPSES had 87% participation. These hospitals have a long-standing relationship with the CDC/NCHS by participation in this survey; although specific reliability and validity data are not reported, the survey data does have historical value and reliability estimates from past performance measures are available.

Study Instrument

Data for the study were derived from the EPSES (the only current national pediatric emergency equipment survey). The EPSES was developed in response to a request from the Maternal Child Health Division of HRSA and EMS-C after the *Guidelines for Preparedness* had been established. It was the first such effort to conduct a national survey of resuscitative pediatric equipment since the National Electronic Injury Surveillance Survey (NEISS) of 1998 (Athey et al., 2001; Middleton, 2005; Moody-Williams et al., 2002). EPSES was designed to gather ED resuscitative equipment preparedness items as well as hospital organizational structure characteristics. Because the survey was administered as a supplement to the NHAMCS sample frame, there is value added as the NHAMCS and the EPSES can be linked by data fields such as patient visits and community characteristics. Health care organizational data reveals the complexity of specialty services offered, and community data reveals the urbanicity,

income, and regional characteristics. Thus, the level of preparedness can be associated with organizational and community data needed for analysis and modeling.

The EPSES survey is comprised of 10 questions regarding the emergency department's form and structure, and then a "check list" of 136 specific items derived from the *Guidelines for Preparedness*. The form was completed by nurses or unit managers in the ED familiar with the equipment. The EPSES results are not available through the public access files; permission and access to the information was obtained through NCHS in Hyattsville, Maryland. The tool was created from the *Guidelines for Preparedness* and thus the survey was reflective of this expert consensus. Though one could assume high content validity because the survey was created from the *Guidelines for Preparedness*, the NHAMCS and the EPSES are tools and have no reported reliability or validity.

EPSES Survey Data

The EPSES is a dichotomous checklist of the equipment necessary to resuscitate pediatric patients. This study sought to identify gaps in equipment and thus identify children at greater risk for missing equipment. Therefore, the EPSES data were recoded by the researcher into three categories for data analysis. The researcher also recoded the sample frame of hospitals, again to further categorize the hospitals by creating a subset of "pediatric hospitals," thus enabling the researcher to evaluate the impact of a pediatric program commitment to the availability of essential equipment. Other data were taken directly from the NCHS data system or other federal agencies' resources as outlined in the data definitions.

Recoding EPSES Data

Over a hundred items essential for pediatric resuscitation from the EPSES were categorized with the Broselow-Luten system. This system is an internationally accepted categorization of pediatric resuscitation equipment and medications based on patient length, which is then used as a predictor of weight, size, and age (Lubitz et al., 1988; Luten & Broselow, 1999; Luten et al., 1992). The tape device has been used since the 1980s in emergency departments (EDs) and is proven to minimize errors in equipment selection and drug dose administrations (Agarwal et al., 2005; Vilke, Marino, Fisher, & Chan, 2001). There have been over 30 publications using this resuscitative aid which has been verified in different health care settings and with different ethnicities. The system continues to develop and evolve as a quality assurance measurement (Frush, Hohenhaus, Luo, Gerardi, & Wiebe, 2006; Kaji et al., 2006; Luten, Zaritsky, Wears, & Broselow, 2007). The safety and efficacy of this assistive device in children's emergency care has been well-established (Hohenhaus 2006b; Agarwal et al., 2005; Frush et al., 2006; Hohenhaus & Frush, 2004; Luten et al., 2007; Vilke et al., 2001).

The panel members with expertise in pediatric resuscitation (as described earlier in this chapter) were asked to review the categorization of the essential pediatric equipment into three categories according to the Broselow-Luten equipment coding scheme. All panel members were familiar with the items and with the Broselow-Luten tape. Recoding essential equipment was done by placing the individual items into the three age-related categories, which were reviewed and accepted without modification by

the experts. The length/size/weight/color delineations were divided into three categories of essential equipment designated by the 2002 Broselow Luten system:

1. Infant essential equipment, since the weight ascribed to the first three colors of length were with infants weighing less than 11 kg.
2. Preschool age essential equipment, with patient's weight from 12 - 18 kg.
3. School-age child essential equipment, with patient's weight from 18 - 36 kg. (Luten & Broselow, 1999; Luten et al., 1992; Luten et al., 2007)

The categories delineated the size of essential equipment in relationship with the child's age/weight/length; thus for an infant, the small breathing tubes, intravenous lines, and monitoring equipment would be categorized together. The essential items were listed together in the appropriate category. The EPSES items and the Broselow-Luten delineations were blended so as to denote the compilation of items necessary to resuscitate a child in that category, depending on length/age/weight (Table 3). Some monitoring devices and equipment crossed age/size categories and were not specific to one category; the categories are not distinct. See Appendix E for detailed item analysis.

Table 3

Description of Three Pediatric Categories by Weight and Broselow Color

Recoded Categories	Data Coding	Weight	Broselow Colors
Infant Resuscitation Equipment	Infresus	3 - 11 kg.	(4) Grey, Pink, Red, and Purple
Preschool Age Resuscitation	Prsresus	12 - 18 kg.	(2) Yellow and White
School Age Resuscitation	Schageresus	19 - 36 kg.	(3) Blue, Orange, and Green

Diffusion of Innovation (DOI) Operationalization

In the second part of the study, the definitions for the organizational structure were operationalized under the concepts of DOI variables. Organizational characteristics that were obtained by the EPSES were categorized into the DOI concepts complexity and interconnectedness, as well as the other characteristics of pediatric patient volume, availability of a pediatric intensive care unit, emergency department specialty, and the availability of a pediatric trauma service. Community health has long been associated with social determinants of education, income, race, employment, poverty, and metropolitan status (Aday, 2005; Budrys, 2003). Community health factors also influence the community's rate of adoption of innovation (IOM, 2003; Lansisalmi et al., 2006). Community characteristics were documented as having relationships with certain community health services such as long-term care facilities and community centers. Data that reflects the population characteristics and specialty care opportunities were assessed for the region's associated affects on social networks and clustering health characteristics (James et al., 2005; Szilagyi et al., 2002; Wetterhall, 2003). Organizational and community characteristics that promote the adoption or non-adoption of *Guidelines for Preparedness* for pediatric readiness were analyzed. Thus, the relationship of availability of equipment (infant, preschool, or school-age), as the criterion variable, was examined through the influences and associations between the various predictive variables from organization and community (Figure 2).

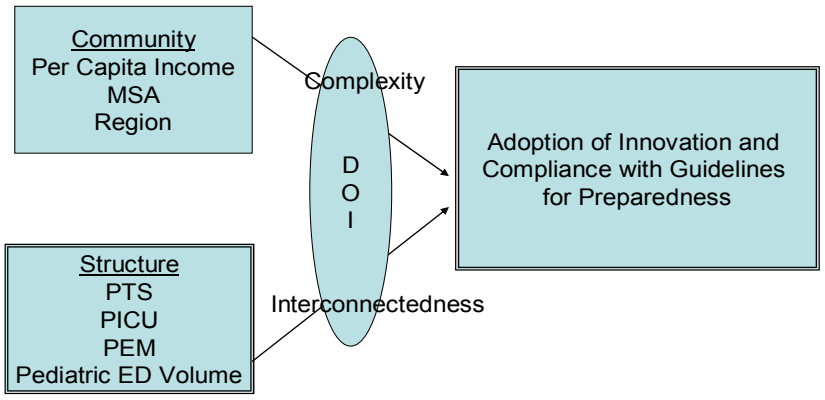

Figure 2. Variable relationships.

Recoding Hospitals

The categorization schemata for "pediatric hospital" are adequate for the purposes of this study because it is difficult to ascertain true numbers defining "children's hospitals emergency departments." There are free-standing children's hospitals, some with and some without EDs. There are also children's hospitals "within hospitals" whose ED facilities care for children within a larger health care system model. And there are major academic centers that provide a wide array of pediatric services but may not be defined as "children's hospitals" by the AHA or by membership in NACHRI. Also, there are major academic centers that are affiliated with a nearby children's hospital, thus not offering pediatric specialty services but routinely seeing children in their ED. Additionally, there are children's hospitals (from AHA and/or membership in NACHRI) that are specialty care facilities for special care needs such as rehabilitation or mental health which do not provide ED services. Thus, for the purpose of this research, the term *pediatric hospital* was used to designate a hospital with a 24-hour/7-day-a-week ED that has a major

pediatric commitment as evidenced by being a hospital that admits only children or a hospital that is a sponsor or major participant in a pediatric residency program. See Appendix F for more details on pediatric hospitals.

Assumptions

The equipment does not by itself guarantee quality; however, quality care of the critically ill or injured child will be impossible without the essential items for pediatric emergency care. The current reading does not attempt to relate pediatric emergency care to quality care outcomes. This study assumes that essential equipment is a necessary prerequisite for adequate resuscitation, and thus potential positive outcomes can occur if appropriately sized equipment is available for treatment. Workforce and skill mix issues are difficult to analyze and interpret; roles in ED care and resuscitation can not be defined solely by title or occupation. Therefore, it is an assumption of this study that "essential equipment" established by the *Guidelines for Preparedness* is an appropriate quality standard.

Data Analysis

Descriptive data analyses were used to explore demographic data regarding various items in the study such as pediatric hospitals, infant resuscitation equipment, and pediatric support specialties. Frequencies of the findings supported the sampling methods. Frequencies were tabulated for pediatric hospitals, pediatric trauma services, pediatric intensive care units, and pediatric EDs. Approximations of this data to other national reference data were discussed if available.

Distribution pattern analysis using Chi Square and Mantel-Haenszel Chi Square was employed to establish differences among groupings. The Mantel-Haenszel Chi Square was used for ordinal variables such as per capita income. Categorical data were explored using variable comparisons among and between variables (Mantel, 1963; Pedhuzer & Schmelkin, 1991).

Logistic regression was done to identify variable relationships to model the criterion variable(s) and to provide odds ratios to determine the probability of changes in the regressor values. The model also provided the percent of explained and unexplained variance among the DOI variables (Pedhuzer & Schmelkin, 1991; Walpole, Myers, Myers, & Keying, 2002).

Ethical Considerations

The proposal for this study was reviewed and approved by the Human Subjects Review Board (HRSB) at George Mason University prior to the research. The extant data from the NHAMCS is de-identified and is a public data set. The EPSES is not a public set and thus required approval from NCHS. Security, ethics, and confidentiality instruction from the NCHS was obtained prior to initiating the research.

Summary

In this chapter the research design and methodology for the study were discussed and rationale for survey tool selection was provided. A detailed methodology described coding new variables from the survey data. Ethical and confidentiality issues were addressed. The next chapter presents the findings of the analysis and was interpreted using descriptive design and correlations as well as logistic regression.

IV. RESULTS

Introduction

This chapter will present the study's findings as analyzed by descriptive design, correlations, and logistical regression. The purpose of this study was first, to examine the gaps in availability of essential emergency resuscitative equipment within pediatrics and second, to investigate the association between the adoption of the *Guidelines for Preparedness*; thus the availability of essential resuscitative pediatric emergency equipment in the ED as associated with the domains of structure and community. Findings are presented identifying the gaps in essential pediatric equipment. The research questions are addressed and associations between community and organizational characteristics and the availability of essential pediatric equipment are made. Logistic regression identifies the explained variance in the model tested.

Description of the Study Sample

The study design was non-experimental, exploratory, and a retrospective descriptive analysis of a national secondary extant data set. Study variables were analyzed using Statistical Analysis Software (SAS). Software for the Statistical Analysis of Correlated Data (SUDAAN) was also utilized to provide weighted samplings according to the guidelines of the NCHS to maximize the validity and reliability of the data results. Missing data elements were controlled using SAS to best define the sample

based upon the most complete data. The initial sampling (n = 722, the two year sample) is a weighted representative of the nation's hospitals (N = 4762) after complex survey study (SUDAAN) designs from the CDC/NCHS were applied. The weighted data were applied and analyzed accordingly. The final sample size for the logistic regression models was N = 4762, with 722 observations. The level of significance was selected as 0.001 for the descriptive analysis and 0.05 for the logistic regression models.

Descriptive exploratory analysis included Chi Square and Mantel-Haenszel Chi Square for linear associations listed in Table 4 and the four ordinal dichotomous criterion variables. Logistic regression analyzed the dichotomous criterion and predictor variables in the three age categories.

Table 4

Description of Variables

Variables	Predictor/Criterion
School-Age Essential Equipment	Criterion
Preschool Essential Equipment	Criterion
Infant Essential Equipment	Criterion
Domain 1 – Community Per Capita Income Metropolitan Service Area Region	Predictors
Domain 2 – Structure of Health Care Pediatric Emergency Medicine Specialty Pediatric Intensive Care Unit Pediatric Trauma Service Volume of Pediatrics in the ED Pediatric Hospital	Predictors Predictor and Criterion

Hospital and ED data were obtained from the NHAMCS and EPSES. This EPSES sample is a subset of NHAMCS hospital ED data set with the additional inclusion criteria of having a 24-hours-a-day/7-days-a-week emergency department that treats children. Thus, the data utilized represents a snapshot of the national pediatric emergency preparedness in emergency departments. The ED data includes various organizational structures that provide emergency care to children—whether the ED is within a children's hospital or a pediatric teaching facility, a large academic medical university or a small community hospital. The NHAMCS, EPSES, U.S. Census, and Area Resource File (ARF) are used to analyze community and organizational variables.

Findings by Research Question

Research Question One: The Gap in Essential Pediatric Equipment, and Differences in Availability

Research Question One: What is the gap in the availability of essential pediatric resuscitative equipment, and are there differences by pediatric age category? What is the state of equipment available for children, and are there differences in equipment availability by pediatric age category (infants, preschool, and school-age children) in U.S. emergency departments?

The essential pediatric equipment items of the EPSES were divided into three non-distinct age categories of infant, preschool age, and school age. Although there are differences in the availability of essential pediatric resuscitative equipment, there were not significant differences between age categories. There were significant gaps in the availability of essential equipment for children.

Of the total 4762 EDs queried, only 308 EDs (6.47%) had the essential equipment to diagnose and treat infants. Preschool age essential equipment was available in 330 (6.93%) of the emergency departments, whereas school-age children's equipment was available most often—although still in only 360 of the nation's 4762 emergency departments (7.57%) (Table 5). The smaller-sized items were missing more frequently. The lack of smaller-sized equipment persisted throughout the age span of pediatrics, with infants' essential equipment missing more than preschoolers, and preschool age essential equipment missing more frequently than school-age equipment. Though the differences between the three age categories are not significant, there is a significant gap in essential equipment for children of all ages.

Table 5

Number of Hospitals with the Essential Pediatric Equipment by Age Categories

Total Hospital EDs (*N* = 4762)	**Infant**	**Preschool**	**School-Age**
Compliant	308	330	360
Not Compliant	4454	4432	4401
Percent Compliant	6.47%	6.93%	7.57%

Note. Data Source: EPSES 2002/2003.

The overall rate of compliance, regardless of age category, was low (range 6.47-7.57%), with less than 8% of the nation's EDs having the essential equipment to treat children in compliance with the *Guidelines for Preparedness*. There is a trend that

smaller-sized equipment is missing more frequently, but this is not statistically significant (see Appendix E for specific item coding).

Research Question Two: Pediatric Hospitals and Availability of Pediatric Equipment

Research Question Two: Are pediatric hospitals associated with increased availability of pediatric resuscitative equipment? Findings indicate emergency departments in pediatric hospitals are more likely to be in full compliance with the *Guidelines for Preparedness* as compared to the emergency departments in community hospitals; reaching statistical but clinical significance is unclear.

This data, derived from the NHAMCS and EPSES, provided a sample of 466 pediatric hospitals, representing approximately 10% of the total hospital sample. This represents the estimated number of pediatric and community hospitals found in the U.S. as verified in the literature and by other reliable data sources such as NACHRI and AHA, and thus used for further analysis in this study. See Table 6.

Table 6

Distribution of Hospitals by Type: Pediatric and Community

Hospitals	**Pediatric Hospitals**	**Community Hospitals**	**Total Hospitals**
Total by Type	466	4296	4762
Percent of Total	9.8%	90.2%	100%

Note. Data Source: EPSES (2002/2003).

Designation as a pediatric hospital significantly increased the probability of essential pediatric equipment being present (p = <.0001). The equipment availability for infant, preschool, and school-age children was increased to 17%, 19%, and 20%, respectively. In comparison to community hospitals, pediatric hospitals were nearly three times more likely to be compliant (see Table 7). The trend of smaller-sized equipment missing more frequently persisted in the pediatric hospitals, as evidenced by the compliance being lowest in the infant age category, increasing in the preschooler, and increasing again in the school-age category.

Table 7

Distribution of Compliance With Essential Pediatric Equipment as Associated With Age and Hospital

Compliance With Essential Pediatric Equipment	Infant	Preschool	School Age
Total Hospitals (N = 4762)	6.5%	7%	7.5%
Pediatric Hospital (n = 466)	17.0%	19%	20.0%

Note. Data Source: EPSES (2002/2003).

The Mantel-Haenszel Chi-Square for availability of essential pediatric equipment based on hospital type is significant for infants (mh χ^2 = 95.07, *df* 1), preschool, and school-age essential equipment availability (mh χ^2 = 110.38, *df* 1 and mh χ^2 = 112.25, *df* 1) (Table 8). Designation as a pediatric hospital was significantly associated with the availability of essential equipment for pediatric, phi coefficient 0.15, thus the variable

pediatric hospital was further tested in the model using logistic regression. (See Appendix G for more information on pediatric hospitals designation.)

Table 8

Distribution of Compliance With Infant and Preschool Essential Equipment by Hospital Type

Essential Equipment	**Pediatric Hospitals** ***n*** **= 466**	**Community Hospitals** ***n*** **= 4296**	**Total Hospitals** ***N*** **= 4762**
Infant Equipment			
Percent Non-Compliant	83%	95%	93.5%
Percent Compliant	17%	5%	6.47%
Preschool Equipment			
Percent Non-Compliant	81%	94%	93.1%
Percent Compliant	19%	6%	6.93%

Note. Data Source: EPSES (2002/2003).

Henceforth, only significant findings are discussed, with graphic depictions presented for the school-age children category. As there are little differences between the age categories, the analysis reported is for the largest category, school-age children (*n* = 361). Unless otherwise stated, the term *essential equipment* references findings for the school-age essential equipment category.

Table 9

Distribution of Compliance With Essential Equipment by Hospital Type

School-Age Essential Equipment	Pediatric Hospitals	Community Hospitals	Total
Non-Compliant	373	4028	4402
Percentage of Total Hospitals	7.8%	84.6%	92.43%
Percentage of Pediatric Hospitals	8.5%		
Percentage of Community Hospitals		91.5%	
Compliant	93	268	361
Percentage of Total Hospitals	1.95%	5.62%	7.57%
Percentage of Pediatric Hospitals	26.0%		
Percentage of Community Hospitals		74.0%	
Percentage of Compliance in Hospital	20.0%	6.2%	

Note. Data Source: EPSES (2002/2003). School-age children only.

As depicted by Table 9, the availability of essential equipment for school-age children is at 7.57 %, with 93 out of the 361 compliant EDs being in pediatric hospitals. Of the nation's EDs in compliance with the *Guidelines for Preparedness* equipment standards, 26% were pediatric hospitals and 74% were community hospitals. Essential pediatric equipment was three times more likely to be available in pediatric hospitals. The overall compliance rate analyzed in pediatric hospitals was 20%, but only 6.2% was found among community hospitals. Though the difference in the availability of essential equipment in the pediatric hospital ED as compared to the community hospital ED is statistically significant ($p < .0001$), the clinical significance is not obvious.

Research Question Three: Community Characteristics

Research Question Three: Are community characteristics such as region, metropolitan service area, and per capita income associated with compliance with the *Guidelines for Preparedness* essential pediatric equipment in emergency departments? Findings indicate community factors were associated with compliance with the *Guidelines*. These findings reached statistical and clinical significance.

Analysis of community characteristics and compliance to the *Guidelines for Preparedness* revealed two variables of significance and a third variable of study interest: metropolitan service area, per capita income, and region. Even though region did not reach statistical significance, it appears to influence variables when related to compliance with the *Guidelines for Preparedness.* Findings for pediatric hospitals were different from those found when compared to community hospitals, thus further analysis was done using pediatric hospitals as the criterion variable.

Metropolitan Service Area

Metropolitan service area is a multifaceted characteristic. Urbanicity has been associated with such factors as emergency medical service coordination, proximity of hospitals, availability of specialty hospitals, as well as changes in socioeconomic and educational levels. Urbanicity plays an important role in health care access and specialty service. As seen in Table 10, there are differences between pediatric hospitals and community hospitals with regard to urban status. Although there are almost the same number of EDs in urban as rural regions, there are virtually no pediatric hospitals found

in rural areas (phi coefficient at 0.28). This influences pediatric ED compliance in rural areas.

In compliance with the *Guidelines for Preparedness*, essential equipment is nearly twice as likely to be present in an urban emergency department (school age mh χ^2 = 20.85, *df* 1; preschool age mh χ^2 = 23.62 , *df* 1; infant mh χ^2 = 27.65, *df* 1) (Table 11). Non-compliant EDs were approximately equal in urban and rural areas, yet compliant EDs were nearly twice as likely to be in urban centers. These findings are statistically ($p < .001$) and are clinically significant given the link between equipment and emergency care for children.

Table 10

Distribution of Urban and Rural Status as Associated With Hospital

Hospitals	Urban	Rural	Total
Community Hospital	53%	47%	4296
Pediatric Hospital	99%	1%	466

Note. Data Source: EPSES (2002/2003).

Table 11

Distribution of Compliance With Essential Equipment by Urban and Rural Status

School-Age Essential Equipment	Urban Hospitals	Rural Hospitals	Total
Non Compliant	2477	1924	4402
Percentage of Total	52%	40%	92%
Percentage of Urban	56.3%		
Percentage of Rural		43.7%	
Compliant	248	113	361
Percentage of Total	5.2%	2.4%	7.6%
Percentage of Urban	69%		
Percentage of Rural		31%	
Percentage Compliance in MSA Type	9%	5.5%	

Note. Data Source: EPSES (2002/2003).

Per Capita Income

Per capita income (PCI) plays an important role in health care access and availability. As seen in Table 12, there are differences between pediatric hospitals and community hospitals with regard to per capita income. The majority of pediatric hospitals are in areas of PCI greater than $25,000, whereas the majority of community hospitals are in areas of PCI less than $25,000.

Table 12

Distribution of Per Capita Income (PCI) as Associated With Hospital

Total Hospitals	PCI < $25,000	PCI $25-34,000	PCI > $34,000
Community Hospital	53%	34%	12%
Pediatric Hospital	11%	62%	27%

Note. Data Source: NHAMCS (2003), EPSES (2002/2003), HRSA (2003).

PCI was also found to be associated with the availability of essential equipment in pediatrics. A linear relationship between PCI and availability of essential equipment exists in pediatrics: school-age equipment was available 5.3% of the time in areas of PCI under $25,000, 9.0% of the time if PCI was greater than $25,000 but less than $34,000, and 12.1% if the PCI exceeded $34,000. This pattern continued for preschool equipment availability at 4.9%, 7.5%, and 12.6%, and infant equipment availability being 4.4%, 7.7%, and 10.7%, accordingly. Hospitals compliant with the essential equipment were more than twice as likely to be in the higher PCI levels. Of the non-compliant hospitals, over half were in the lowest PCI level, with only 13% of non-compliant hospitals found in those with greater than $34,000, see Table 13. This association reached statistical significance ($p < .0001$, with school age mh $\chi^2 = 42.04$, *df* 1; preschool age mh χ^2 46.02 = *df* 1; infant mh χ^2 =40.74, *df* 1).

Table 13

Distribution of Compliance With Essential Equipment by Per Capita Income (PCI)

School-Age Essential Equipment	PCI < $25,000	PCI $25-$34,000	PCI > $34,000	Total
Non Compliant	2216	1609	577	4402
Percentage of Total	50%	37%	13%	100%
Compliant	123	158	80	361
Percentage of Total	34.%	44.%	22%	100%
Percentage Compliant in PCI Range	5.3%	9.0%	12.0%	

Note. Data Source: NHAMCS (2003), EPSES (2002/2003), HRSA (2003).

Findings for region did not reach the level of significance, but are analyzed and presented because region will be discussed later in explaining differences in pediatric preparedness. The areas of highest compliance were found in the Northeast and South at 8% and 9.3% respectively. Lower compliance was found in the Midwest and West at 5.8% and 6.5%, respectively (Table 14). Though not statistically significant ($p = .0016$), the analysis (school-age $\chi^2 = 15.33$, *df* 3; preschool age $\chi^2 = 21.56$, *df* 3; infant $\chi^2 = 24.83$, *df* 3) revealed more than half of the prepared hospital EDs located in the South. Caution is noted because the South did have a slightly larger sample and the West had a smaller sample in the survey. The West had the fewest pediatric hospitals (7%), whereas other regions were similar (29-33%). While the Northeast had a higher percent of pediatric hospitals, those hospitals did not have the highest compliance rates. The West had the fewest pediatric hospitals yet was not among those with the lowest compliance (Table 15).

Table 14

Distribution of Compliance With Essential Equipment by Region

School-Age Essential Equipment	Northeast	Midwest	South	West	Total
Non Compliant	678	1333	1657	734	4402
Percentage	14.2	28.0	34.8	15.4	92.4
Compliant	59	82	169	51	361
Percentage	1.24	1.72	3.55	1.07	7.57
Percentage of Hospitals in the Region That Are in Compliance	8.00	5.78	9.25	6.50	

Note. Data Source: NHAMCS (2003) and EPSES (2002/2003).

Table 15

Distribution of Hospital Type as Associated With Region

Region	Percentage of Hospitals (*N* = 4762)	Percentage of Pediatric Hospitals (*n* = 466)	Percentage of Community Hospitals (*n* = 4296)
Northeast (*n* = 736)	15.5	29	14
Midwest (*n* = 1414)	29.7	31	30
South (*n* = 1826)	38.4	33	39
West (*n* = 785)	16.5	7	18

Note. Data Source: NHAMCS (2003) and EPSES (2002/2003).

Other community characteristics such as median household income, percent of poverty, and percent of the population under the age of 20 were analyzed but not included for discussion due to lack of significant findings. Within the domain of community characteristics, metropolitan service area and per capita income were significantly associated with the availability of essential resuscitative equipment for pediatrics, and thus was further tested with the regression model.

Research Question Four: Health Care Structure Characteristics

Research Question Four: Health care structure characteristics, such as the presence of a pediatric specialty physician (pediatric emergency care physician or pediatrician), the volume of pediatric patients seen in the ED, the availability of a pediatric intensive care unit, and the presence of a pediatric trauma service, are associated with compliance to the *Guidelines for Preparedness* in emergency departments. These findings were statistically and clinically significant.

Organizational characteristics were examined for multiple factors such as population density, pediatric hospital or proximity to a pediatric hospital, size of service area, and emergency department characteristics.

Volume of Pediatric Patients in the ED

Pediatric emergency department volume was calculated using the annual ED visit volume and the percent of visits by pediatrics as reported in the NHAMCS (2003). Volume was then coded by the researcher into quartiles for the purpose of analysis. Findings indicate ED pediatric patient volume varies in both pediatric and community hospitals, with half of pediatric hospitals treating more than 8,000 patients a year and half of community hospitals treating less than 4,000 patients a year. This data revealed the majority of children treated in community hospitals are treated by EDs that see less than 4,000 pediatric patients a year (Table 16).

Table 16

Annual Pediatric Emergency Department (ED) Volume as Associated With Hospital

Annual Pediatric ED Volume	Percentage of Pediatric Hospitals	Percentage of Community Hospitals
ED Pediatric Patients < 2,000 (*n* = 1450)	17	30
ED Pediatric Patients 2,000 - 4,000 (*n* = 1162)	13	25
ED Pediatric Patients 4,000 - 8,000 (*n* = 1053)	21	22
ED Pediatric Patients > 8,000 (*n* = 1097)	49	23

Note. Data Source: NHAMCS (2003) and EPSES (2002/2003).

The volume of less than 4,000 pediatric patients a year (approximately 10 per day) was associated with a drop in the level of compliance for pediatric equipment in those EDs. It appears that volume is associated with compliance among facilities treating 4,000 children a year, as hospitals with a higher volume (over 8,000 pediatric visits) were not found to have an increased compliance. There are more children being treated in community EDs. Of the EDs that see greater than 8,000 children a year, nearly half of those facilities are pediatric EDs, yet pediatric EDs are only 10% of the total sample (Table 17).

Table 17

Distribution of Compliance With Essential Equipment by Pediatric Emergency Department (ED) Volume

School-Age Essential Pediatric Equipment	**ED Pediatric Patients < 2,000**	**ED Pediatric Patients 2,000 - 4,000**	**ED Pediatric Patients 4,000 - 8,000**	**ED Pediatric Patients > 8,000**
Non Compliant	1410	1086	931	975
Percentage of Total	30%	23%	20%	20%
Compliant	40	76	122	123
Percentage of Total	0.85%	1.59%	2.56%	2.57%
Percentage Compliance With Pediatric Patient Volume	2.78%	6.53%	11.6%	11.2%

Note. Two decimal points are used only for numbers under 10%. Data Source: NHAMCS (2003) and EPSES (2002/2003).

Pediatric Specialty Physician

The presence of a pediatrician in the ED was associated with availability of essential pediatric equipment ($p < 0001$), (school age mh $\chi^2 = 118.38$, *df* 1; preschool age mh $\chi^2 = 109.74$, *df* 1; infant mh $\chi^2 = 125.22$, *df* 1). The correlation was phi coefficient of 0.158. But, if the pediatric specialty physician was a pediatric emergency medicine physician (PEM), the phi coefficient was 0.283 and the likelihood of resuscitative equipment being available was twice as likely. Thus, the association was stronger for the presence of a pediatric emergency physician (school age mh $\chi^2 = 381.90$, *df* 1; preschool age mh χ^2 377.98 = *df* 1; infant mh $\chi^2 = 369.45$, *df* 1). EDs were six times more likely to be compliant with essential equipment if they had a PEM. The majority of the EDs (65%) that were compliant with the *Guidelines for Preparedness* had a PEM. Yet, there were EDs (20%) with a PEM who were not compliant (close to the national PEM rate), as only 23% of EDs reported having a pediatric emergency medicine physician (Tables 18 and 19).

Table 18

Distribution of Pediatric Emergency Medicine (PEM) Physician by Hospital Type: Pediatric and Community

Hospitals	Pediatric Hospitals	Community Hospitals	Total Hospitals
Pediatric Emergency Medicine Physician	40%	21%	23%
No Pediatric Emergency Medicine Technician	60%	79%	77%

Note. Data Source: EPSES (2002/2003).

Table 19

Distribution of Compliance with Essential Equipment by Pediatric Emergency Medicine (PEM) Physician

School-Age Essential Equipment	Pediatric Emergency Medicine Physician	No Pediatric Emergency Medicine Physician	Total
Non Compliant - frequency	862	3540	4402
Percentage	18.1%	74.3%	92.43%
With a PEM	20%		
Without a PEM		80%	
Compliant- frequency	233	128	361
Percentage	4.9%	2.7%	7.57%
With a PEM	65%		
Without a PEM		35%	
Percentage Compliance and PEM	21%	3.5%	

Note. Data Source: EPSES (2002/2003).

In exploring the relationships between complexity of the organization and compliance, the presence of a PEM was associated with the complexity of care in the ED. The next logical extension to organizational complexity is to evaluate in-hospital specialty services such as a pediatric intensive care unit and pediatric trauma service.

Pediatric Intensive Care Unit

Pediatric intensive care units (n = 485) are specialty care units in roughly 10% of hospitals, with 43% located within pediatric hospitals and only 7% located in community hospitals. The majority of pediatric hospitals did not have an intensive care unit (56%), (phi coefficient of pediatric hospitals and pediatric intensive care units of 0.366) with 42% of pediatric hospitals and 58% of community hospitals having pediatric intensive care units (Table 20).

The presence of a pediatric intensive care unit (PICU) was significantly associated with the availability of essential equipment ($p < .0001$) (school age mh χ^2 = 201.91, *df* 1; preschool age mh χ^2 169.76 = *df* 1; infant mh χ^2 =150.30, *df* 1). If the ED was located in a facility that had a PICU, it was four times more likely to be compliant (phi coefficient 0.206).

Table 20

Distribution of Pediatric Intensive Care Unit (PICU) by Hospital

Hospitals	Pediatric Hospitals	Community Hospitals	Total Hospitals
PICU	42%	7%	10%
No PICU	56%	93%	90%

Note. Data Source: EPSES (2002/2003).

Table 21

Distribution of Compliance With Essential Equipment by Pediatric Intensive Care Unit (PICU)

School-Age Essential Equipment	Pediatric Intensive Care Unit	No Pediatric Intensive Care Unit	Total
Non Compliant	370	4031	4402
Percentage	7.8%	84.7%	92.%
With a PICU	8%		
Without a PICU		92%	
Compliant	115	245	361
Percentage	2.4%	5.2%	7.57%
With a PICU	32%		
Without a PICU		68%	
Percentage Compliance and PICU	23.7%	5.7%	

Note. Data Source: EPSES (2002/2003).

Pediatric Trauma Service

The availability of essential equipment was influenced by the presence of a pediatric trauma service (PTS) ($p < .0001$), for all age categories (school age mh $\chi^2 = 350.85$, *df* 1; preschool age mh $\chi^2 = 323.79$, *df* 1; infant mh $\chi^2 = 312.49$, *df* 1). The presence of a PTS ($n = 670$) increased the likelihood of having essential equipment by five times (Tables 22 and 23).

Table 22

Distribution of Pediatric Trauma Services (PTS) by Hospital

Hospitals	Pediatric Hospitals	Community Hospitals	Total Hospitals
Pediatric Trauma Services	39%	11%	14%
No Pediatric Trauma Services	61%	89%	86%

Note. Data Source: EPSES 2002/2003.

Table 23

Distribution of Compliance With Essential Equipment by Pediatric Trauma Service

School-Age Essential Equipment	Pediatric Trauma Service	No Pediatric Trauma Service	Total
Non Compliant	500	3902	4402
Percentage of Total	10.5%	82%	92.4%
With a PTS	11%		
Without a PTS		88%	
Compliant	170	191	361
Percentage of Total	3.6%	4%	7.57%
With a PTS	47%		
Without a PTS		53%	
Percentage Compliance and PTS	25.3%	4.7%	

Note. Data Source: EPSES 2002/2003.

The relationship between the availability of essential school-age equipment and the presence of a PTS is strong (phi coefficient 0.272). Pediatric trauma services (n = 670) are specialty care units in roughly 14% of hospitals: 27% are located within pediatric hospitals and 73% are located in community hospitals. The majority of pediatric hospitals did not have a pediatric trauma service (61%) (phi coefficient of pediatric hospitals and pediatric trauma services 0.237) with 27% of pediatric hospitals and 7% of community hospitals having pediatric trauma services. The relationship between PTS and a pediatric hospital was also explored (phi coefficient at 0.237).

Demographics of Emergency Care

Due to the correlations between and among study characteristics with pediatric hospitals, further analysis was conducted to explore relationships with pediatric hospitals as the criterion variable, to further explore the relationship between pediatric hospitals and community disaster and emergency planning.

Community hospital data indicates that EDs were roughly equal in urban (57%) and rural (43%) settings throughout the country. The economic data related to EDs revealed counties whose per capita income was less than $25,000 housed half of the emergency facilities (49%). To review the geographic dispersion of EDs see Table 24: The percentage of EDs, population, and pediatric hospitals all are within 15% points except for the West.

Table 24

Distribution of Emergence Departments (EDs) and Population as Associated With Region

United States	Northeast	Midwest	South	West
Percentage of EDs	16	30	38	16
Percentage of Population	19	22	35	24
Percentage of Pediatric Hospitals In	29	30	33	7

Note. Source: NHAMCS (2003) and U.S. Census Data (2000).

The findings regarding pediatric hospitals were consistent with the number of pediatric hospitals (n = 466) found in the published literature and reported by professional organizations, thus supporting the hypothesis that this data would adequately represent pediatric hospitals and pediatric emergency care. During the study there appeared to be clustering of data regarding pediatric hospitals. Data were then compared using pediatric hospitals as the criterion variable to explain differences between pediatric hospitals and community hospitals as related to the characteristics of community and organization.

The demographics of the pediatric hospital emergency department are different from the community hospital emergency department. Among pediatric hospitals, the majority (99%) were located in urban areas where the per capita income exceeded $25,000 (89%). In comparison, half of the community emergency departments (53%) were based in urban areas and nearly half (49%) were in counties with per capita income less than $25.000. The distribution of pediatric hospitals throughout the regions of the Northeast (18.5%), the South (10.1%), and the Midwest (8.5%) had similar findings, with

approximately 10% of all hospitals being pediatric. Only 4% percent of the hospitals in the West met pediatric hospital criteria, but the sample was noted to be small (Table 25).

There have been numerous references in literature and health care policy to the lack of pediatric specialty care in rural areas; it was evident that not all states are equally represented in pediatric education programs, which are part of the designation criteria for a pediatric hospital. There are 44 states and the District of Columbia that have pediatric residency programs—with New York having over 30, but with the majority of states having only 1. Four of the six states that do not have pediatric residency programs are in the region of the West: Montana, Wyoming, Alaska, and Idaho, whereas the other two, the Dakotas, are in the Midwest region according to their U.S. Census region. There are states that do not have pediatric residency programs and states that do not have pediatric hospitals. Appendix G lists the AHA (2005) listing children's hospitals as recognized by that organization and data from NACHRI (n.d.). There are community and organizational structure differences between pediatric hospitals and community hospitals which may influence the adoption of innovation.

Table 25

Variable Differences in Pediatric and Community Hospital Emergency Departments (EDs)

Percentage of Variable	Percentage Pediatric Hospitals (n = 466)	Percentage Community Hospitals (n = 4402)
Community Per Capita Income Less than $25,000 Greater than $34,000	 11 27	 53 12
Urban Location	99	53
ED Pediatric Patients < 2,000/year > 8,000/year	 17 49	 32 20
Available Pediatric Intensive Care Unit	44	7
Available Pediatric Trauma Service	39	11
Available Pediatric Emergency Medicine Physician	41	21

Note. Community Per Capita Income from $25,000 to $34,000 did not reach a level of statistical significance. Data Source: NHAMCS (2003), EPSES (2002/2003), HRSA (2003).

Logistic Regression

Significant variables (per capita income, volume of pediatric patients, pediatric emergency medicine, pediatric trauma service, pediatric intensive care unit, and MSA status) were modeled using logistical regression (SAS and SUDAAN) to ascertain the variance in predicting compliance with the *Guidelines for Preparedness* Appendix H). Logistic regression was run using a (weighted count) of n = 4762 with 722 observations. To determine the relative importance of each independent variable in predicting

differences in compliance with the guidelines, separate multiple logistic regression models were run for each age category. Additional models tested included factors from the domains of community and structural organization. The predictive power of each factor was assessed using the Nagelkerke adjustment to the Cox and Snell r-square. The dichotomous criterion variable (school-age equipment, preschool equipment, and infant equipment) was used to assign predictor variables from the domains of community and structure, associated with emergency department compliance to the *Guidelines for Preparedness*.

The reported value for the school-age model was $R^2 = 0.103$; approximately 10% of the variance was explained variance for the criterion variable of school-age essential equipment availability and compliance with the *Guidelines for Preparedness*. This portion of the variance was accounted for by the predictor variables in the model: pediatric emergency medicine, pediatric trauma service, pediatric ED volume, and per capita income, metropolitan service area, pediatric intensive care unit, and pediatric hospital. The predictor variables of significance ($p < 0.05$) in this model were pediatric trauma service, pediatric emergency care physician, pediatric ED volume, and per capita income. The variables and data in the regression model for school-age essential equipment are listed in Table 26.

Table 26

Regression Model Variables of Significance and Odds Ratio Data

Regression Variable	Significance	Confidence Interval	Odds Ratio
Pediatric Emergency Medicine Physician	$p = 0.00$	0.10 to 0.43	0.21 to 1.0
Pediatric Trauma Service	$p = 0.0026$	0.10 to 0.66	0.25 to 1.0
Per Capita Income < $25,000 a Year $25 to $34,000 a Year	 $p = 0.0488$ $p = 0.432$	 0.17 to 0.99 0.32 to 0.98	 0.41 to 1.0 0.56 to 1.0
Pediatric Emergency Department Annual Volume 4,000 to 8,000	$p = 0.045$	1.02 to 4.66	2.18 to 1.0

Note. Per Capita Income > $34,000 a Year did not reach statistical significance. Data Source: NHAMCS (2003) and EPSES (2002/2003).

This analysis suggests the factors of pediatric emergency medicine, pediatric trauma service, pediatric ED volume, and per capita income influenced the availability of school-age essential equipment, therefore increasing compliance with the *Guidelines for Preparedness*. This model held constant through the other two age categories: See Appendix F.

Summary

The findings of the data analysis were presented. There were differences in compliance with equipment in the age categories. The characteristics of community and organization were related to compliance with both the *Guidelines for Preparedness* and the availability of pediatric equipment in the ED. The characteristics of pediatric hospitals as compared to community hospitals were described. The results of the regression model explained that 10% of the variance and variables of significance in the

model were pediatric emergency medicine, pediatric trauma service, pediatric volume, and per capita income.

V. DISCUSSION OF FINDINGS

Introduction

The purpose of this study was to identify the gaps within pediatric essential equipment in emergency departments (EDs), and to explore associations among and between the characteristics of community and organizational structure associated with hospitals' adoption of the *Guidelines for Preparedness*.

This chapter discusses findings, especially the disparities in pediatric essential equipment availability and relationships between community and organizational structure and compliance with the *Guidelines for Preparedness*. There are patterns in missing pediatric equipment, associations between community and organizational characteristics and preparedness, as well as demographics of pediatric hospitals, that assist in identifying those EDs with best practices. Congruent with the theory of Diffusion of Innovation, hospitals' size, economics, complexity, and interconnectedness are favorable characteristics for adoption of innovation. This chapter also discusses implications for nursing practice in pediatric emergency and disaster care. Suggestions are made for future research to assist health care administrators, federal and state policy makers, and disaster planners be better prepared for children's everyday emergencies and disaster care.

Interpretation of Findings

Diffusion of Innovation theory supports the characteristics of communities' and organizations' size, money, complexity, and interconnectedness as driving factors behind adoption of innovation. This study looked at community and organizational characteristics and found size, urbanicity, per capita income, and organizational characteristics consistent with concepts of complexity and interconnectedness, and that they were related to adoption of the *Guidelines for Preparedness.* Rogers (1995, 2003) goes further and relates the characteristics of an organization or community with those of an individual, suggesting these characteristics provide equivalent information. Thus, in the following discussion regarding adoption of the *Guidelines for Preparedness* as evidenced by essential pediatric equipment compliance, characteristics of the community, the organization, and the individual were examined.

Mytinger, in a study of organizational adoption of innovations, suggested that size—of community as well as organization (health care department)—was the most compelling factor to drive innovativeness (Mytinger, 1968; Rogers, 2003b). Odetola et al.'s work (2005) associates the number of beds (volume and size) in the Pediatric Intensive Care Unit (PICU) to services and equipment available; and as this study suggests, there is an association between a hospital's volume, size, complexity, and equipment availability. These studies, though few and limited in number, suggest what was found in this research: There is a relationship between size, money, services, and equipment. The concepts of complexity and interconnectedness created an organizational environment that was associated with the adoption of innovation. In this study, the

adoption pattern is associated with organizational factors such as a pediatric patient volume and trauma service, community factors such as upper per capita income and urbanicity, and individual factors such as the presence of a pediatric emergency medicine (PEM) physician in the ED. The concepts of complexity and interconnectedness in hospital EDs as related to pediatric specialty services were associated with adoption of the innovation.

Discussion of Answers to Research Questions

Discussion of Research Question One: The Gap in Essential Pediatric Equipment, and Differences in Availability

Even though differences between age categories were not significant, it is of value to identify the fact that the smaller-sized equipment was missing more frequently, even if the ED was in a pediatric hospital. Infants are at the greatest risk for harm due to missing equipment. Although several studies had suggested that smaller-sized equipment was more apt to be missing, the pattern of smaller-sized equipment missing persists throughout the age categories—not just with infants' equipment. Preschoolers were at greater risk than school-age, and although school-age equipment was the least likely to be missing, it was only present 7.5% of the time. Thus for this model we can predict the pattern to persist, and that smaller-sized equipment would be missing more frequently than adult equipment.

The greatest number of pediatric ED visits is made in the first year of life, at a rate of 96 visits per 100 infants; thus infants represent 13% of the pediatric ED population (McCaig & Burt, 2005). Yet, the essential equipment is more apt to be missing for this

vulnerable population. One reason for the gap may be that there are a greater number of different-sized items required for infants and small children. Although infants have the highest patient visit rate, the school-age child makes up the majority of pediatric visits. The ED was best prepared for this age group, as expected, since a school-age child may use equipment that would be commonly used for a small adult; but the small child and infant require different items that would not work in an adult setting. Because of the ongoing lack of essential pediatric equipment as identified in this study and others, the accreditation organizations, to include the Joint Commission and the state regulatory bodies, should make minimum standards for accreditation. There have been studies documenting five decades of concerns with pediatric ED equipment. Ironically, refrigerator temperatures are recorded for quality assurance (required by the Joint Commission), yet pediatric essential equipment is not an ED quality assurance measure for accreditation.

As the Joint Commission begins to assimilate disaster requirements into hospital accreditation per federal mandate, these findings are directly related to disaster response. Clearly, smaller-sized equipment that is routinely missing translates into equipment that needs to be overstocked by disaster and emergency response teams. Federal disaster medical assistance teams (DMAT) and state emergency teams should have *adequate* pediatric supplies, and also be prepared to supplement what are inadequate community resources; yet studies of readiness teams reveal DMATs do not carry even *sufficient* quantities of essential pediatric equipment (Mace & Bern, 2007). During routine viral and influenza seasons, infants require respiratory support measures and hospitalization. In

times of pandemic flu or disaster, push packs should be available at the local, state, regional, and federal level, to compensate for the noted deficits in pediatric essential equipment. As national disaster response plans have addressed, in time of disaster or epidemic, hospitals may be required to care for families as a unit (Markenson, DiMaggio, & Redlener, 2003). All hospitals, including children's hospitals, need to be "all-hazards" ready to care for all members of their community.

Discussion of Research Question Two: Pediatric Hospitals and Availability of Pediatric Equipment

There is a difference in the availability of essential pediatric resuscitative equipment in the emergency departments of pediatric hospitals when compared to the emergency departments in community hospitals.

Pediatric hospitals were better prepared for pediatric emergency care and have higher compliance measures with essential equipment; but only 10% of hospitals are pediatric hospitals. Yet, these 10% of hospitals provide 25% of the nation's pediatric ED preparedness. Pediatric hospitals are in compliance with the *Guidelines for Preparedness* at a higher rate in part due to the concept of complexity. Clinicians at these facilities are knowledgeable in the specialty area of pediatrics, and the organization adopts guidelines applicable to children's special care needs. But their homogenous community characteristics place rural and low-income children at greater risk for harm. These children will be cared for in community EDs rather than pediatric or children's hospital EDs. Also, there are virtually no beds for critically ill children in rural areas. For children's hospitals, which receive philanthropic and community donations to care for

needy children, pediatric transport plans need to be established to facilitate rapid response of these specialized teams from pediatric hospitals.

Designation as a pediatric hospital influenced the availability of equipment and services. However, when assessing pediatric hospitals (n = 466) for emergency and critical care capabilities, there were notable differences among pediatric hospitals. Less than half of these hospitals have a pediatric intensive care unit (44%) or an ED that has a pediatric emergency medicine physician (40%), and just over a third have a pediatric trauma service (39%). It can not be assumed that all pediatric hospitals have the same level of critical care capabilities. This is an important point for national disaster response planners.

There is little regional surge capability with so few pediatric hospitals to provide emergency and critical care services to children (Krug & Gausche-Hill, 2007). Organizations such as the National Association of Children's Health Related Institutions (NACHRI) are exploring bed capacity in children's hospitals because many hospitals are finding it difficult to manage critically ill or injured children. Planned intensive care needs care can be scheduled (such as cardiac surgery) and provided at centers of excellence, but emergency care does not have that luxury. Pediatric hospitals provide a high level of care to a great number of children, but the majority of children receive emergency care in community hospitals. Pediatric emergency response can not be a solely pediatric hospital responsibility.

Though pediatric hospitals, by specialty training and experience, are the resource hospitals for complex pediatric care, they have not been ascribed the leadership role (by

the federal or state governments or professional organizations) in pediatric emergency and disaster care. Monies for pediatric readiness should be available to ensure pediatric hospitals provide "carts" of essential emergency equipment and host educational mock pediatric emergencies at nearby referral hospitals. Identifying area hospitals at risk by factors in this study—rural, low per capita income, low pediatric volume, and hospitals with few pediatric resources—could create benefits for these at-risk hospitals by interconnectedness with a pediatric hospital.

Using the DOI concepts, such as complexity and interconnectedness, to promote pediatric emergency outreach activities could enable pediatric hospitals to assist smaller EDs to adopt the *Guidelines for Preparedness*. Pediatric outreach education has diminished since pediatric hospitals have had to compete with community hospitals for business through insurers. Trauma hospitals have a mandate to provide assistance and education to benefit the trauma system; pediatric hospitals should have the same mandate, and again take the leadership role and assist outlying facilities to be in compliance with the *Guidelines for Preparedness*. Children's hospitals depend on community donations; many of these hospitals are being "bought" by companies to support their communities (such as Nationwide and Dell Children's Hospitals). These donations/purchases are made so children's hospitals can care for the community's children, to include emergency care for poor and rural children. Thus children's hospitals have an ethical obligation. Outreach programs, similar to those funded by the Emergency Medical Services for Children (EMS-C) in the 1980s to address pediatric trauma needs, could again be used to address our nation's pediatric emergency and disaster care needs.

Discussion of Research Question Three: Community Characteristics

Community characteristics such as metropolitan service area and per capita income, and, to a lesser degree, region, are associated with the availability of essential resuscitative equipment in emergency departments.

In looking at the community characteristics through the lenses of complexity and interconnectedness, there are community factors associated with hospitals' compliance with *Guidelines for Preparedness*: they look "different" than other hospitals. These EDs that have the essential pediatric equipment were twice as likely to be located in urban areas, and a linear relationship exists between equipment and the community's PCI. The richer the community, the more likely the essential equipment for pediatrics will be present. The poorest communities are half as likely to have the essential equipment. Urbanicity and higher per capita incomes are factors common to these compliant hospitals.

Region

There are concerns about geographic location and emergency preparedness. Region presents an interesting blend of characteristic in emergency care because of numerous factors such as population, population density, universities, and medical schools, geography, coordination of EMS and medical services, state and federal responsibilities, along with population growth and migration patterns. There is variability in findings between regions, though it may be a sampling error or related to other factors such as metropolitan service area (MSA) status.

The Northeast is population dense and has many universities and medical schools, so not unexpectedly it has the most pediatric hospitals. Whereas the West has the largest number of states that do not have medical schools and has fewer urban centers; it also has the fewest pediatric hospitals. Since the West has the fewest pediatric hospitals (7%) as compared to other regions (29%-33%), one would expect the West's compliance with *Guidelines for Preparedness* to be low. Even when the data is reviewed as percent of hospitals within the region, again the West has the lowest percentage (4%) as compared to the other regions (8.5% - 18.5%). Yet the West's compliance rate is not the lowest at 6.5% (range 5.8% - 9.3%), perhaps due to California's emergency department approved for pediatrics (EDAP) state regulation that accredits EDs. Implementing such a state accreditation process nationally would mandate and monitor pediatric essential equipment. There have been studies that look at states as organizations and evaluate adoption of innovation in state regulations, laws, and policies. California is thought to be an innovative state (Bekemeier, Riley, Padgett et al., 2007) and is perhaps correspondingly more open to adoption of innovation and *Guidelines for Preparedness*.

The Northeast and the South are two regions having a compliance rate above the national average (7.57%), with 8% and 9.3% respectively. The Northeast has twice as many pediatric hospitals as the South; but while only 9% of the nation's counties have children's hospitals, the South has several states with 5 to 10 children's hospitals. The South also had more hospitals in compliance than the other regions, representing 47% of the prepared hospitals in the nation. The South has a great proportion of the nation's children, and that number is anticipated to increase over the next decade as many of the

nation's top-growth counties fall into the Southern region. Seven out of the top 10, and over 70 of the top 100 highest growth counties, are found in the Southern region. Perhaps these factors—along with the frequency natural disasters (e.g. hurricanes)—explains why the South is a region of best practice.

Per Capita Income

A community characteristic associated with compliance with the *Guidelines for Preparedness* is affluence. Half of the non-compliant EDs were in areas of low PCI. The findings revealed a relationship between per capita income and compliance: As per capita income increased, compliance increased. There is the also the interaction of pediatric hospitals and per capita income. Whereas half of the nation's EDs are located in communities with a per capita income of less than $24,000, only 2% of these EDs are found in pediatric hospitals. Children in low income and rural areas will be treated at community hospitals. Virtually all pediatric hospitals are located in urban areas, making transport of these patients an emergency response priority.

Metropolitan Service Area

The homogenous characteristics of the pediatric hospital community—being urban, affluent, and having cosmopoliteness—can be problematic for disaster planning. Disaster planners will need to integrate resources from pediatric hospitals to address the deficiencies in rural and poor communities. Such communities are vulnerable to the devastations of disease or disaster, and pediatric resources are not currently available. As witnessed in Hurricanes Katrina and Rita, the poor are more vulnerable to the effects of disaster. When designing emergency response models for children, it is important to

recognize the community factors associated with EDs' adoption of the *Guidelines for Preparedness*.

Discussion of Research Question Four: Health Care Structure Characteristics

Health care structure and organizational characteristics, such as the volume of pediatric patients seen in the ED, the presence of a pediatric specialty physician (pediatric emergency care physician or pediatrician), the presence of a pediatric trauma service, or the availability of a pediatric intensive care unit, are associated with the adoption of the *Guidelines for Preparedness*.

Volume

In the analysis, EDs which treated less than 4,000 pediatric patients a year had a greater propensity to be missing essential pediatric equipment. Since pediatric patient ED volume is significant in predicting pediatric preparedness, institutions with small pediatric patient volumes may require assistance to comply with the *Guidelines for Preparedness.* These hospitals, if responsible for disaster coordination, may need to review their pediatric equipment and supplies.

Pediatric hospital ED volumes are usually higher because they see only children. These pediatric hospitals (49%) treat over 8,000 children a year (20 children a day), whereas only 20% of community hospital EDs treat greater than 8,000 children in a year. Yet, the majority of children (55%) are seen in EDs that routinely see less than 4,000 children a year (10 children a day). Solely looking at the visit volume, the average of 4,000 pediatric visits a year appears to be a marker for equipment availability. If the

average pediatric visits to the ED are greater than 4,000 a year, the likelihood of resuscitative equipment being present is twice that of the ED that treats less than 4,000 patients a year. As many as 30% of pediatric hospitals treat less than 4,000 patients a day. If the annual ED volume of 4,000 pediatric patients a year is a critical marker, then half of all the nation's hospitals fall below the marker. These EDs, in turn, were half as likely to have the essential equipment needed to care for children.

In various areas of clinical care there are associations between quality care markers and the sheer volume of patients. This has been studied in cardiac surgery and oncology centers. Volume of pediatric patient visits appears to be a factor in the diffusion of innovation. Although pediatric emergency care has not been tasked with quality care markers yet, annual pediatric ED volume does appear to be a factor in essential pediatric equipment preparedness, albeit there are other factors that influence pediatric emergency care.

Pediatric Hospitals

Volume is one indicator of essential equipment availability: Only 20% of the pediatric EDs with greater than 8,000 visits a year were in compliance with the essential equipment, but these 20% were four times as likely to have the essential equipment and be in compliance with the *Guidelines for Preparedness*. Other factors must be considered. With national "all-hazards readiness" as an ED focus, the Joint Commission could use best practices to influence and "redesign" pediatric ED care. The IOM and DHS could jointly fund institutions with low pediatric volumes but in "high risk" areas to

comply with the *Guidelines for Preparedness* (which, as discussed earlier, has a minimal price tag at less than $2,000 per hospital).

Pediatric hospital EDs could be mandated, as are trauma programs, to provide quality assurance monitoring focused on pediatric emergency care. If larger EDs provided outreach support to smaller area EDs, a majority of the national ED sample could be reached. Thus, rural and small-volume EDs would benefit from periodic compliance "mock code" that would be part of an accreditation by regional pediatric referral hospitals, perhaps with a quarterly patient transfer review or update. This interconnectedness would support the IOM recommendation of creating regional care programs that are seamless. Regional centers have an ethical and financial responsibility to participate in assuring quality patient care systems exist for critically ill and injured children. Because as many as 90% of pediatric ED patients are seen in non-children's hospitals, ED care can only be enhanced by first response preparedness, and hospital care can only be enhanced by ED preparedness. It has been proven, with regionalization and pre-hospital care, that outcomes are better and care is more efficient if appropriate resources are available (Gausche-Hill, 2003; Sacchetti et al., 2000).

Complexity and interconnectedness are driving concepts in the diffusion of innovation. Adoption of a practice, such as the *Guidelines for Preparedness*, would be hindered in an environment lacking these supports. The pinnacle of complexity of care within the organization would be the pediatric intensive care unit, yet the influences and associations were not significant.

Pediatric Specialty Services

The pediatric intensive care unit (PICU) is not connected to the ED, not sharing the same space in the same way, as the pediatric trauma service (PTS). PICUs are not connected as closely to the ED within the institution, though it would be interesting to evaluate those EDs that were in a hospital with a PICU independently. PICUs have outside EDs as a source for referrals, but there are few systems in place to give feedback on ED care by the receiving pediatric intensive care unit. If anything, the "referral patterns" are driven off of a business model that would prevent the PICU or PTS from correcting a deficit at an outlying ED. The system needs to change: Only with adequate data collection can low-volume procedures be monitored for quality care measures, and at present HIPPA would prevent sharing such information.

Thus, in the model the only structural factors to reach statistical significance were the presence of a pediatric trauma service and the presence of a pediatric emergency medicine (PEM) physician. These factors both relate to organizational size and pediatric volume. Both also have built-in roles to champion pediatric issues. There appears to be value added with the emergency medicine physician or a "pediatric trauma coordinator" that has been previously suggested and heralded by several sources (Gausche-Hill et al., 2007; Henderson, 2002; Institute of Medicine & Committee of the Future of Emergency Care in the U.S. Health System, 2006). In the Essential Pediatric Supplies and Equipment Survey (EPSES) this was the only individual "role" that was questioned and interpreted as valuable to have: a pediatric emergency physician or a nurse as pediatric trauma coordinator that acts as a champion for pediatrics. Even though one could argue that the

level of complexity is greater in the PICU, or the added specialization of a pediatric hospital enhances the general knowledge base in the ED, it appears to be the interconnectedness of the trauma service or PEM, and the leadership role of these "team members," that adds value to the preparedness model.

Pediatric Champion. The pediatric trauma service is a broadly based team which has a designated pediatric coordinator who does provide some outreach and quality assurance monitoring, as well as championing pediatric causes by function of the job description. Identifying this champion is integral to the innovation process, as it is most likely to be the innovation decision process of authority innovation-decision made by this trauma coordinator or PEM who possess the "power, position, or expertise" to adopt the innovation. Also of import, this champion is more likely to see the consequences of the innovation, being repeatedly involved in pediatric resuscitations in the ED and therefore more apt to see the clustering affects of the innovation's adoption. It is interesting that this factor is significant in pediatric trauma programs which are not in pediatric hospitals. It is the assigned responsibility to a person for pediatric care provisions throughout the emergency response that fosters the adoption process.

The IOM report (2006) states the need for a designated person, nurse or physician, to champion pediatric care issues in the ED. It states "simply recommending more training and the development of guidelines is not enough" (IOM, 2006). Similarly, the IOM goes on to state that developing guidelines is useless unless there is a method to ensure their widespread adoption. The *Guidelines for Preparedness* have been defined and disseminated but not widely adopted. It was recently reported by Gausche-Hill

(2006) in a follow-up study regarding the *Guidelines for Preparedness* that 59% of the EDs responded that they were aware of the *Guidelines*; and though awareness of the *Guidelines* made a difference in levels of adherence, she added that the role of pediatric coordinator tended to make EDs more prepared. Research continues to support the need for such a designated role, relating to organizational interconnectedness, to ensure the issues surrounding pediatric equipment and services are addressed. Pediatric trauma coordinators, usually nurses, serve as exemplars in this role. They have an established interconnectedness with pre-hospital and community disaster services. Pediatric trauma programs offer a strong association with the availability of essential equipment in the ED due to the integral role of the "champion," the pediatric trauma coordinator. This may be one reason pediatric trauma services were significantly related to compliance with the *Guidelines for Preparedness*.

Summary of Research Question Discussions

In summary, while assessing the capabilities of EDs to care for critically ill and injured children, it is important to keep the following in perspective:

1. only 50% of the nation's EDs see more than 4,000 pediatric patients a year,
2. only 23% of the nation's EDs have a pediatric emergency medicine specialist,
3. only 15% the nation's hospitals have pediatric trauma services, and
4. only 10% of the nation's hospitals have pediatric intensive care units.

While these factors have a positive relationship with the adoption of the *Guidelines for Preparedness* and the availability of essential pediatric equipment, these services represent but a fragment of the emergency care system. Less than 8% of the nation's

emergency departments are compliant with the essential pediatric equipment. The strongest organizational factor associations were with the presence of a pediatric emergency medicine specialist (PEM) and the availability of a pediatric trauma service. There has been little change in this since 1998, even though emergency and disaster readiness have been a national focus for over five years. The emergency care system is fragmented, with no clear exemplar of characteristics associated with a prepared pediatric emergency department. Even if relying on solely pediatric hospitals, only 25% of these emergency departments have the essential pediatric resuscitation equipment. Regardless of hospital type, the smaller the child, the more likely equipment will be missing and thus the greater the risk to the child. When the *Guidelines for Preparedness* essential equipment list of over 150 items was minimized to solely 50 items basic to pediatric resuscitation (equipment listed in the AHA Pediatric Advanced Life Support Resuscitation course), only 25% of emergency departments had the equipment necessary to resuscitate a child.

Conclusions

Pediatric emergency equipment availability is a problem. Pediatrics continues to be an afterthought in emergency and disaster management, and as a nation we are not prepared for pediatric emergencies or pediatric disaster care.

This research lends further credibility to the Diffusion of Innovation framework by suggesting a relationship between organizational structure (size, volume, and presence of specialty personnel) and adoption of an innovation, *Guidelines for Preparedness.* There is wide variation in pediatric emergency department characteristics and wide

variation in the hospitals that house these emergency departments. This analysis provides disaster planners a methodology to identify pediatric emergency resources in local communities and to inform the community regarding the local capacity for pediatric disaster care. After decades of lacking pediatric emergency equipment, this study identifies characteristics of the emergency departments compliant with *Guidelines for Preparedness*, along with the community and organizational characteristics that support these best practices and identify those emergency departments that may be at greater risk for non-compliance with the *Guidelines for Preparedness.*

The recoded definition of a pediatric hospital allows national databases to be used to analyze the strengths and weaknesses of these specialty hospitals. Pediatric emergency departments may not be a well-defined entity, but at least now there are well-defined *Guidelines for Preparedness* that identify essential pediatric equipment and services. With the vast majority of children being seen in non-children's hospitals and the majority of emergency departments seeing less than 4,000 children a year, there is a need to standardize pediatric emergency care. In following the IOM recommendations, there should be a designated pediatric emergency coordinator for every emergency department, and state or Joint Commission accreditation for pediatric equipment and supplies should exist. A nurse coordinator would embody the organization's (hospital's) commitment to pediatric emergency care, ensuring compliance with the *Guidelines for Preparedness* by providing equipment and supplies, as well as ensuring children's needs are not forgotten as emergency response plans address national, regional, and local readiness for disasters such as pandemic influenza, H5N1 outbreak, or terrorist attack.

Politics of Children's Health Care

As the country struggles with health care reform, much of the energy and innovation will be centered on the adult system. Repeatedly, there are examples of children's health care being lost in the vast adult care system. After studies revealed that children were dying needlessly because of gaps in emergency care and the inability of the system to adequately treat children, the newly developed federal Emergency Medical Services for Children (EMS-C) began pediatric outreach to every state with emergency care education and injury prevention programs. Through this federal agency, several states made essential pediatric equipment standardized on ACLS ambulances. The need for pediatric emergency care accreditation continues to be ignored (Huddleston, 2006).

The National Health Interview Survey (NHIS) indicates that unmet health care needs are prevalent among children. The current battle in attempts to pass a State Children's Health Insurance Program (S-CHIP) bill in Congress highlights disparities in politics and policies regarding the perception of children's access to health care services. Disaster response disparities in pediatric emergency care in regard to race, affluence, and special health care needs blend into the tapestry of community demographics and require an environment assessment beginning at the local emergency department. Federal support requires further research into the structure and availability of pediatric and specialty services. Federal resources need to be accessible to address the emergency care needs of this low-volume but high-risk population which represents our greatest national resource.

Limitations

Limitations of this study include using extant data which may not be complete or accurate. The data was collected by the U.S. Census Bureau upon request from the CDC as a supplement to the NHAMCS. There are limitations in the sampling method and the complex weighted data computations utilized by NCHS. There may be concerns with the linkage of the two databases although they are from the same subject base. Definitions are based on the CDC-user dictionary and may not represent the most current definitions and clinical interpretations in the literature. Variables available for study in this research have been those identified by the CDC, thus those available from the extant databases. There may be other additional yet unidentified variables not available in these databases and thus not studied in context to the research questions. The data for this study were derived from 2002 and 2003 extant data sets; therefore it is possible that the availability of essential resuscitative equipment patterns have changed.

Even though this data is from a large national survey, the number of pediatric specialty care services is small. Low frequency counts in individual cells were common and increase the potential for error. This is a common problem for pediatric health service research but is a limitation to the study.

Suggestions for Future Research

The relationship between essential resuscitative equipment and quality emergency care has not been established, and there is potential for data mining in these large national ED databases along with inferential "expert domain" theory to assess adherence to clinical care guidelines. These data sets are rich and reveal EDs' ability to diagnose and

treat groups by age, sex, and race, and to identify variations in procedures, drug use, or geographic variations in treatment protocols. Bayesian modeling is a relevant methodology for data mining and to determine associations and establish probabilities for variables in large data repositories. Caution is needed in generalizing large effect findings that alternative modeling methods may explain. Researchers can access these data sets and recode them to further explore and define emergency care patterns, access, and quality markers. The NHAMCS has quality markers such as emergency wait times, procedures, and drugs administered to be evaluated against demographics of such as age, race, insurance, and hospital demographics.

Interventional studies should be performed to assess the impact of a pediatric coordinator (champion) role on community hospital ED compliance. As the lack of pediatric equipment has been acknowledged for decades, it seems time the Joint Commission confer with hospitals and provide accreditation criteria for EDs "approved for pediatrics" to ensure adequate pediatric emergency equipment and care. Disaster planners and emergency response teams should be aware of community and organizational characteristics that promote pediatric preparedness. Disaster drills should include whether or not an ED is in compliance with the *Guidelines for Pediatric Preparedness*.

As noted earlier, pediatrics continues to be an afterthought in emergency and disaster management, and as a nation we are not prepared for pediatric emergencies or pediatric disaster care.

Appendix A. Disaster Care and Children

Background

Numerous disasters over the past decade have heightened awareness of the need for disaster readiness. After 9/11 and the subsequent anthrax attacks, much of the readiness focus was on bioterrorism and the risk of smallpox. The President's program on smallpox vaccination exemplified the neglect of children in the planning phases by developing a solely adult vaccination program with little to no thought regarding children (Thorne, Hirshon, Himes, & McDiarmid, 2003; Fine, Goldmann, Forbes, Harris, & Mandl, 2006; Veneema, 2006). Infectious disease research repeatedly demonstrates that children are at the greatest risk and frequently are the greatest vector of disease spread. Yet little has been done in the area of childhood vaccination research and public health policy, even for seasonal influenza—much less chemical agents of terror (Gray, 2003; Huddleston, 2006; Joellenbeck, Zwanziger, Durch, & Strom, 2002; Martin & Didion, 2003). And even less has been done to evaluate the access to services and essential equipment essential to treat children in times of emergency and disaster.

Vulnerable Populations

Hurricane Katrina in August of 2005 demonstrated the differences in disaster mitigation; the economic disparities of disaster response became obvious and vulnerable populations suffered disproportionately. Such recent events have brought the aspects of both emergency care and disaster care to public scrutiny (Jamieson, Lammie, Wardle, & Krutt, 2003; Markenson & Redlener, 2005). Globally, there were terrorist attacks in

Russia, Madrid, Israel, and London, as well as a tsunami in the Pacific, along with various earthquakes, hurricanes, and cyclones. In every one of these disasters, there have been children involved. Sometimes, like the attacks in Breslan, Russia, children were the targets. Other times, like Hurricane Katrina, affected thousands of children. It has been nearly three years and over 55,000 children are still displaced, which places these children at additional risks for health, mental, and educational crises (DiMaggio, Markenson, Henning, Redlener, & Zimmerman, 2006).

Emergency care is the cornerstone for disaster response. Disaster response starts with emergency care, and many emergency departments have been tasked to participate in, if not lead, community level disaster readiness plans. Yet, health care planners continue to focus on adult care and, as a result, vulnerable populations have been marginalized (Aday, 2005). Without an organized and prepared emergency care system that includes children's needs, disaster response can not be adequate. Children are a quarter of our population and will be represented accordingly in disasters. Pediatric emergency care is an essential component of community disaster readiness and must not be "lost" in planning our national or local disaster response (Markenson & Redlener, 2005).

Local and National Response Efforts

Most aspects of disaster planning and preparations consider solely adults' needs. Integrating children's needs into federal, state, and local disaster plans is crucial to the success of the disaster response. Unpublished data from FEMA in 1997 states that there were no pediatric issues addressed in state disaster plans (Institute of Medicine &

Committee on the Future of Emergency Care in the U.S. Health System, 2006; Markenson & Redlener, 2003, 2004). Pediatrics is a relative newcomer to the field of emergency and disaster medicine, which has its foundation in the roots of military field medicine. Thus, it is no surprise that the system structure of emergency medicine and trauma has included children's care only as an afterthought; and the same pattern is present in national, state, and local disaster planning (Ferguson, 2002; Henretig, Mechem, & Jew, 2002; Veenema, 2003a).

Yet, repeatedly in the national disaster drills (coined "TOP OFF" because of top officials' involvement in the role playing), there has been no pediatric involvement. Although disaster drills are mandatory for hospital accreditation through the Joint Commission, few hospitals have drilled with pediatric patients; even those that have, have not approximated the true population proportion (Markenson & Redlener, 2005). Determining the availability and accessibility of adequate pediatric emergency care services and identifying the type of emergency care entities that providing such services are an important aspect of connecting disaster planning and emergency management (Markenson & Redlener, 2003, 2004; Phillips, 2003; Redlener & Markenson, 2003).

Differences in Disaster Readiness for Children

Children are physiologically and psychologically vulnerable and thus suffer more in the event of a natural or man-made disaster. Many of the physiological differences make them more susceptible to chemical attacks because they have a faster respiratory rate and thinner skin, therefore absorbing more of the chemical agent. They are also more susceptible to fluid shifts from chemical or biological agents which induce vomiting or

diarrhea, and therefore are more likely to suffer severe dehydration (Hohenhaus, 2005b; Veenema, 2003b). The antidotes for most biologicals are based on adults—usually healthy males from military research—and therefore have little to no pediatric dosing or efficacy research (Markenson & Redlener, 2003, 2004).

A post-9/11 focus on national bioterrorism readiness included nationwide drills regarding anthrax, botulism, and smallpox. Various public health agencies and support institutions such as the Institute of Medicine (IOM), the Center for Disease Control and Prevention (CDC), and the Agency for Healthcare Research and Quality (AHRQ) initiated data collection and research projects regarding planning, implementing, and executing mass casualty incidents, mass immunization programs, and regional isolation and quarantine procedures. Coordination between public health agencies and the health care system was identified as a gap in providing these emergency care services. Yet, much if not all of this energy centered on major metropolitan areas, urban centers, and academic medical centers due to the way monies are awarded in the grant process—and few of these efforts dealt with children (Cieslak & Henretig, 2003; Veneema, 2003b; Rosenfield & Bernardo, 2001).

It has been asserted that children and other special needs populations were not included in plans for emergency and disaster response; the lack of planning required for these special populations would hinder all response efforts (Agency for Healthcare Research and Quality, 2002; Heinrich, 2003; Markenson & Redlener, 2003, 2005; Markenson & Reynolds, 2006; National Academy of Sciences, 2002).

This expert consensus recommended dosing for prophylaxis in children exposed to bioterrorism and made broad recommendations to address the wide range of children's developmental and emotional needs (Harbison & Novak, 2002; Shaw, 2003). System recommendations were made such that each hospital keep a 48-hour supply of pediatric equipment and pharmaceuticals on hand for the average daily number of patients plus the population expectation for pediatrics in the area in case of a disaster; thus if the ED expects 200 people could be brought in during an event, then resources for 50 children should be on hand (Hohenhaus, 2005b; White, Henretig, & Dukes, 2002b).

Summary

Emergency care is a challenge for the health care system and the quality varies depending on a host of community health service characteristics such as the emergency medical services; system, hospital, and facility service type; community resources; and regulatory structure (Eisenburg, Horwood, Cummins, Reynolds-Haertle, & Hearne, 1990). The IOM has stated in numerous reports over the past two decades that pediatric care across the nation is "uneven" (IOM, 1993, 2004, 2006). The lack of adequate pediatric emergency equipment is still a problem even though emergency readiness has been a national focus since 9/11 (Middleton, 2005; Middleton & Burt, 2006). There is a wide variance in the equipment available in community EDs to care for critically ill or injured children in time of disaster, and that has not changed despite the advent of the *Guidelines for Pediatric Preparedness* in 2001 (Gausche-Hill & Wiebe, 2001; Markenson & Redlener, 2004).

Appendix B. National Hospital Ambulatory Medical Care Survey (NHAMCS) and Emergency Pediatric Supplies and Equipment Survey (EPSES)

This research utilizes the national sample of the Emergency Pediatric Supplies and Equipment Survey (EPSES) collected as a supplement to the annual National Hospital Ambulatory Medical Care Survey (NHAMCS) for the years 2002 and 2003. This survey is a probability sample survey conducted by the Center for Disease Control and Prevention (CDC) and the National Center for Health Statistics (NCHS) with cooperation from the U.S. Census Bureau. It is an in-person visit to the target universe of non-federal, short stay hospitals (defined as the average length of stay less than 30 days), to include general medical, surgical, and children's general care hospitals. The main goal of the NHAMCS is to estimate annual volume and medical characteristics that create the emergency and outpatient patient visits. A two-stage probability sample design was used to select EDs in the NHAMCS sample of hospitals. Randomly, the hospitals were assigned to a four-week reporting panel. The form was completed by 87% of the facilities. The form was not given to a specific person or title but many of the forms were completed by a nurse in the ED.

Survey Tools

National Hospital Ambulatory Medical Care Survey (NHAMCS)

The NHAMCS comprises a national probability sample of visits to emergency departments in the 50 states and the District of Columbia. The survey is designed to provide emergency care estimates in the following areas: region of the country, hospital

ownership, insurance type, metropolitan statistical area (MSA), among other variables that can be seen in more detail with the public-use downloadable documentation files (NHAMCS, n.d.). Nearly 400 hospitals participate annually, with a different sampling every year. It has a 95% response rate, thus providing annual sample patient visit data for approximately 113.9 million visits to the ED. Census Department staff completed the patient record forms during a systematic random sample of patient visits occurring during a randomly selected four-week period time.

Emergency Pediatric Equipment and Supplies Survey (EPSES)

The EPSES survey consists of 10 general pediatric health care organization questions regarding hospital structure to include the form and structure of the ED, inpatient and critical care beds, pediatric physician expertise, and a checklist of 136 items listed in the Guidelines for Pediatric Resuscitation from the American Academy of Pediatrics (AAP) and the American College of Emergency Physicians (ACEP) that are grouped into three children's age/size categories. The items are listed such that respondents check off the item as available or not available. Of the 396 eligible EDs, 346 completed the EPSES, for an 87% return response rate. The form was completed largely by nurses in the ED. Two years of data were used for this study and weighted appropriately to NCHS standards.

For more information to include the data collection forms, visit the official NHAMCS website, http://www.cdc.gov/nchs/about/major/ahcd/nhamcsds.htm, or visit the NCHS Research Data Center at http://www.cdc.gov/nchs/r&d/rdc.htm.

Appendix C. Letter to Expert Panel

Kathi Huddleston
Diffusion of Innovation: Analysis of Pediatric Emergency Department Readiness
Modified Delphi Survey
September 20, 2006

Dear Expert Panel Member,

Thank you for agreeing to participate in this study of emergency department pediatric readiness. Extant data sources from the Center for Disease Control and Prevention (CDC), National Center for Health Statistics (NCHS) that evaluated the pediatric preparedness of the nation's emergency departments will be used. In addition to these data sets I am also interested in the community characteristics that are involved in pediatric emergency readiness. I will be accessing census and regional data to analyze the effects of income, education, and population trends as they may influence emergency readiness. Thank you for your participation and support of my research.

I have asked 10 experts in the area of pediatric care, pediatric emergency care, and pediatric disaster readiness to frame the concepts of adoption of innovation with the questions regarding pediatric equipment and supplies. This modified Delphi technique is expected to require 2 to 3 mailings and a total of less than a total of 2 hours of your time for group consensus. I do not anticipate at this time that we will need to actually meet together, as consensus defined at 80% agreement should be attainable by solely electronic mailings.

The conceptual framework for this study is Diffusion of Innovation by Everett Rogers (2003, originally published in the 1960s). This theory presents "predictive characteristics" of the adoption of innovation as a) complexity, and b) interconnectedness. Roger's theory defines

a) **complexity** as "the degree to which an organization's members possess a relatively high level of knowledge and expertise, usually measured by the member's range of occupational specialties and their degree of professionalism (expressed by formal training)"; with an operational definition of "the ability to deliver pediatric emergency care services as evidenced by type, structure and personnel, whereas,

b) **interconnectedness** is defined by Rogers as "the degree to which the units in a social system are linked by interpersonal networks. New ideas can flow more easily among organizational members if it has a higher degree of network interconnectedness"; with an operational

> definition of "the services and activities that connect the hospital emergency department and pediatric emergency care to the community services and other resources creating cosmopolite communication and networking channels." (Rogers, 2003)

The following questions were on the Emergency Pediatric Services and Equipment Supplement (EPSES) that was administered to 387 hospitals in 2002 and 2003, and again in 2005. Please read them and review for the underlying conceptual frame of the question, being complexity or interconnectedness. The questions should be categorized as complexity (C) or interconnectedness (I) – please type a "C" or an "I" after each question…. If you are unsure or feel that it does not fit in either concept then please place a "U" after the question.

Several of you have been selected for your expertise (and age ☺) when the concept of pediatric trauma was developing and it became obvious that a system/community change was required. It became apparent that knowledge alone did not remedy the problems. Please keep the trauma evolution process in your mind as you deliberate on these concepts, as knowledge is always in the cornerstone of innovation adoption—but after much review, other issues are also central and perhaps unique to the pediatric emergency readiness concept.

1) Does your hospital admit pediatric patients? y/n

2) Does your hospital have a separate pediatric ward or department intended for exclusively treating children? y/n

3) Does your hospital have a 23-hour observation area exclusively for pediatric patients, an area for pediatric patients who are not admitted to the hospital but whose condition following treatment may warrant further assessment before admission or discharge? y/n

4) Does your hospital have a pediatric trauma service, that is, coordinated trauma care for a pediatric patient from admittance to discharge? y/n

5) Does your hospital have a written transfer agreement with a facility that has a pediatric trauma service? y/n

6) Generally, critically injured pediatric patients requiring hospitalization would be cared for

   a) in your hospital
   b) in another hospital, per written transfer agreement
   c) in another hospital, but no written transfer agreement exists

7) Pediatric patients requiring intensive care would be cared for

   a) in a pediatric intensive care unit
   b) in the adult ICU in your hospital
   c) in another hospital

8) Does your hospital have a written transfer agreement with a facility that has a pediatric intensive care unit? y/n

9) Do you have written protocols stating under what conditions a pediatrician will be called to the emergency department? y/n/na – (n/a would be having a pediatrician on duty 24/7 in the ED)

10) Does your emergency department have 24 hour/7 day a week access to the following attending physicians, either in house or on call? y/n

   a) board certified emergency medicine physician – y/n
   b) board certified pediatric emergency medicine physician? y/n
   c) board certified pediatric attending physician? y/n

Also if within your expertise, as a physician/nurse that leads resuscitations, would you please review and evaluate the three size/age categories of essential pediatric equipment attached. All of these items are listed in the ACEP/AAP "Care of Children in the Emergency Department: Guidelines for Preparedness" (March, 2001). I have taken these items and grouped them into three categories (using the Broselow-Luten colors). These categories will be reviewed for gaps in equipment inventories to identify children at risk.

Thank you for your time and cooperation with this study,

Kathi C. Huddleston

Appendix D. Results of Delphi Survey on Theory

	MD	MD	MD	MD	RN	RN	RN	RN	Percentage Total Theory	Complexity
EPSES1 *	c	c	c/i	c	c	i	c	c	100%	93%
EPSES2 *	c	c	c/i	c	c	c	c	c	100%	93%
EPSES3 *	c	c	c/i	i	c	i	c	i	100%	56%
EPSES4	i	c	c	i	c	i	c	i	100%	50%
EPSES5	i	i	i	i	i	c	i	i	100%	13%
EPSES6	i	c	c/i	i	c	c	i	i	100%	44%
EPSES7 *	c	c	c/i	c/i	c	c	c	c/i	100%	81%
EPSES8	i	i	i	i	i	i	c	i	100%	13%
EPSES9 *	i	c	c	c/i	c	i	c	c/i	100%	57%
EPSES10 *	c	c	c	c	c	u	c	c	88%	88%
Total With Theory > 85%									100%	

Note. * Complexity > 50%.

Appendix E. Detailed Explanation on Emergency Pediatric Services and Equipment Supplement (EPSES) Coding

Resuscitative equipment: Emergency Pediatric Services and Equipment Supplement (EPSES) equipment according to size/weight – three categories:

1. Approximate age under 1 year and <12 kg
2. Approximate age 1 year to 4 years and 12- 17 kg
3. Approximate age 5 years to 10* years and 18- 32kg (* after age 12 much equipment is the same as for a small adult)

EPSES Items	Only One Pediatric Size Available/Needed	Code Number YES/NO Answer
Infant Scales	Pediatric	G.1
Heating Source	Pediatric	G.4
Pediatric Restraining Devices	Pediatric	G.5
Chest Tube Thoracostomy	Pediatric	E.1
Laryngoscope Handles	Pediatric	C.10

Pediatric Supplies < 1 year	0 - 11 kg.	EPSES Item
Oral Airway	Infant/Small Child	C.3
BVM – Bag	Infant/Child	C.5
O2 Mask	Neonatal/Infant	C.1.a/b
O2 Mask Rebreather	Infant	C.2.a
Oral Airways	Sizes 00, 0	C.3.a/b
Nasopharangeal Airways	Size 10	C.4
Nasal Cannula	Infant	C.6.a
Laryngoscope Handles	Pediatrics	C.10
Laryngoscope Blades	1 Straight	C.12.a/b
Magill Forceps	Pediatrics	C.13
ETT	(2.5 Premie) 3-4	C.7. a/b/c/d
Stylet	6 fr	C.9.a
Suction Catheter	5-8 fr.	C.15.a/b/c
BP Cuff	Neonatal/Infant	A.7.a/b

Vascular Access – Catheter	20-24	B.2.c/d/e
Butterfly	23-25	B.1.c/d
IO	Child	A.5
NG Tube	5-10	C.14.a/b/c/d
Urinary Catheter	5-10	E.3.a/b/c
Chest Tube	8-18	C.16.a/b/c/d/e
Defibrillator With Electrodes Paddles	4.5 Paddles	A.1/2
Pulse Oximetry Sensor	*Newborn/Adult	A.4a
Tracheostomy Tubes	Sizes 00, 0 , 1	17.a/b/c
Lumbar Puncture	Spinal Needle 20-22	E.2.b/c
Cervical Immobilization	Infant	F.1.a
Comments:		
Pediatric Supplies 1 - 4 years	**12 - 17 kg.**	**EPSES item**
Oral Airway	Child	C.3
BVM – Bag	Child	C.5
O2 Mask	Pediatric	C.1.a/b
O2 Mask Rebreather	Infant/Child	C.2 .a/b
Oral Airways	Sizes 0, 1, 2	C.3.a/b
Nasopharangeal Airways	Sizes 14, 16, 20	C.4
Nasal Cannula	Infant/Child	C.6.a
Laryngoscope Blades	2 Straight or Curved	C.12.a/b
Magill Forceps	Pediatrics	C.13
ETT	4.5-5.0	C.7.a/b/c/d
Stylet	6 fr	C.9.a
Suction Catheter	10 fr	C.15.a/b/c
BP Cuff	Child	A.7.a/b
Vascular Access – Catheter	18-22	B.2.c/d/e
Butterfly	21-23	B.1.c/d
IO	Child	A.5
NG Tube	10-12	C.14.a/b/c/d
Urinary Catheter	10-12	E.3.a/b/c
Chest Tube	20-24	C.16.a/b/c/d/e/f/g
Defibrillator With Electrodes Paddles	4.5 Paddles	A.1/2
Pulse Oximetry Sensor	*Newborn/Adult	A.4a
Tracheostomy Tubes	Sizes 2, 3, 4	17.a/b/c

Lumbar Puncture	Spinal Needle 20-22	E.2.a/b
Cervical Immobilization	Child	F.1.a
Comments:		
Pediatric Supplies 5 - 10 years	**18 - 32 kg.**	**EPSES item**
BVM – Bag	Child/Adult	C.5
O2 Mask	Pediatric – Child	C.1.a/b
O2 Mask Rebreather	Child	C.2.a
Oral Airways	Sizes 2, 3	C.3.d/e
Nasopharangeal Airways	Sizes 16, 20, 24	C.4
Nasal Cannula	Child	C.6.b
Laryngoscope Handles	Pediatrics	C.10
Laryngoscope Blades	2-3 Straight and Curved	C.11 a/b C.12 a/b
Magill Forceps	Pediatrics	C.13
ETT Uncuffed (C.7) and Cuffed (C.8)	4.0-6.5	C.7.f.g/h/i/j/k C.8 a/b/c/d/e
Stylet	14 fr – Pediatric	C.9.b
Suction Catheter	10 fr	C.15.b/c/d
BP Cuff	Child/Adult	A.7.c/d
Vascular Access – Catheter	18-22	B.2.b/c/d/e
Butterfly	21-23	B.1.a/b/c
IO	Child	A.5
NG Tube	12-18	C.14.d/e/f
Chest Tube	24-40	C.16.g/h/i/j
Defibrillator With Electrodes Paddles	Pediatrics/Adult	A.1/2
Pulse Oximetry Sensor	*Newborn/Adult	A.4a/b
Tracheostomy Tubes	Sizes 4, 5, 6	17.f/g/h
Lumbar Puncture	Spinal Needle 20-22	E.2.a/b
Cervical Immobilization	Child	F.1.a
Comments:		

Note. * After age 12 much equipment is the same as for a small adult.

Appendix F. Detailed Explanation on Pediatric Hospital Coding

Children's Hospitals on the 2005 AHA Annual Survey

Hospital Name	Address	City	State
Children's Hospital of Alabama	1600 Seventh Avenue South	Birmingham	AL
Searcy Hospital		Mount Vernon	AL
Rivendell Behavioral Hlth Serv	100 Rivendell Drive	Benton	AR
Arkansas Children's Hospital	800 Marshall Street	Little Rock	AR
Phoenix Children's Hospital	1919 East Thomas Road	Phoenix	AZ
Childrens Hospital Los Angeles	4650 Sunset Boulevard	Los Angeles	CA
Shriners Hosps for Children	3160 Geneva Street	Los Angeles	CA
Children's Hospital Central CA	9300 Valley Children's Place	Madera	CA
Children's Hosp & Research Ctr	747 52nd Street	Oakland	CA
Children's Hosp of Orange Cnty	455 South Main Street	Orange	CA
Lucile Packard Children's Hosp	725 Welch Road	Palo Alto	CA
Shriners Hosps for Children	2425 Stockton Boulevard	Sacramento	CA
Rady Children Hosp & Hlth Ctr	3020 Children's Way	San Diego	CA
Children's Hospital	1056 East 19th Avenue	Denver	CO
Cleo Wallace Centers Hospital	8405 Church Ranch Boulevard	Westminster	CO
Connecticut Children's Med Ctr	282 Washington Street	Hartford	CT
Riverview Hospital for Child	915 River Road	Middletown	CT
Children's National Med Center	111 Michigan Avenue NW	Washington	DC
HSC Pediatric Center	1731 Bunker Hill Road NE	Washington	DC
Meadow Wood Behavioral Hlth	575 South Dupont Highway	New Castle	DE
Alfred I duPont Hospital	1600 Rockland Road	Wilmington	DE
Devereux Hosp & Children's Ctr	8000 Devereux Drive	Melbourne	FL
Miami Children's Hospital	3100 SW 62nd Avenue	Miami	FL
All Children's Hospital	801 Sixth Street South	Saint Petersburg	FL
Shriners Hosps for Children	12502 Pine Drive	Tampa	FL
Sandypines	11301 SE Tequesta Terrace	Tequesta	FL
Children's Healthcare Atlanta	1600 Tullie Circle, NE	Atlanta	GA
Hillside Hospital	690 Courtney Drive NE	Atlanta	GA
Inner Harbour	4685 Dorsett Shoals Road	Douglasville	GA
Devereux Treatment Network	1291 Stanley Road NW	Kennesaw	GA
Shriners Hosps for Children	1310 Punahou Street	Honolulu	HI
Children's Memorial Hospital	2300 Children's Plaza	Chicago	IL
La Rabida Children's Hospital	East 65th St at Lake Michigan	Chicago	IL
Shriners Hosps for Children	2211 North Oak Park Avenue	Chicago	IL
Streamwood Behavioral Center	1400 East Irving Park Road	Streamwood	IL
Children's Mercy South	5808 West 110th Street	Overland Park	KS
NorthKey Community Care	502 Farrell Drive	Covington	KY
Shriners Hosps for Children	1900 Richmond Road	Lexington	KY
RiverValley Behavioral Hosp	1000 Industrial Drive	Owensboro	KY
Dubuis Hosp of Lake Charles	524 South Ryan, 5th Floor	Lake Charles	LA

Children's Hospital	200 Henry Clay Avenue	New Orleans	LA
New Orleans Adolescent Hosp	210 State Street	New Orleans	LA
Shriners Hosps for Children	3100 Samford Avenue	Shreveport	LA
Isham Health Center	180 Main Street	Andover	MA
Children's Hospital Boston	300 Longwood Avenue	Boston	MA
Franciscan Hosp for Children	30 Warren Street	Boston	MA
Shriners Hosp for Children	51 Blossom Street	Boston	MA
Massachusetts Hospital School	3 Randolph Street	Canton	MA
Shriners Hospitals for Child	516 Carew Street	Springfield	MA
Kennedy Krieger Institute	707 North Broadway	Baltimore	MD
MT Washington Pediatric Hosp	1708 West Rogers Avenue	Baltimore	MD
Children's Hosp of Michigan	3901 Beaubien Street	Detroit	MI
Hawthorn Center	18471 Haggerty Road	Northville	MI
Children's Hospitals & Clinics	2525 Chicago Avenue South	Minneapolis	MN
Shriners Hosps for Children	2025 East River Parkway	Minneapolis	MN
Children's Hospital & Clinics	345 North Smith Avenue	Saint Paul	MN
Gillette Children's Healthcare	200 East University Avenue	Saint Paul	MN
Children's Mercy Hosp & Clinic	2401 Gillham Road	Kansas City	MO
Ranken Jordan	11365 Dorsett Road	Maryland Heights	MO
CenterPointe Hospital	5931 Highway 94 South	Saint Charles	MO
Shriners Hosps for Children	2001 South Lindbergh Blvd	Saint Louis	MO
SSM Cardinal Glennon Child Ctr	1465 South Grand Boulevard	Saint Louis	MO
St Louis Children's Hospital	One Children's Place	Saint Louis	MO
Shodair Children's Hospital	2755 Colonial Drive	Helena	MT
Boys Town Natl Research Hosp	555 North 30th Street	Omaha	NE
Children's Hospital	8200 Dodge Street	Omaha	NE
Children's Specialized Hosp	150 New Providence Road	Mountainside	NJ
Carrie Tingley Hospital	1127 University Boulevard NE	Albuquerque	NM
Willow Springs Res Treatment	690 Edison Way	Reno	NV
Bronx Children's Psych Center	1000 Waters Place	Bronx	NY
Western NY Children's Center	1010 East and West Road	Buffalo	NY
Sagamore Children's Psych Ctr	197 Half Hollow Road	Dix Hills	NY
Queens Children's Psych Center	74-03 Commonwealth Blvd	Jamaica	NY
Rockland Children's Psych Ctr	599 Convent Road	Orangeburg	NY
Blythedale Children's Hospital	95 Bradhurst Avenue	Valhalla	NY
Akron Children's Hospital	One Perkins Square	Akron	OH
Children's Hosp Medical Center	3333 Burnet Avenue	Cincinnati	OH
Shriners Hosps for Children	3229 Burnet Avenue	Cincinnati	OH
Cleveland Clinic Child Hosp	2801 Martin Luther King Jr Dr	Cleveland	OH
Children's Hospital	700 Children's Drive	Columbus	OH
Children's Medical Center	One Children's Plaza	Dayton	OH
Willow Crest Hospital	130 'A' Street SW	Miami	OK
J D McCarty Ctr for Children	2002 East Robinson	Norman	OK
Shadow Mountain Behavioral	6262 South Sheridan Road	Tulsa	OK
Foundations Behavioral Health	833 East Butler Avenue	Doylestown	PA
Shriners Hosps for Children	1645 West 8th Street	Erie	PA
KidsPeace Children's Hospital	5300 Kids Peace Drive	Orefield	PA

Children's Hospital of Philade	34th St & Civic Center Blvd	Philadelphia	PA
Shriners Hosps for Children	3551 North Broad Street	Philadelphia	PA
St Christopher's Hospital	Erie Avenue at Front Street	Philadelphia	PA
Children's Home of Pittsburgh	5618 Kentucky Avenue	Pittsburgh	PA
Children's Hosp of Pittsburgh	3705 Fifth Avenue	Pittsburgh	PA
Children's Inst of Pittsburgh	1405 Shady Avenue	Pittsburgh	PA
Southwood Psychiatric Hospital	2575 Boyce Plaza Road	Pittsburgh	PA
Emma Pendleton Bradley Hosp	1011 Veterans Memorial Pkwy	East Providence	RI
Shriners Hosps for Children	950 West Faris Road	Greenville	SC
Childrens Care Hospital & Schl	2501 West 26th Street	Sioux Falls	SD
East Tennessee Children's Hosp	2018 Clinch Avenue	Knoxville	TN
St Jude Children's Res Hosp	332 North Lauderdale Street	Memphis	TN
Driscoll Children's Hospital	3533 South Alameda Street	Corpus Christi	TX
Children's Med Cntr of Dallas	1935 Motor Street	Dallas	TX
Our Children's House at Baylor	3504 Swiss Avenue	Dallas	TX
Texas Scottish Rite Hospital	2222 Welborn Street	Dallas	TX
Cook Children's Medical Center	801 Seventh Avenue	Fort Worth	TX
Trinity Springs Pavilion	1500 South Main Street	Fort Worth	TX
Shriners Hosps for Children	815 Market Street	Galveston	TX
Shriners Hosps for Children	6977 Main Street	Houston	TX
Texas Children's Hospital	6621 Fannin Street	Houston	TX
Covenant Children's Hospital	3610 21st Street	Lubbock	TX
CHRISTUS Santa Rosa Child Hosp	333 North Santa Rosa Street	San Antonio	TX
Southwest Mental Health Center	8535 Tom Slick	San Antonio	TX
Primary Children's Med Center	100 North Medical Drive	Salt Lake City	UT
Shriners Hosps for Children	Fairfax Road & Virginia Street	Salt Lake City	UT
Copper Hills Youth Center	5899 West Rivendell Drive	West Jordan	UT
Graydon Manor	801 Children's Center Road SW	Leesburg	VA
Cumberland Hosp for Children	9407 Cumberland Road	New Kent	VA
Children's Hospital	601 Children's Lane	Norfolk	VA
Children's Hospital	2924 Brook Road	Richmond	VA
Commonwealth Ctr for Children	1355 Richmond Road	Staunton	VA
Children's Hosp & Medical Ctr	4800 Sand Point Way NE	Seattle	WA
Shriners Hosps for Children	911 West Fifth Avenue	Spokane	WA
Children's Hosp of Wisconsin	9000 West Wisconsin Avenue	Milwaukee	WI

Note. Source: Health Forum, 2005 American Hospital Association Annual Survey of Hospitals.

The above database was merged with the National Association of Children's Hospitals and Related Institutions (NACHRI) database of over 160 hospitals, accessed June 2006. See http://www.childrenshospitals.net/AM/Template.cfm?Section=Member_Hospital_Directory1&Template=/CustomSource/HospitalProfiles/HospitalProfileSearch.cfm.

Appendix G. Definitions of Pediatric Health Care Delivery Systems

There are several definitions for pediatric health care delivery systems at present. The American Hospital Association (AHA) (2005) has a listing of 121 facilities that are declared "children's hospitals." The National Association of Children's Hospitals and Related Institutions (NACHRI) has in its membership approximately 120 children's hospitals, a very different listing from that of the AHA. NACHRI has documented 33 members as having "free-standing" children's hospitals with emergency departments, 98 being within a larger health care system and seeing pediatrics in the emergency departments (unknown as to whether the pediatric emergency care is in a separately designated ED). On both of these lists, there are many specialized care facilities such as Shriner's children's hospitals and various mental health and rehabilitative care facilities listed as AHA or NACHRI members that would have highly variable abilities to care for pediatric medical and surgical emergencies. In response to these conflicting and difficult data sets, a listing of the "pediatric teaching hospitals" as defined by the Accreditation Council for Graduate Medical Education (2007) was created and cross-referenced to be able to assess the interplay with the designation of a pediatric teaching facility and the overall pediatric equipment availability and preparedness. All hospitals that are included in the data set are designated pediatric teaching facilities; if facilities were only used for one month specialty rotations, they were not included.

Due to the difficulty in identifying hospitals that "specialize" in caring for children, the below data set describes hospitals that care for children. It is not unusual for

pediatric care to be centered in the "Children's Hospital," but that care is relegated to only 120 facilities nationwide, and they are only in approximately 10% of the nation's counties. There are 8 states that do not have a children's hospital. Pediatric teaching institutions most often provide similar services to children's hospitals in the manner of emergency, trauma, and critical care. There are times that these large academic centers provide a "front door" for a nearby children's hospital, treating children in the ED but then referring them to the children's hospital for admission.

Therefore, the designation of "pediatric hospitals" was in part a result of a pediatric residency program hospital sponsor or major participant and in part due to the patient population. Hospitals that participated in the education of pediatricians were included, but if the hospital provided only a one month per year rotation for a specialty service, such as a "Shriner's Hospital," it was not included. All children's hospitals that were exclusive to pediatric patients and provided general acute care services were included, regardless of their involvement with a pediatric residency program. Specialty children's hospitals such as rehabilitation centers or mental health facilities were not included.

Appendix H. Logistical Regression Model

```
                                S U D A A N
          Software for the Statistical Analysis of Correlated Data
         Copyright        Research Triangle Institute    February 2005
                                Release 9.0.1


Number of zero responses      :   661
Number of non-zero responses  :    61

Independence parameters have converged in 7 iterations

Number of observations read       :    722    Weighted count:     4762
Number of observations skipped    :    304
(WEIGHT variable nonpositive)
Observations in subpopulation     :    722    Weighted count:     4762
Observations used in the analysis :    722    Weighted count:     4762
Denominator degrees of freedom    :     51


Maximum number of estimable parameters for the model is 10

File NEW3 contains  172 Clusters
 172 clusters were used to fit the model
Maximum cluster size is  46 records
Minimum cluster size is   1 records


Sample and Population Counts for Response Variable SCHAGERESUS
  0:  Sample Count      661    Population Count      4402
  1:  Sample Count       61    Population Count       361

R Square for dependent variable SCHAGERESUS (Cox & Snell, 1989): 0.102703

-2 * Normalized Log-Likelihood with Intercepts Only :   387.23
-2 * Normalized Log-Likelihood Full Model           :   308.99
Approximate Chi-Square (-2 * Log-L Ratio)           :    78.24
Degrees of Freedom                                  :        9

Note: The approximate Chi-Square is not adjusted for clustering.
      Refer to hypothesis test table for adjusted test.
```

Variance Estimation Method: Taylor Series (WOR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable SCHAGERESUS: SCHAGERESUS
For Subpopulation: DISP901 = 1
Effect of hospital, geographic and economic structures on school age resuscitation equipment availability
by: Independent Variables and Effects.

Independent Variables and Effects	P-value T-Test B=0
Intercept	0.4750
VOLUME	
<2K	0.4097
2K-4K	0.7897
>4-8K	0.0450
>8K	.
PCI	
1	0.0488
2	0.0414
3	.
MSA	
1	.
2	0.1014
PTS	
1	.
2	0.0026
PEDHOSP	
pediatric hospital	.
general hospital	0.0741
PEMDOC	
1	.
2	0.0000

Variance Estimation Method: Taylor Series (WOR)
SE Method: Robust (Binder, 1983)
Working Correlations: Independent
Link Function: Logit
Response variable SCHAGERESUS: SCHAGERESUS
For Subpopulation: DISP901 = 1
Effect of hospital, geographic and economic structures on school age resuscitation equipment availability
by: Independent Variables and Effects.

Independent Variables and Effects	Odds Ratio	Lower 95% Limit OR	Upper 95% Limit OR
Intercept	1.24	0.68	2.25
VOLUME			
<2K	0.58	0.16	2.15
2K-4K	0.86	0.28	2.61
>4-8K	2.18	1.02	4.66
>8K	1.00	1.00	1.00
PCI			
1	0.41	0.17	0.99
2	0.56	0.32	0.98
3	1.00	1.00	1.00
MSA			
1	1.00	1.00	1.00
2	2.24	0.85	5.92
PTS			
1	1.00	1.00	1.00
2	0.25	0.10	0.60
PEDHOSP			
pediatric hospital	1.00	1.00	1.00
general hospital	0.54	0.27	1.06
PEMDOC			
1	1.00	1.00	1.00
2	0.21	0.10	0.43

REFERENCES

REFERENCES

Accreditation Council for Graduate Medical Education. (n.d.). *Home page*. Retrieved March 12, 2007, from http://www.acgme.org

Aday, L. A. (Ed.). (2005). *Reinventing public health policies and practices for a healthy nation*. San Francisco, CA: John Wiley and Sons, Inc.

Advocates for EMS. (n.d.). *EMS-C Program*. Retrieved August 2006 from http://www.advocatesforems.org/library/upload/EMSC_program_Fact_Sheet.pdf

Agarwal, S., Swanson, S., Murphy, A., Yaeger, K., Sharek, P., & Halamek, L. P. (2005). Comparing the utility of a standard pediatric resuscitation cart with a pediatric resuscitation cart based on the Broselow tape: A randomized, controlled, crossover trial involving simulated resuscitation scenarios. *Pediatrics, 116*(3), e326-333.

Agency for Healthcare Research and Quality (2002). *Bioterrorism preparedness and response use of information technologies and decision support systems*. Retrieved from http://purl.access.gpo.gov/GPO/LPS49388

Akinbami, L. (2006). *The state of childhood asthma, in the United States, 1980 - 2005*. Hyattsville, MD.

American Academy of Pediatrics. (2001). Care of children in the emergency department: guidelines for preparedness. *Pediatrics 107*, 777-781.

American Academy of Pediatrics, & Committee on Pediatric Emergency Medicine. (1995). Guidelines for pediatric emergency care facilities. *Pediatrics, 96*(3 Pt. 1), 526-537.

American College of Emergency Physicians. (2001). Policy statements: The role of emergency physicians in the care of children. *Annals of Emergency Medicine, 38*(5), 619.

American College of Emergency Physicians, & American Academy of Pediatrics. (2001). *Annals of Emergency Medicine, 37*, 423-428.

American Hospital Association. (2005). *Health Forum* Annual Survey of Hospitals.

American Hospital Association. (n.d.). *About the American Hospital Association*. Retrieved from http://www.aha.org/aha/about

Athey, J. L., Dean, J. M., Ball, J., & Wiebe, R. A. (2001). Ability of hospitals to care for pediatric emergency patients. *Pediatric Emergency Care, 17*(3), 170-174.

Beitel, A. J., Olson, K. L., Reis, B. Y., & Mandl, K. D. (2004). Use of emergency department chief complaint and diagnostic codes for identifying respiratory illness in a pediatric population. *Pediatric Emergency Care, 20*(6), 355-360.

Bekemeier, B., Riley, C. M., & Berkowitz, B. (2007). Leveraging finances for public health system improvement: Results from the turning point initiative. *Journal of Public Health Management and Practice: JPHMP, 13*(6), 642-648.

Bekemeier, B., Riley, C. M., Padgett, S. M., & Berkowitz, B. (2007). Making the case: leveraging resources toward public health system improvement in turning point states. *Journal of Public Health Management and Practice, 13*(6), 649-654.

Berry, J. G., Lieu, T. A., Forbes, P. W., & Goldmann, D. A. (2007). Hospital volumes for common pediatric specialty operations. *Archives of Pediatric and Adolescent Medicine, 161*(1), 138-43.

Bravata, D., McDonald, K., Owens, D., Wilhelm, E., Brandeau, M., Zaric, G., et al. (2004). *Regionalization of bioterorism preparedness and response* (Evidence Report/Technology Assessement No. 96). Rockville, MD: Agency for Healthcare Research and Quality.

Budrys, G. (2003). *Unequal Health*. Lanham, MD: Rowman & Littlefield Publishers, Inc.

Burkle, F. M., Jr. (2003). Measures of effectiveness in large-scale bioterrorism events. *Prehospital & Disaster Medicine, 18*(3), 258-262.

Burt, C. W., McCaig, L., & Valverde, R. (2006). *Analysis of ambulance transports and diversions among U.S. emergency departments*. Hyattsville, MD: Maryland National Center for Health Statistics.

Burt, C. W., & Middleton, K. R. (2007). Factors associated with ability to treat pediatric emergencies in US hospitals. *Pediatric Emergency Care, 23*(10), 681-689.

Butler, A. S., Panzer, A. M., & Goldfrank, L. R. (2003). Preparing for the psychological consequences of terrorism: Understanding the psychological consequences of traumatic events, disasters, and terrorism. In Institute of Medicine, *Preparing for*

the Psychological Consequences of terrorism. Washington, DC: The National Academis Press.

Cappiello, J. (2002). *Emergency Preparedness and Response: Building Responsive Communities*. Paper presented at the 15th Annual State Health Policy Conference. Joint Commission on Accreditation of Healthcare Organizations.

Chaloupka, F. J., & Johnston, L. D. (2007). Bridging the Gap: Research informing practice and policy for healthy youth behavior. *American Journal of Preventive Medicine, 33*(4 Suppl), S147-161.

Chien, L.-Y., Tai, C.-J., Chu, K.-H., Ko, Y.-L., & Chiu, Y.-C. (2007). The number of baby friendly hospital practices experienced by mothers is positively associated with breastfeeding: A questionnaire survey. *International Journal of Nursing Studies, 44*(7), 1138-1146.

Chung, S., & Shannon, M. (2007). Hospital planning for acts of terrorism and other public health emergencies involving children. *Archives of the Diseases of Childhood, 90*(3), 1300-1307.

Cieslak, T. J., & Henretig, F. M. (2003). Bioterrorism. *Pediatric Annals, 32*(3), 154-165.

Clancy, C. M. (2003). *Testimony on Technology, Innovation, and the Costs of Health Care*. Retrieved June 15, 2006 from http://www.ahrq.gov/news/sp040405.htm

Clements, B., & Evans, R. G. (2004). Bioterrorism preparedness coordination: An ataxic saga continues. *Public Health Reports, 119*(1), 16-18.

Coleman, J. S., Katz, E., & Menzel, H. (1959). Social processes in physicians' adoption of a new drug. *Journal of Chronic Diseases, 9*, 1-19.

Coleman, J. S., Katz, E., & Menzel, H. (1966). *Medical innovation: A diffusion study*. New York: Bobbs-Merrill.

Cone, D. C., Richardson, L. D., Todd, K. H., Betancourt, J. R., & Lowe, R. A. (2003). Health care disparities in emergency medicine. *Academic Emergency Medicine: Official Journal of the Society for Academic Emergency Medicine, 10*(11), 1176-1183.

Croen, L. A., Najjar, D. V., Ray, G. T., Lotspeich, L., & Bernal, P. (2006). A comparison of health care utilization and costs of children with and without autism spectrum disorders in a large group-model health plan. *Pediatrics, 118*(4), e1203-1211.

Dharshi, A. (2006). The future of emergency care in the United States health system: A report from the Institute of Medicine. *Journal of Pediatric Surgery, 41*(11), 1793-1798.

DiMaggio, C., Markenson, D., Henning, K., Redlener, I., & Zimmerman, R. (2006). Partnership for preparedness: A model of academic public health. *Journal of Public Health Management and Practice: JPHMP, 12*(1), 22-27.

Eisenburg, M., Horwood, B., Cummins, R., Reynolds-Haertle, R., & Hearne, T. (1990). Cardiac arrest and resuscitation: A tale of 29 cities. *Annals of Emergency Medicine, 19*(2), 179-186.

Emergency Pediatric Services and Equipment Supplement (EPSES). (2002/2003). Retrieved June 14, 2005, from http://www.cdc.gov/NHAMCS

Falk, A.-C., Klang, B., Paavonen, E. J., & von Wendt, L. (2007). Current incidence and management of children with traumatic head injuries: The Stockholm experience. *Developmental Neurorehabilitation, 10*(1), 49-55.

Feifer, C., Ornstein, S. M., Jenkins, R. G., Wessell, A., Corley, S. T., Nemeth, L. S., et al. (2006). The logic behind a multimethod intervention to improve adherence to clinical practice guidelines in a nationwide network of primary care practices. *Eval Health Prof, 29*(1), 65-88.

Ferguson, S. L. (2002). Preparing for disasters: Enhancing the role of pediatric nurses in wartime. *Journal of Pediatric Nursing, 17*(4), 307-308.

Fifield, G., Magnuson, c., Carr, W., & Deinard, A. (1984). Pediatric emergency care in a metropolitan area. *Journal of Emergency Medicine 1*(6), 495-507.

Fine, A. M., Goldmann, D. A., Forbes, P. W., Harris, S. K., & Mandl, K. D. (2006). Incorporating vaccine-preventable disease surveillance into the national health information network: Leveraging children's hospitals. *Pediatrics, 118*(4), 1431-1438.

Fleuren, M., Weifferink, K., & Paulussen, T. (2004). Determinants of innovation within health care organizations. *Journal for Quality in Health Care, 16*(2), 107-123.

Foltin, G., Markenson, D., Tunik, M., Wellborn, C., Treiber, M., & Cooper, A. (2002). Assessment of pediatric patients by emergency medical technicians-basic. *Pediatric Emergency Care, 18*(2), 81-85.

Frush, K., Hohenhaus, S., Luo, X., Gerardi, M., & Wiebe, R. A. (2006). Evaluation of a Web-based education program on reducing medication dosing error: A multicenter, randomized controlled trial. *Pediatric Emergency Care, 22*(1), 62-70.

Gausche-Hill, M. (2000). Pediatric continuing education for out-of-hospital providers: Is it time to mandate review of pediatric knowledge and skills? *Annals of Emergency Medicine, 36*(1), 72-74.

Gausche-Hill, M. (2003). Ensuring quality in prehospital airway management. *Current Opinion in Anaesthesiology, 16*(2), 173-181.

Gausche-Hill, M. (2006). Integrating children into our emergency care system: Achieving the vision. *Annals of Emergency Medicine, 48*(2), 131-134.

Gausche-Hill, M., & Johnson, R. W. (2003). The role of the emergency physician in emergency medical services for children. *Annals of Emergency Medicine, 42*(2), 206-215.

Gausche-Hill, M., Schmitz, C., & Lewis, R. J. (2007). Pediatric preparedness of U.S. emergency departments: A 2003 survey. *Pediatrics, 120*, 1229-1237.

Gausche-Hill, M., & Wiebe, R. A. (2001). Guidelines for preparedness of emergency departments that care for children: A call to action. *Annals of Emergency Medicine, 37*(4), 389-391.

Gebbie, K., Rosenstock, L., & Lyla M. Hernandez. (2003). Who will keep the public healthy?: The future of public health education. In Institute of Medicine, *Who will keep the public healthy?*. Washington, DC: The National Academy Press.

Goes, J., & Park, S. (1997). Interorganizational links and innovation: The case of hospital services. *Academy of Management Journal, 40*, 673-696.

Government Acountability Office. (2003). *Hospital emergency departments: Crowded conditions vary among hospitals and communities*. Washington, DC: Author.

Goyder, E. C., Goodacre, S. W., Botha, J.L., & Bodiwala, G. G. (1997). How do individuals with diabetes use the accident and emergency department? *Journal of Accident and Emergency Medicine, 14*(6), 371-374.

Gray, J. (2003). Public health: Bush's smallpox vaccination plan. *Journal of Law, Medicine & Ethics, 31*(2), 312-314.

Greer, A. (1995). The shape of resistance...the shapers of change. *Joint Community Journal of Quality Improvement, 21*, 328-332.

Haller, J. A., Jr. (2002). The evolution and current status of emergency medical services for children. *The Surgical Clinics of North America, 82*(2), 263.

Handel, D. A., Sklar, D. P., Hollander, J. E., Asplin, B. R., & Hedges, J. R. (2007). Executive summary: The Institute of Medicine report and the future of academic emergency medicine. *Academic Emergency Medicine, 14*(3), 261-267.

Harbison, S., & Novak, J. C. (2002). Bioterrorism, children, and the United States' health and security. *Journal of Pediatric Health Care, 16*(5), 265-266.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing, 32*(4), 1008-1010.

Health departments remain ill-prepared to respond to public health emergencies [Editorial]. (2004). *Hospitals & Health Networks, 78*(2), 78-80.

Health Services and Resources Administration. (2003). User documentation for the Area Resource File (ARF) [February 2003 release]. Rockville, MD: Health Services and Resources Administration, Department of Health and Human Services.

Heinrich, J. (2003). *Infectious disease outbreaks: Bioterrorism preparedness efforts have improved public health response capacity, but gaps remain*. Retrieved from http://purl.access.gpo.gov/GPO/LPS43543

Henderson, D. P. (2002). Role of "nurse coordinator for pediatric emergency care": Important part of new consensus guidelines. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 28*(1), 73-77.

Henretig, F. M., Mechem, C., & Jew, R. (2002). Potential use of autoinjector-packaged antidotes for treatment of pediatric nerve agent toxicity. *Annals of Emergency Medicine, 40*(4), 405-408.

Hohenhaus, S. M. (2001). Is this a drill? Improving pediatric emergency preparedness in North Carolina's emergency departments. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 27*(6), 568-570.

Hohenhaus, S. M. (2002). Assessing competency: The Broselow-Luten resuscitation tape. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 28*(1), 70-72.

Hohenhaus, S. M. (2005a). Policy advocacy for children. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 31*(2), 209-210.

Hohenhaus, S. M. (2005b). Practical considerations for providing pediatric care in a mass casualty incident. *The Nursing Clinics of North America, 40*(3), 523.

Hohenhaus, S. M. (2006a). Giving liquid medications to pediatric patients. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 32*(1), 69-70.

Hohenhaus, S. M. (2006b). Triage acuity levels and color. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 32*(2), 170-171.

Hohenhaus, S. M., & Frush, K. S. (2004). Pediatric patient safety: Common problems in the use of resuscitative aids for simplifying pediatric emergency care. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 30*(1), 49-51.

Holahan, J., Dubay, L., & Kenney, G. M. (2003). Which children are still uninsured and why. *The Future of Children/Center for the Future of Children, The David and Lucile Packard Foundation, 13*(1), 55-79.

Holahan, J., Weil, A., & Wiener, J. M. (2003). Which way for federalism and health policy? What's right, and what's wrong, with the federal-state division of responsibility for health care. *Health Affairs, Supplement Web Exclusives*, W3, 317-333.

Huddleston, K. (2006). Pediatric health policy analysis. *Pediatric Nursing 32*(2), 167-172.

Hunt, E. A., Hohenhaus, S. M., Luo, X., & Frush, K. S. (2006). Simulation of pediatric trauma stabilization in 35 North Carolina emergency departments: Identification of targets for performance improvement. *Pediatrics, 117*(3), 641-648.

Illinois Department of Public Health. (n.d.). *EMS for children*. Retrieved from http://www.idph.state.il.us/about/hospital/emschome.htm

Isaacman, D. J. (1990). Pediatric emergency medicine—current standards of care: Results of a national survey. *Annals of Emergency Medicine, 19*(5), 527-531.

Institute of Medicine. (1993). *Emergency medical services for children*. Washington, DC: National Academies Press.

Institute of Medicine. (2003). *The future of the public's health*. Washington, DC: The National Academies Press.

Institute of Medicine. (2004) Children's health: The nation's wealth. National Research Council,Washington, DC: The National Academies Press.

Institute of Medicine. (2006). *The future of emergency care in the U.S. health system: Parts 1 - 3: Emergency medical services at the crossroads*; *Hospital-Based emergency care: At the breaking point*; *Pediatric emergency care: Growing pains*. Washington, DC: The National Academies Press.

Isaacman, D. J. (1990). Pediatric emergency medicine—current standards of care: Results of a national survey. *Annals of Emergency Medicine, 19*(5), 527-531.

James, C. A., Bourgeois, F. T., & Shannon, M. W. (2005). Association of race/ethnicity with emergency department wait times. *Pediatrics, 115*(3), e310-315.

Jamieson, K. H., Lammie, K., Wardle, C., & Krutt, S. (2003). Questions about hypotheticals and details in reporting on anthrax. *Journal of Health Communication, 8*(Suppl. 1), 121-123.

Joellenbeck, L. M., Zwanziger, L. L., Durch, J. S., & Strom, B. L. (2002). The anthrax vaccine: Is it safe? Does it work? [Executive summary]. In Institute of Medicine, *The anthrax vaccine: Is it safe? Does it work?* Washington, DC: The National Academies Press.

Kaji, A. H., Gausche-Hill, M., Conrad, H., Young, K. D., Koenig, W. J., Dorsey, E., et al. (2006). Emergency medical services system changes reduce pediatric epinephrine dosing errors in the prehospital setting. *Pediatrics, 118*(4), 1493-1500.

Kellerman, A. L. (2007). Crisis in the emergency department. *New England Journal of Medicine, 355*(13), 1300-1303.

Khan, A. M., Larson, C. P., Faruque, A. S. G., Saha, U. R., Hoque, A. B. M. M., Alam, N. U., et al. (2007). Introduction of routine zinc therapy for children with diarrhea: Evaluation of safety. *Journal of Health, Population, and Nutrition, 25*(2), 127-133.

Kissoon, N. (2006). Pediatric emergency care: Are family characteristics important? *Canadian Journal of Emergency Medicine, 8*(4), 275-276.

Kotagal, U. R., Schoettker, P. J., Atherton, H. D., Hornung, R. W., Bush, D., Pomerantz, W. J., et al. (2002). Relationship between early primary care and emergency

department use in early infancy by the Medicaid population. *Archives of Pediatrics and Adolescent Medicine, 156*(7), 710-716.

Krug, S. E., & Gausche-Hill, M. (2007). When there is "no room at the inn": Potential solution for overcrowding in a tertiary pediatric center. *Archives of Pediatrics and Adolescent Medicine, 161*(9), 911-913.

Krug, S., & Kuppermann, N. (2005). Twenty years of emergency medical services for children: A cause for celebration and a call for action. *Academic Emergency Medicine, 12*(4), 345-347.

Lancaster, L. (2005). Mission impossible: Minimising the terror of pediatric resuscitation for staff in the ED. *Accident and Emergency Nursing, 13*(1), 24-28.

Lansisalmi, H., Kivimaki, M., Aalto, P., & Ruoranen, R. (2006). Innovation in healthcare: A systematic review of recent research. *Nursing Science Quarterly, 19*(1), 66-72.

Leape, L., Brennan, T., Laird, N., Lawthers, A., Localio, A., Barnes, B., et al. (1991). The nature of adverse effects in hopsitalized patients. Results of the Harvard Medical Practice Study II. *New England Journal of Medicine, 324*(6), 377-384.

Lipsky, A. M., Gausche-Hill, M., Henneman, P. L., Loffredo, A. J., Eckhardt, P. B., Cryer, H. G., et al. (2006). Prehospital hypotension is a predictor of the need for an emergent, therapeutic operation in trauma patients with normal systolic blood pressure in the emergency department. *The Journal of Trauma, 61*(5), 1228-1233.

Lubitz, D. S., Seidel, J. S., Chameides, L., Luten, R. C., Zaritsky, A. L., & Campbell, F. W. (1988). A rapid method for estimating weight and resuscitation drug dosages from length in the pediatric age group. *Annals of Emergency Medicine, 17*(6), 576-581.

Luten, R., & Broselow, J. (1999). Rainbow care: The Broselow-Luten system: Implications for pediatric patient safety. *Ambulatory Outreach*, 14-16.

Luten, R. C., Wears, R. L., Broselow, J., Zaritsky, A., Barnett, T. M., Lee, T., et al. (1992). Length-based endotracheal tube and emergency equipment in pediatrics. *Annals of Emergency Medicine, 21*(8), 900-904.

Luten, R. C., Zaritsky, A., Wears, R., & Broselow, J. (2007). The use of the Broselow tape in pediatric resuscitation. *Academic Emergency Medicine, 14*(5), 500.

Mace, S. E., & Bern, A. I. (2007). Needs assessment: Are Disaster Medical Assistance Teams up for the challenge of a pediatric disaster? *The American Journal of Emergency Medicine, 25*(7), 762-769.

MacLean, S., Dacsy, P., Juarez, A., Perhats, C., & Gacki-Smith, J. (2006). Research education needs of pediatric emergency nurses. *Journal of Emergency Nursing, 32*(1), 17-22.

Mantel, N. (1963). Chi-Square tests with one degree of freedom: Extensions of the Mantel-Haenszel Procedure. *Journal of the American Statistical Association, 58*(303), 690-700.

Markenson, D., & Redlener, I. (2003). *Pediatric preparedness for disasters and terrorism: A national concensus conference* [Executive summary]. Columbia University Mailman School of Public Health, National Center for Disaster Preparedness.

Markenson, D., Redlener, I. (2003). *Pediatric preparedness for disasters and terrorism: A national consensus conference.* Paper presented at the Pediatric preparedness for disasters and terrorism, Columbia University Mailman School of Public Health.

Markenson, D., & Redlener, I. (2004). Pediatric terrorism preparedness national guidelines and recommendations: Findings of an evidenced-based consensus process. *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science, 2*(4), 301-319.

Markenson, D., & Redlener, I. (2005). *Pediatric and vulnerable populations preparedness for disasters and terrorism: A national consensus conference.* Paper presented at the Vulnerable Populations Preparedness For Disasters And Terrorism conference, Washington DC.

Markenson, D., DiMaggio, C., & Redlener, I. (2005). Preparing health professions students for terrorism, disaster, and public health emergencies: Core competencies. *Academic Medicine: Journal of The Association of American Medical Colleges, 80*(6), 517-526.

Markenson, D., & Reynolds, S. (2006). The pediatrician and disaster preparedness. *Pediatrics, 117*(2), e340-362.

Martin, M. E., & Didion, J. (2003). The smallpox threat: The school nurse's role. *Journal of School Nursing, 19*(5), 260-265.

McCaig, L. F., & Burt, C. W. (2003). *National Hospital Ambulatory Medical Care Survey: 2001 Emergency Department Summary* (Advanced Data No. 335). Hyattsville, MD: National Center for Health Care Statistics.

McCaig, L. F., & Burt, C. W. (2004). *National Hospital Ambulatory Medical Care Survey: 2002 Emergency Departmen* (Advanced Data No. 340). Hyattsville, MD: National Center for Health Care Statistics.

McCaig, L.F., & Burt, C. W. (2005). *National Hospital Ambulatory Medical Care Survey: 2003 Emergency Department Summary* (Advanced Data No. 358). Hyattsville, MD: National Center for Health Care Statistics.

McCaig, L. F., & Ly, N (2002). *National Hospital Ambulatory Medical Care Survey: 2000 Emergency Department* (Advanced Data Number 326). Hyattsville, MD: National Center for Health Care Statistics.

McGillivray, D., Nijssen-Jordan, C., Kramer, M. S., Yang, H., & Platt, R. (2001). Critical pediatric equipment availability in Canadian hospital emergency departments. *Annals of Emergency Medicine, 37*(4), 371-376.

McManus, M. L., Long, M. C., Cooper,A., & Litvak, E. (2004) Queuing theory accurately models the need for critical care resources. *Anesthesiology, 100*(5), 1271-6.

Meakins, J. L. (2006). Evidence-based surgery. *Surgical Clinics of North America, 86*(1), 1-16, vii.

Middleton, K. R. (2005). *National Center for Health Statistics Survey, Emergency Pediatric Services and Equipment Supplement.* Paper presented at the 2005 EMSC Annual Grantee Meeting, Washington, DC., Retrieved November 10, 2005, from http://www.cademedia.com/archives/mchb/emsc2005/tue.

Middleton, K. R., & Burt, C. W. (2006a). *Availability of pediatric services and equipment in emergency departments: United States, 2002-03*. Hyattsville, MD: National Center for Health Statistics.

Middleton, K. R., & Burt, C. W. (2006b). *Emergency pediatric preparedness in U.S. hospitals* (Advanced Data No. 360). Hyattsville, MD: National Center for Health Statistics.

Moody-Williams, J. D., Krug, S., O'Connor, R., Shook, J. E., Athey, J. L., & Holleran, R. S. (2002). Practice guidelines and performance measures in emergency medical services for children. *Annals of Emergency Medicine, 39*(4), 404-412.

Mytinger, R. (1968). *Innovation in local health services: A study of the adoption of new programs by local health departments*. Washington, DC: Public Health Service, U.S. Department of Health, Education, and Welfare.

National Academy of Sciences. (2002). *Making the nation safer: Complex and interdependent systems*. Washington, D.C.: IOM.

National Association of Children's Hospitals and Related Institutions. (n.d.). *Member hospital directory*. Retrieved November 19, 2006, from http://www.childrenshospitals.net

National Association of Children's Hospitals and Related Institutions. (n.d.) *Database*. Retrieved June, 2006 from http://www.childrenshospitals.net/AM/Template.cfm?Section=Member_Hospital_Directory1&Template=/CustomSource/HospitalProfiles/HospitalProfileSearch.cfm

National Center for Health Statistics. (n.d.). *Ambulatory health care data*. Retrieved from http://www.cdc.gov/nchs/about/major/ahcd/nhamcsds.htm

National Center for Health Statistics. (n.d.). Research Data Center home. Retrieved from http://www.cdc.gov/nchs/r&d/rdc.htm

National Hospital Ambulatory Medical Care Survey. (2003). *NCHS – NAMCS/NHAMCS – NHAMCS Description*. Retrieved from http://www.cdc.gov/nchs/about/major/ahcd/nhamcsds.htm

Odetola, F. O., Miller, W. C., & Davis, M. (2005). The relationship between the location of pediatric intensive care unit facilities and child mortality from trauma: A county-level ecological study. *Journal of Pediatrics, 147*(1), 74-77.

Osuntokun, B. (2006). Clinical trials in pediatrics: The drug delivery dimension. *Advanced Drug Delivery Reviews, 58*(1), 90-105.

Pedhuzer, E. J., & Schmelkin, L. P. (1991). *Measurement, design, and analysis*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Phillips, S. (2003). Setting research priorities for disaster preparedness: The role of AHRQ. *Managed Care, 12*(11 Suppl), 16-18.

Pitetti, R., Glustein, J. Z., & Bhende, M. S. (2002). Prehospital care and outcome of pediatric out-of-hospital cardiac arrest. *Prehospital Emergency Care, 6*(3), 283-290.

Ramenofsky, M., Luterman, A., Quindlen, E., Riddick, l., & Curreri, P. (1984). Maximum survival in pediatric trauma: The ideal system. *The Journal of Trauma 24*(9), 818-823.

Randolph, A. G., Gonzales, C. A., Cortellini, Y., & Yeh, T. S. (2004). Growth of pediatric intensive care units in the United States from 1995 to 2001. *Journal of Pediatrics, 144*, 792-798.

Redlener, I., & Markenson, D. (2003). Disaster and terrorism preparedness: What pediatricians need to know. *Advances in Pediatrics, 50*, 1-37.

Richardson, L. D., Babcock Irvin, C., & Tamayo-Sarver, J. H. (2003). Racial and ethnic disparities in the clinical practice of emergency medicine. *Academic Emergency Medicine: Official Journal of The Society for Academic Emergency Medicine, 10*(11), 1184-1188.

Rogers, E. M. (1995). *Diffusion of Innovation* (4th ed.). New York: The Free Press.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). New York: The Free Press. (Original work published 1963).

Rosenfield, R. L., & Bernardo, L. M. (2001). Pediatric implications in bioterrorism part II: postexposure diagnosis and treatment. [Review] [12 refs]. *International Journal of Trauma Nursing, 7*(4), 133-136.

Rubinson, L., & O'Toole, T. (2005). Critical care during epidemics. *The Critical Care Forum, 9*(4), 311-313.

Ryan, B., & Gross, N. C. (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology, 8*, 15-24.

Sacchetti, A., Brennan, J., Kelly-Goodstein, N., & Graff, D. (2000). Should pediatric emergency care be decentralized?: An out-of-hospital destination model for critically ill children. *Academic Emergency Medicine: Official Journal of The Society for Academic Emergency Medicine, 7*(7), 787-791.

Seidel, J. (1986). Emergency care services and the pediatric patient: Are the needs being met? Training and equipping emergency medical services providers for pediatric emergencies. *Pediatrics, 78*(5), 808.

Seidel, J. S., & Gausche-Hill, M. (2001). Pediatric equipment availability and emergency preparedness. *Annals of Emergency Medicine, 37*(4), 388-389.

Seidel, J. S., Henderson, D., Tittle, S., Jaffe, D., Spaite, D., Dean, J. M., et al. (1999). Priorities for research in Emergency Medical Services for Children: Results of a

consensus conference. EMSC Research Agenda Consensus Committee, National EMSC Resource Alliance. *Journal of Emergency Nursing: JEN: Official Publication of The Emergency Department Nurses Association, 25*(1), 12-16.

Seidel, J. S., Henderson, D., Ward, P., Wayland, B., & Ness, B. (1991). Pediatric prehospital care in urban and rural areas. *Pediatrics, 88*(4), 681.

Seidel, J. S., Hornbien, M., Yoshiyama, K., Kuznets, D., Finklestein, J., & St. Geme, K. J. (1984). Emergency medical services and the pediatric patient: Are the needs being met? *Pediatrics 73*(6), 769-772.

Shaw, J. A. (2003). Children exposed to war/terrorism. *Clinical Child and Family Psychology Review, 6*(4), 237-246.

Sorrentino, A., Monroe, K., & King, W. (2003). Barriers to pediatric advanced life support training in the state of Alabama. *Pediatric Emergency Care, 19*(6), 408-411.

State of California. (n.d.). *Emergency Medical Services Authority: Local EMS Agency Ambulance Diversion Policies – Los Angeles*. Retrieved from http://www.emsa.ca.gov/Ems_lems/ambdla1.asp

Surpure, J. S., & Walker, J. S. (1992). Pediatric emergency care: An annotated bibliography of the recent literature. *The American Journal of Emergency Medicine, 10*(4), 379-389.

Szilagyi, P. G., Schaffer, S., Shone, L., Barth, R., Humiston, S. G., Sandler, M., et al. (2002). Reducing geographic, racial, and ethnic disparities in childhood immunization rates by using reminder/recall interventions in urban primary care practices. *Pediatrics, 110*(5), 8p.

Taylor, B. W. (2006). Demography of pediatric emergency care in Halifax, Canada. *CJEM: Canadian Journal of Emergency Medical Care (JCMU: Journal Canadien De Soins MÃ©dicaux D'urgence), 8*(4), 269-274.

Thorne, C. D., Hirshon, J. M., Himes, C. D., & McDiarmid, M. A. (2003). Emergency medicine tools to manage smallpox vaccination complications: Clinical practice guideline and policies and procedures. *Annals of Emergency Medicine, 42*(5), 665-680.

U.S. Census Data 2000, Retrieved from http://www.census.gov/main/www/cen2000.html

van Amerongen, R. H., Fine, J. S., Tunik, M. G., Young, G. M., & Foltin, G. L. (1993). The Avianca plane crash: An emergency medical system's response to pediatric survivors of the disaster. *Pediatrics, 92*(1), 105-110.

Veenema, T. G. (2003a). *Disaster nursing and emergency preparedness for chemical, biological, and radiological terrorism and other hazards*. New York: Springer Pub. Co.

Veenema, T. G. (2003b). Safeguarding our nation's children: The diagnosis, management, and containment of smallpox in infants and children. *Biological Research for Nursing, 4*(4), 295-304.

Vilke, G. M., Marino, A., Fisher, R., & Chan, T. C. (2001). Estimation of pediatric patient weight by EMT-PS. *The Journal of Emergency Medicine, 21*(2), 125-128.

Walker, J. L. (1966). The diffusion of innovations among the American states. *American Political Science Review, 63*, 880-899.

Walpole, R. E., Myers, R. H., Myers, S. L., & Keying, Y. (2002). *Probability and Statistics for Engineers and Scientists* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Wetterhall, S. F. (2003). Responding to bioterrorism. *Ethnicity and Disease, 13*(3 Suppl 3), S3-58-62.

White, S. R., Henretig, F. M., & Dukes, R. G. (2002a). Medical management of vulnerable populations and co-morbid conditions of victims of bioterrorism. *Emergency Medicine Clinics of North America, 20*(2), 365-392

Young, K. D., Gausche-Hill, M., McClung, C. D., & Lewis, R. J. (2004). A prospective, population-based study of the epidemiology and outcome of out-of-hospital pediatric cardiopulmonary arrest. *Pediatrics, 114*(1), 157-164.

Zaritsky, A. L., French, J. P., Schafermeyer, R., & Morton, D. (1994). A statewide evaluation of pediatric prehospital and hospital emergency services. *Archives of Pediatrics and Adolescent Medicine, 148*(1), 76-81.

CURRICULUM VITAE

Kathi C. Huddleston has been a pediatric nurse since 1979. She has worked in a variety of settings to include critical care, trauma and outpatient practice. Kathi has participated in third world medical missions. Her areas of interest are pediatric critical care and emergency response. She is currently the Secretary of the Epsilon Zeta Chapter of the Sigma Theta Tau International Nursing Honor Society. She is a member of American Critical Care Nurses Association and the Emergency Nurses Association, as well as the American Nurses Association. She is also active as a nurse review editor for two professional nursing journals. She is currently employed by at Inova Fairfax Children's Hospital where she enjoys the challenge of staying current as a critical care researcher, nurse educator, and pediatric critical care nurse.