NURSES' PRACTICES WITH BLOOD TRANSFUSIONS IN MEDICAL-SURGICAL PATIENT CARE UNITS OF ACUTE CARE U.S. HOSPITALS

THE STATE OF THE SCIENCE

A DISSERTATION

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ABSTRACT

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Blood transfusions occur in all areas of a hospital with nurses at the point-of-care responsible for specimen collection, blood administration, patient surveillance, and adverse event reporting. Unfortunately there is a paucity of nursing research on blood transfusions. The purpose of this study was to describe the state of the science of medical-surgical acute care nurses' practices with blood transfusion therapy. Seven research questions addressed the comprehensive scope of nurses' involvement with blood transfusions. Data was collected via a valid and reliable web-based survey, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care.* A random selection of U.S. hospitals with a nurse executive who was a member of the American Organization of Nurse Executives was recruited via postal letter. One survey was completed per hospital with 148 hospitals responding (18.3% response rate).

Nurses' practices in transfusion processes are similar across the country. The hospital's transfusion policy was the most influential source of information for nurses because it specified nurses' transfusion practices. Limitations in surveillance of the medical-surgical patient with a blood transfusion were due to the lack of current

information on transfusion reaction symptoms included in the education programs, delegation of transfusion vital signs to non-licensed staff that were not educated on symptoms of a transfusion reaction, and transportation of patients with blood infusing to tests and procedures. Hospitals were in the process of adopting electronic technologies to reduce or eliminate wrong-blood-in-tube errors or wrong blood administered mistransfusion errors. Nurses need to collaborate with the transfusion service to update the transfusion policy and the blood transfusion education programs; include non-licensed staff in compulsory blood transfusion education; and closely evaluate the capabilities of an electronic documentation system to truly match the patient to the blood product. This descriptive study is a foundation for future research of nurses with blood transfusions.

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CHAPTER I

INTRODUCTION

Blood transfusions can be lifesaving for bleeding patients following trauma or during cardiopulmonary bypass (Despotis, Eby, & Lubin, 2008), for patients with leukemia, other cancers, sickle cell disease, thalassemia, and for patients who are critically ill. Blood transfusion is the most frequent inpatient hospital procedure in the United States (U.S.) and occurred in over 10% of hospitalizations that included at least one procedure in 2009 (Wier et al., 2011). This translates to approximately 24 million blood product units transfused each year in the U.S. (U.S. Department of Health & Human Services, 2011). The vast number of transfused units does not negate the verity that transfusion of allogeneic blood, donated from someone other than the recipient, is a liquid organ [living tissue] transplant with many clinical risks (Spiess, 2007).

The drive to improve the safety of blood transfusions in the U.S. has galvanized organizations and the U.S. government to bolster their transfusion safety initiatives. On April 25, 2011, the U.S. Department of Health and Human Services' posted a notice in the *Federal Register* affirming the growing importance of biovigilance and requesting information on "identifying research needs; proposing and conducting short and long-term research studies; identifying knowledge gaps that prevent effective surveillance or reporting; [and] proposing strategies for closing these gaps" (p. 22901). Although the decision to transfuse rests with the physician, the actual transfusion outside of the

operating suites is conducted entirely by the nurse who is at the point-of-care and therefore has an essential role in patient safety during a blood transfusion. Nurses have an opportunity to provide essential contributions to the national transfusion safety initiatives and to nursing science by conducting research that is focused on the gaps in transfusion knowledge, surveillance, and reporting transfusion adverse events.

Problem of Study

Despite decades of nurses' involvement with blood transfusions, there is scant research to describe the practice of nurses as it relates to blood transfusions (Fitzgerald, Hodgkinson, & Thorp, 1999; Row & Doughty, 2000). The overwhelming majority of articles in the nursing literature that focus on blood transfusion described case studies and provided education on recognizing transfusion reactions, but are not reports of research involving nurses and blood transfusions. Within the last sixteen years, only 14 research articles were identified that describe the blood transfusion knowledge and practice of nurses, and 12 were conducted in countries other than the U.S. This gap in the research literature is most noticeable for U.S. nurses' transfusion practices. Key zones of transfusion safety are directly related to the nurse's interactions with the patient at the point-of-care (W. H. Dzik, 2007), yet the scope of the nurses' role has not been described. Once a comprehensive description of the nurses' role with blood transfusions is known, subsequent studies can be designed to appropriately address key aspects of transfusion safety including adverse reaction recognition by nurses and effective education of nurses on transfusion therapy.

Rationale for the Study

The justification for this study is the paucity of nursing research in the U.S. on blood transfusion practices, the national focus on transfusion safety including adverse event reporting, and the emerging innovations in technology that have the potential to enhance transfusion safety. Although many advances in donor-screening and blood testing have made the U.S. blood supply very safe, recommendations for further improvements in transfusion safety consistently point to a safety-gap in the administration process, a process that is primarily within the domain of nursing.

Nurses Transfusion Practices

The importance of patient assessments during a blood transfusion is universally acknowledged but practices differ based on level of care. A majority of transfusions occur in high acuity areas such as intensive care units and operating suites where a nurse or physician is present for constant observation. Conversely, in the medical-surgical acute care units the nurse-to-patient ratio is higher and patients in private and semiprivate rooms are not directly visible to the nurse for the duration of the transfusion. Additionally, the use of non-licensed nursing assistants to obtain vital signs is a common practice in many institutions (Baffa, 2011). Limitations in surveillance in non-acute settings and the use of non-licensed nursing assistants to obtain transfusion vital signs support a study of nurses' transfusion practices in medical-surgical acute care areas.

Within the last sixteen years, only 14 reports of research and ten quality audits or quality improvement projects were identified that describe the blood transfusion knowledge and practice of nurses. The nursing research was primarily conducted in countries other

than the U.S. that included studies from Australia, Canada, France, Jordan, Iran, Scotland, Turkey, Uganda, the United Arab Emirates, and the United Kingdom. The distribution of articles from many areas in the world affirms that administering blood transfusions is a widespread nursing practice. Only six articles and abstracts were identified that evaluated the knowledge and practice of U.S. nurses with blood transfusions, and a mere two were published in nursing journals. Houck and Whiteford (2007) conducted a quality improvement evaluation of the use of infusion pumps for blood transfusions through peripherally inserted central catheters (PICC) and concluded that the bedside technology was safe, saved time, and cost-effective. Their findings were published in the *Journal of Infusion Nursing*. Adams and Tolich (2011) interviewed twenty-one patients regarding their transfusion experiences and concluded that patient's lacked information, that brochures were insufficient, and that interaction with nurses was most helpful in reassuring and educating patients. Their qualitative research findings were published in the *American Journal of Nursing*.

U.S. nurses' practices with blood transfusion are not described by means of nursing research but by quality audits and research sponsored by medical transfusion societies and then published in the medical literature, out of the sphere of information accessible to nurses. The qualitative research of Heddle et al. (2012) was designed to understand the pretransfusion checking process from the perspective of the nurses from five countries that included the U.S. The findings of this research are rich in providing an appreciation for what nurses' perceive about their important role of administering blood transfusions.

Three quality improvement projects evaluated U.S. nurses' transfusion practices and were reported in *Transfusion*. Saxena, Ramer, and Shulman (2004) directly observed 982 blood transfusions administered by nurses in a California hospital. Over a period of 51 months improvements were observed in compliance with pretransfusion identification processes and patient observations including vital signs during the transfusion. The underreporting of transfusion reactions was the focus of two quality reports. Transfusion reactions were underreported by 50% in a single hospital evaluation of 58 transfusions (Narvios, Lichtiger, & Newman, 2004), and by 47% in a multicenter audit of 3024 transfusions (Thomas & Hannon, 2010). Narvios et al. (2004) credited the experience and training of the nurses in recognizing and responding to the signs and symptoms of transfusion reactions even though the physician chose to not report the occurrence to the transfusion service. Conversely, from the retrospective review of 3024 transfusions episodes Thomas and Hannon (2010) concluded that the clinical staff [nurses] were the source of the safety concerns for not recognizing the clinical signs of a transfusion adverse event.

No studies of U.S. nurses' transfusion knowledge or hospital-based education on transfusions were identified. Nurses as the bedside transfusionists have a critical role in transfusion safety yet their blood transfusion knowledge and practice is inadequately studied in the U.S.

National Focus on Transfusion Safety

Multiple national groups address the safety of blood transfusions in the U.S. The Center for Biologics Evaluation and Research (CBER) of the Federal Drug

Administration (FDA) oversees the safety of the blood supply in the U.S with multiple initiatives including strict donor screening, blood testing, and the requirement for machine readable barcode labels on each unit of blood that identifies the donation facility, the donor, the product, and the donor ABO and Rh (U.S. Department of Health and Human Services, Food and Drug Administration, Center for Biologics Evaluation and Research (2010). As a result of these initiatives, the U.S. blood supply is one of the safest in the world. The AABB authors the *Circular of Information for the Use of Human Blood and Blood Components* and establishes the standards of practice for donor and patient safety (AABB, 2009). The Joint Commission's National Patient Safety Goal 1 was strengthened in 2009 to state, "eliminate transfusion errors related to patient misidentification" (The Joint Commission, 2011). Additionally there are national affiliation groups such as The University Healthcare Consortium (UHC) that have listserv groups focused specifically on transfusions safety, performance improvement, and education.

The establishment of the U.S. Biovigilance Network by the AABB and the Centers for Disease Control and Prevention (CDC) was an important leap in advancing the national focus on transfusion safety. The mission of the U.S. Biovigilance Network is to identify risks and develop strategies to enhance transfusion safety, strategies that include educational activities to promote safer transfusions (AABB, 2011). A key part of this network is the Hemovigilance Module of the National Healthcare Safety Network (NHSN) which was launched in 2010 to provide a national database for transfusion adverse event reporting. The underreporting of adverse transfusion events first to the

hospital transfusion services and second to a national database is widely accepted (U.S. Department of Health and Human Services, April 25, 2011; Vamvakas & Blajchman, 2009). The rate of reported adverse transfusion reactions in the U.S. in 2009 was only 0.25% (2.5 per 1,000 units transfused), considerably lower than the rates reported from other countries (U.S. Department of Health & Human Services, 2011). The report *Biovigilance: Efforts to Bridge a Critical Gap in Patient Safety and Donor Health*, drew attention to this critical gap of underreporting of adverse transfusion events, a gap that hinges on the nurse's clinical recognition of a potential transfusion reaction (Public Health Service (PHS) Biovigilance Working Group (BWG), (2009). Despite a strong national focus on transfusion safety that has made the U.S. blood supply the safest in history as a result of donor screening, blood testing, and process improvements in the transfusion services, a safety gap remains at the point-of-care where the nurse is directly involved in the transfusion process.

Innovations in Blood Transfusion Administration

Innovations in transfusion medicine and in nursing have the potential to improve patient safety. Technological advances in matching the correct blood product to the correct patient with barcode scanning, radio-frequency (RFID) tags, or BloodLoc caps that require a patient identification code to unlock, and the use of smart infusion pumps are recognized as improving transfusion safety at the bedside (Dzik, 2003). The use of pneumatic transport systems decreases the blood unit conveyance time to the clinical area (Massachusetts General Hospital, 2005). Knowledge related to blood transfusions and hemovigilance has increased, and as a result, the adverse symptoms and types of

transfusion reactions have expanded (U.S. Centers for Disease Control and Prevention, 2011). Online learning is available for ongoing [continuing] education of nurses. Despite advancements in safety technology, scientific knowledge, and education platforms, the diffusion and adoption of innovations in health care occurs at a slow pace (Balas & Boren, 2000; Berwick, 2003). Identifying the proportion of transfusion innovations adopted into nursing practice is important in describing the state of the science of U.S. nurses' blood transfusion practices.

Rationale Summary

Thomas and Hannon (2010) linked the national focus to improve transfusion safety in the U.S. with the need to address the knowledge and performance gaps of the bedside transfusionists, the nurses, yet a description of U.S. nurses' preparation and practices with blood transfusions is lacking. Research is needed to address the gap in the literature related to the important role of nurses with blood transfusions in the U.S. and to validate or refute the findings of quality reports on nurses' transfusion practices. A comprehensive description of nurses' practices with blood transfusions will identify the state of the science of U.S. nurses with blood transfusions, inform nurses of opportunities to improve care of the patients receiving a blood transfusions, establish a foundation for focused observational and interventional studies related to nurses and blood transfusions, and contribute to the worldwide perspective of the important role of nurses with patient safety related to blood transfusions.

Theoretical Framework

The theoretical framework for this research is Everett Rogers' diffusion of innovations theory which explains the spread of new ideas, technology, and practices within a group. An innovation starts as an invention of thought, technology, or practice that is progressively shared through various communication networks among members of a group. Over time the innovation is tried and the consequences, both favorable and unfavorable, are evaluated until a decision is made to adopt or reject the innovation. The adoption of an innovation does not occur within the whole group at one time, but slowly gains acceptance with innovators and early adopters incorporating the innovation at the beginning, followed by the early majority, then the late majority, and finally the laggards who persisted in resisting the change (Rogers, 2003; Robinson, 2009; University of Twente, 2010). The progressive adoption of an innovation is analogous to a progressive change in a nursing or healthcare standard of practice.

Adoption is the decision to implement an innovation because it is the best course of action and assessed to be a good fit for the individual, group, or organization. The assessment is based on subjective perceptions that may have a stronger influence than the weight of scientific merit on the decision to adopt or drop the innovation (Estabrooks et al., 2006). Rogers (2003) identified five perceived attributes of an innovation that account for 49-87% of the variance in the rate of adoption of an innovation and are considered the generalizations of the diffusion of innovations theory. These influential attributes are *relative advantage* or better than current practice; *compatibility* with the current system including structure, values and practices; *complexity* or difficulty to understand and to use

which is alternately described as *simplicity* to understand and to use (Frazer, n.d.; Robinson, 2009); *testability* or the ability try it in stages or modify the innovation; and *observability* or the extent to which the change and its' impact are visible to others (Rogers, 2003). Three clusters of influence correlate with the *rate of adoption*, or the rate of spread of a change: "(1) perceptions of the innovation; (2) characteristics of the people who adopt the innovation, or fail to do so; and (3) contextual factors, especially those involving communication, incentives, leadership, and management" (Berwick, 2003, p.1970).

Reaching this decision requires progressing through the innovation-decision process over a period of time during which information about the innovation is sought after, and the advantages and disadvantages are progressively evaluated until a sense of certainty about a decision to adopt or reject the innovation is reached. Integration of the innovation into the routine practices of the group occurs only when confirmation of the innovation is affirmed. Throughout the decision-making process, the methods and sources of communication have a robust impact on the probability that an innovation will be adopted (Wejnert, 2002). Rogers (2003) used the Bass Diffusion Model to explain the importance of external and internal communications that occur over a period of time to the innovation-decision process.

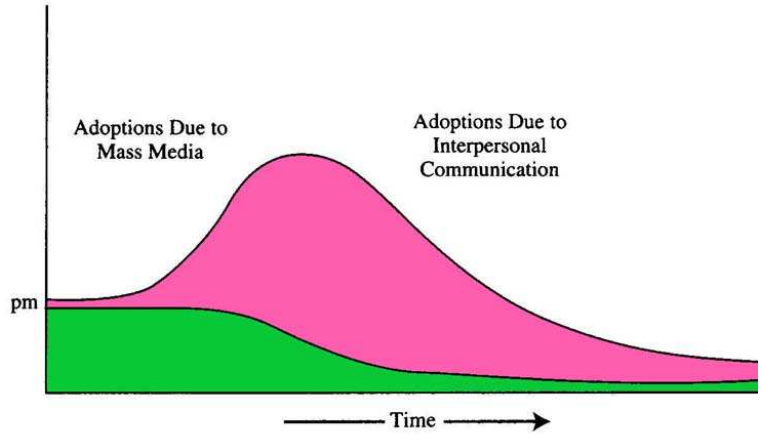

Figure 1. The Bass Diffusion Model illustrates the increased influence of face-to-face communications over time in the decision to adopt an innovation.
Source: Robinson (2009) as reproduced in Rogers (2003) based on Mahajan, Muller, and Bass (1990) (see Appendix A for permission for use of the Bass Model figure)

Mass communication methods such as use of the Internet, and information from sources external to the local social system including individuals, organizations, and regulations are most influential during the knowledge stage, while internal peer-to-peer conversations, peer networks, and the influence of opinion leaders are more important at the persuasion stage. The local change agents and gatekeepers also influence opinions as well as the decision regarding adopting an innovation (Rogers, 2003; Robinson, 2009).

The diffusion of innovation theory is supported by over fifty years of social science research and is gaining relevance in healthcare (Berwick, 2003). The Institute of Medicine (IOM) and Robert Woods Johnson Foundation (RWJ) Future of Nursing Initiative advocate the use Rogers' theory as a framework to not only evaluate the rate of spread and incorporation of evidence-based knowledge and practices into healthcare routines but also to orchestrate the innovation adoption process (Green, 2011). Rogers'

diffusion of innovations theory is an appropriate foundation of for this descriptive study of nurses' practices with blood transfusions as it recognizes that innovations encompass any information, process, or technology that is perceived as new by a person, group, or hospital. Roger's theory also acknowledges that innovations are not adopted by an entire group at one time, but gradually become incorporated into customary actions of a group over a period of time.

Assumptions

The assumptions underlying this research pertained to the accuracy of responses and the use of Roger's diffusion of innovations theory as a foundation to describe the adoption innovations in blood transfusion practices. There were three assumptions fundamental to having confidence in the accuracy of the responses and therefore reliability of the data.

1. American Organization of Nurse Executives (AONE) members are likely to support nursing research as part of their leadership role to advance nursing practice and patient care.
2. The reported responses by a single nurse respondent from the hospital will accurately represent the customary transfusion practices on medical-surgical acute care units and not practices from other clinical areas of the hospital such as critical care or the operating suites.
3. The nurse respondent will seek out information not personally known to him or her in order to provide an accurate response.

There were two assumptions fundamental to the use of Roger's diffusion of innovations theory as a foundation to describe the adoption of innovations in blood transfusion practices.

1. Reported practices of technological or process innovations, or new transfusion information are analogous to adoption of an innovation.
2. The innovation-decision process of communication and diffusion of the innovation within the organization preceded the reported adopted practice.

Research Questions

The following research questions guided this description of the state of the science of blood transfusion practices of nurses in medical-surgical patient care units in U.S. hospitals.

1. What are the reported blood transfusion practices of nurses in medical-surgical patient care units in U.S. hospitals?
2. What innovations in technology and processes have been adopted by nurses in medical-surgical patient care units in U.S. hospitals?
3. What education content and methods of communication are used in the hospital-based preparation of medical-surgical nurses and nursing staff related to the administration of blood products?
4. What internal and external sources of information influence the communication and diffusion of blood transfusion practices of nurses in medical-surgical units in U.S. hospitals?

5. How are patients and their families instructed about symptoms to report during a blood transfusion in medical-surgical patient care units in U.S. hospitals?
6. Do reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differ based on hospital size?
7. Do reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differ based on Magnet status?

Definition of Terms

Variables in this study will be defined as follows:

1. Blood transfusion practices: Blood transfusion practices encompassed procedures, interventions, processes, and use of personnel as specified in hospital policy and/or reported as being carried out in the clinical environment. In this study, blood transfusion practices included transfusion orders, blood specimen collection, transporting blood products, vital signs frequency and parameters, transfusion verification procedures, handoff communications, and notifications of suspected transfusion reactions as identified in responses to Questions 7-18, 20-21, 31, 33-35, 42-44, and 66- 67, and 69 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*

2. Hospital: A hospital included any acute care institution whose primary function was to provide diagnostic and therapeutic services for a particular or general medical condition. The term hospital was inclusive of investor-owned and not-for-profit; local and state government; rural and urban; free-standing, system, and network community hospitals; and teaching and non-teaching hospitals (American Hospital Association, 2012). U.S. hospitals were those located in states, territories, and commonwealths of the United States and those located in the District of Columbia. In this study, hospitals were described according to the responses to Questions 1-4 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*
3. Magnet recognition: Magnet recognition is awarded to "health care organizations for quality patient care, nursing excellence and innovations in professional nursing practice" (American Nurses Credentialing Center, 2012). In this study, hospitals were classified as magnet hospitals if they responded affirmatively to Question 5 on the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*
4. Innovation: Innovation is any technology, process, or information that is perceived as a new.
    a. Technology innovations: In this study technology innovations were devices and technologies used in the administration of blood products that are designed to enhance safety. These technological innovations included computerized provider order entry (CPOE), automated

systems for transporting blood products to the clinical area such as pneumatic tubes and robots, vending machines to dispense blood, thermal coolers to store blood for up to 24 hours, intravenous volume pumps for infusion rate control, specimen collection verification equipment, positive patient identification (PPID) equipment, electronic transfusion verification scanning equipment, blood wristbands, and automatic devices for vital signs and use of pulse oximetry as identified in responses to Questions 6, 22-28, 30, 32, and 36-41 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*

b. Process innovations: In this study, process innovations encompassed handoff communication, number of staff required for electronic pretransfusion verification, double check at the point of blood product issue, hemovigilance reporting, employment of transfusion safety nurses, and nurse representation on the Transfusion committee as identified in responses to Questions 19, 29, 68, and 70-72 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*

5. Adoption: Adoption is the decision to incorporate the new knowledge, process, or technology into practice. In this study, adoption was the report of a blood transfusion technology or process innovation as defined above.

6. Education content: Education content is the subjects or topics addressed in an education offering. In this study, education content included hospital procedures, transportation of blood products, equipment for blood transfusion, types of blood products and filters, infusion rates and duration of infusion, symptoms of transfusion reactions, patient management during a transfusion reaction, types of transfusion reactions, blood conservation, blood wastage, and responsibilities during a transfusion reaction as identified in responses to Questions 47-54 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*
7. Education methods: Education methods are planned processes to accomplish an education goal. In this study, education methods included online modules, video, classroom presentation, in-service, reading the transfusion policy, self-learning module with content in addition to the transfusion policy, competency validation skills station, simulation with discussion, case studies, blended learning, who receives blood transfusion education, and frequency of blood transfusion education as identified in responses to Questions 45-46, and 55-58 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care.*
8. Communication: Communication is a process of sharing information between two or more people so that each view or position is appreciated and a mutual understanding is reached. Diffusion is a subset of communication about

something perceived as new and is strongly influenced by the methods and sources of information.

a. Internal sources of communication influence. In this study, internal sources of communication influence were those within the hospital that included hospital policy, clinical nurse specialists or nurse practitioners, nurse education specialists, nurse managers, nurse peers, physicians, staff from the transfusion service or blood bank, transfusion safety medical officers, and transfusion safety nurses as identified in responses to Question 58 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care*.
b. External sources of communication influence. External sources of influence are those outside the hospital included the AABB, the *Circular of Information*, Google and other general search engines, members of an online professional listserv or group, journal articles, Medscape (free weekly electronic newsletter, or nursing education CE, etc.), subscribed online sources such as Mosby Skills and Nursing CE, textbooks, webinars on blood transfusions, and other internet sources as identified in responses to Question 59 of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care*.

9. How are patients and family instructed about symptoms to report during a blood transfusion: How are patients and family instructed on symptoms to report during a blood transfusion is a communication method of patient and

family teaching. In this study, how are patients and families instructed about symptoms to report during a blood transfusion included frequency of use of verbal and of printed instructions, and developer of the blood transfusion pamphlets or information sheets as indicated by responses to Questions 61 to 65 of the Patient and Family Instructions section of the survey *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care*.

Limitations

The limitations present in this study that pose challenges to describing the state of the science of U.S. nurses' practices with blood transfusion included:

1. Membership in the American Organization of Nurse Executives (AONE) is not a requirement for the position of Chief Nursing Officer and therefore the study population may not include every acute care medical-surgical hospital in the U.S.
2. The nurses' practices may have been reported and not observed.
3. The length of time required to obtain information might have decreased the number of completed questions or surveys.
4. The unidirectional progression of data entry in PsychData prevents returning to a previous web-based survey page; questions must be answered in sequence without the ability to modify a previously answered question (PsychData™, LLC, 2006).

Summary

Nurses have been caring for patients receiving blood transfusions for decades yet there is sparse research to support their role in transfusion therapy. The primary sources for describing blood transfusion practices of U.S. nurses are from performance improvement audits by non-nurse groups. The importance of patient assessments during a blood transfusion is universally acknowledged but practices differ based on level of care. Nurses on medical-surgical acute care units have less opportunity for direct patient observations during the course of a transfusion than patients in higher acuity areas. This supports a study of nurses' transfusion practices in medical-surgical acute care areas. The U.S. national focus on blood transfusion safety is multifaceted with many accomplishments in providing a safe blood supply in the U.S., but the necessity to improve bedside adverse transfusion event recognition and reporting with the need for transfusion education for nurses is consistently highlighted. There is an explosion new knowledge, transfusion processes, and technology that impact transfusion practices of nurses. Using Everett Rogers' diffusion of innovations theory as the foundation for this research, a description of medical-surgical acute care nurses' transfusion practices and the spread of innovations that impact the nurses' transfusion practices were studied. Subsequent studies will be able to use the descriptions of nurses' transfusion practices to design research that addresses the process of adverse reaction recognition as well as educational interventions to improve transfusion knowledge and safe practices.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter is a review of the literature related to nurses' practices with blood transfusions. The literature search encompassed the last 16 years so that it would fill in the gap since the review by Wilkinson and Wilkinson (2001) published in the *Journal of Clinical Nursing* on error and blood transfusions reported in the literature from 1989 to 1996. The initial searches in the databases of CINAHL, PubMed, and the AHRQ Patient Safety Network used many key words and key word combinations including blood transfusion, adverse effects, transfusion reaction, nursing, education, complications, patient education, transfusions errors, hemovigilance, non-licensed nursing personnel, safety in transfusion therapy, electronic transfusion verification, barcode technology, and positive patient identification (PPID). Registration with PubMed for notification of new articles pertaining to nursing and blood transfusion identified pertinent articles that were available online prior to print publication. A review of references cited in other articles was valuable in the identification of pertinent research and expert opinion literature. Google searches pointed to important articles and hemovigilance groups in the United Kingdom. A search in ProQuest Dissertation and Theses identified two relevant master's theses, one ethnographic research and the other historical research on nurses and blood transfusion. Subsequently a search within the JSTOR database provided a historical foundation for nurses' involvement in blood transfusions. A limitation to the literature

search was the requirement that the each identified article or abstract had to be available in English.

In this review of the literature, the *historical perspective* section provides support that nurses in the U.S. have been involved in blood transfusions for decades and that administrative errors involving the nurse have been recognized for over 50 years. The section on *nursing practice and transfusion safety* includes the single review article of studies published from 1989 to 1996, the research relevant to nursing practice and blood transfusion therapy published in English from 1997 to 2012, and relevant quality reports that supplement a description of nurses' transfusion practices. The section on *patients* synthesizes the literature on patient's perceptions of blood transfusions and of the nurses who care for them during the transfusion. The subsequent sections review the literature related to content germane to the survey *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care*. The section on *education of nurses on blood transfusions* provides a review of the nursing literature on the nurses' blood transfusion knowledge evaluated by research and relevant quality reports that report proportion of nurses who receive education on blood transfusion. The section on *hemovigilance* addresses the United States (U.S.) focus on hemovigilance reporting in the U.S, the underrecognition and underreporting of transfusion reactions, and the expanded list of types and symptoms of transfusion reactions. The section on *technology and safety innovations* reviews devices and processes within the practice sphere of nursing that improve safe transfusions. This chapter supports the integral role of nurses with the high-risk and multifaceted processes of blood transfusion therapy.

Historical Perspective

In the U.S., the recognition of blood transfusion as a lifesaving therapy began in 1917 when the U.S. entered World War I and used blood transfusions to treat American combatants (Bradbury & Cruickshank, 1995; Zarychanski, Ariano, Paunovic, & Bell, 2008). Nurses have been instrumental in the care of wounded soldiers since the 1850s as a result of the efforts of Florence Nightingale in the Crimea and Clara Barton in the Civil War. It is therefore plausible that nurses were present and possibly assisting with the transfusion of blood at its inception in World War I, although the scope of the nurse's assistance is unknown. As early as 1923 Lulu St. Clair(1923) described the technique of blood transfusionstated that "transfusion of blood . . . has become almost entirely a ward procedure and only occasionally an operating room performance" (p. 738). Highly skilled operating room nurses set up the equipment, assisted the physician, and watched the patient for a reaction as well as the donor's condition. Recognition of the role of nurses with blood transfusions is found in textbooks and articles written by nurses beginning as early as the 1930s. Woolf's textbook *Principles of Surgery for Nurses* included a section on transfusions (1930). Frances Burgess (1937) described a transfusion cart with all necessary equipment for administering a blood transfusion on the wards; the practice was more commonly performed in the operating rooms. Lucille Heimann (1938) described two methods for blood transfusion, the two-syringe method and the citrate method, and stated "although the procedure itself is carried out by the doctor, nevertheless much responsibility, in the transfusion of blood, rests with the nursing staff" (p. 408). Kenneth Lemmer (1938) acknowledged the importance of nursing with blood transfusions with his

article that described the process for ABO cross-matching, the indications and contraindications for transfusions, and unfavorable reactions. Alice Hartley (1940) published a comprehensive article titled *Nursing Care in Blood Transfusions* that included an overview of blood transfusion procedures, indications, ABO compatibility, and transfusion reactions. The article identified incompatibility of blood as the main cause of a transfusion reaction, stated that the early symptoms of reactions occur after only 50 to 100 cc of blood, and listed common transfusion reaction symptoms. These symptoms continue to be recognized as indications of a transfusion reaction and therefore remain an important focus for nursing observations. The importance of nurses in blood transfusions is evident from these very early publications.

The evolution of role of the nurse with blood transfusions was described in the historical analysis of a Canadian hospital (Toman, 1998). Authenticity and accuracy of the historical data was established by oral history interviews of nurses who had been students, practicing nurses, or educators during the time under study; by a rich source of archival material that included artifacts, lecture notes, examinations, photographs, scrapbooks, yearbooks, procedure and policy manuals, alumnae association newsletters, administrative correspondence, meeting minutes and annual reports; by a literature review of nursing and allied fields for articles on blood transfusion during the historical period; and by a historiography on blood agencies and laboratories in Canada. From 1924 to 1947 blood transfusions were performed by physicians and nurses provided assistance with the complex procedure. The nurse's role was setup and cleanup of equipment, as well as preparation and management of both the transfusion recipient and the donor.

From 1947 to 1970 select nurses became members of Blood Teams who were acknowledged for their advanced knowledge and skill with intravenous technologies including blood transfusions. As demand for transfusions increased, the administration, assessment, and monitoring of blood transfusions were shifted to bedside nurse. From 1970 to 1990 transfusion therapy was incorporated as a basic competency within the scope of practice for nursing.

The important role of nurses in preventing errors in transfusion by proper labeling the blood samples and matching the blood unit to the patient was reported as early as 1955. Rath (1955) acknowledged that patients may respond incorrectly to yes/no questions regarding their identity and therefore nurses are obligated to make certain that the transfusion requisitions and tube of blood sent for cross-matching are correctly labeled with the patient's identifying information. In response to a fatal blood transfusion reported in the *Daily Telegraph* newspaper in the U.K., Osborn (1967) acknowledged that clerical errors lead to incompatible ABO transfusions and hospitals vary in how patient identification is safeguarded relative to blood transfusions. He recommended a new process of a three label/color coded system for transfusion verification that involved nurses in the checking procedure. This marked the importance of process and technology improvements to advance the safety of blood transfusions, a practice that centers on the role of the nurse.

Nursing practices related to the transfusion of blood products have evolved over time and began with providing technical assistance to the doctor and progressed to nurses administering transfusions as a routine practice. In 1990, a nationwide guideline for U.S.

nurses was established by the National Blood Resource Education Program's Nursing Education Working Group, with representatives from the Red Cross, Oncology Nursing Society, two major university medical centers, a university nursing program, the Department of Transfusion Medicine from the National Institute of Health, and the National Heart and Blood Institute. Two seminal publications emanated from the Working Group. *Transfusion Therapy Guidelines for Nurses* (Callery et al., 1990), a National Institute of Health publication, was the first and remains the only U.S. government sponsored guideline specifically for nurses on blood transfusion therapy; the guideline is no longer available. The guideline covered ABO and Rh compatibility, transfusion options, different blood components, transfusion reactions and administration procedures. The Working Group authored a four part article in the *AJN* in 1991 in an effort to educate a large number of U.S. nurses on the guidelines; continuing education credit was offered as an enticement (National Blood Resource Education Program's Nursing Education Working Group, 1991a, 1991b, 1991c, & 1991d). The importance of errors contributing to transfusion reactions was recognized in the second article *Preventing and Managing Transfusion Reactions*, "Studies have shown that the primary sources of hemolytic transfusion reactions are administrative errors in specimen collection and labeling, and errors in identifying patients" (1991b, p. 50). Subsequent to the *Transfusion Therapy Guidelines for Nurses* (Callery et al., 1990), the universal guideline for blood transfusion endorsed by the U.S. government for nurses and all healthcare disciplines has been the *Circular of Information for the Use of Human Blood and Blood Components* (AABB, 2009).

Nursing Practice and Transfusion Safety

The transfusion practices of nurses and patient safety are integrally linked. With the exception of the operative services, once a blood product is issued from the transfusion service, the nurse is responsible for the blood administration, the clinical assessment of the patient, and prompt recognition of adverse responses that require immediate intervention; these established practices have been in place for decades. Three zones of error in blood transfusions are described by W.H. Dzik (2007), patient identification (ID) along with pretransfusion specimen labeling, the decision to transfuse, and bedside pretransfusion verification intended to match the right blood to the right patient. Although the decision to transfuse rests with the physician, the actual transfusion is conducted entirely by the nurse who is at the point-of-care and therefore has an essential role in patient safety during a blood transfusion.

Wilkinson and Wilkinson (2001) searched the medical and nursing literature for research and quality reports that investigated error and blood transfusion published from 1989 to 1996. Eight articles were identified in medical journals and but none in the nursing literature. Only one article was a prospective randomized study and the others were quality audits, a survey of hematology departments, and analyses of incident reports; one analysis of incident reports was from the U.S. and the others studies were conducted in Europe. No appraisal of the prospective survey research study conducted in Belgium was provided. Two primary content areas were identified from the reviewed articles. The first content area was *errors associated with blood transfusions* in which nursing failure was often identified as the source of error and where there was a

consensus that errors are underreported. The second content area was *recommendations for good practice* that focused on protecting the patient from harm. Nursing practice was fundamental in that nursing care of the patient, observations for a transfusion reaction, and management of the transfusion process were essential to preventing patient harm. "Given the substantial role of nurses in the administration of blood transfusions, they must play their part in contributing to, and taking the lead in, these initiatives" (p. 169). Inclusion of this review of the literature is relevant in that it underscores the role of nurses in blood transfusions, the lack of research on blood transfusion errors published in nursing journals, and the reliance on quality audits not research to describe transfusion practices.

The design, sample, appraisal, and major finding for four research studies are presented as they are cited numerous times and in multiple sections in the following review of the literature on nursing practice and transfusion therapy. These qualitative studies strengthen multiple aspects of this paper. See Appendix B for a matrix table of the research relevant to nursing conducted in the U.S. and other countries.

1. Adams and Tolich (2011) conducted a descriptive phenomenology study of patient's experiences with blood transfusions at a Midwest hospital in the U.S. Medically stable non-ICU adult patients who voluntarily consented were interviewed 24 hours post transfusion using an open-ended semi-structured interview approach. Trustworthiness was established by verbatim transcription of the data which were reviewed by two investigators and by use of the actual words of the participants. Although dependability was attempted by including

patients of different ages with diverse cultural backgrounds and different etiologies for the anemia that required transfusion, the sample of 21 patients was primarily comprised of older white women; diverse etiologies for anemia were achieved. Data saturation was reached with 21 patient interviews. Four themes emerged from the interviews: *paternalism and decision makin*g, *patient knowledge, blood safety and administration, and nurse's role.*

2. Heddle et al. (2012) reported on a qualitative study designed to understand the pretransfusion checking process from the perspective of the transfusion practitioners, and to identify concerns and recommend safety improvements. Theoretical sampling of nurse transfusionists (n = 65) from six hospitals in five countries, Canada, Italy, Norway, the U.K. and the U.S., plus physicians (n = 7) with clinical expertise in anemia and hematology comprised the sample (n = 72). Trained facilitators used a discussion guide for the focused groups (n = 12) conducted with the nurse transfusionists and for the individual interviews with the physicians. Concurrent analysis with constant comparison was conducted by five members of the research team; consensus was reached on a coding scheme and a single researcher coded the complete data set. Five main themes emerged from the data: *pretransfusion checking, policy, training, opportunity for error,* and *monitoring the transfusion process*.
3. Fitzgerald et al. (1999) conducted an interpretive phenomenology study of patient's experiences with the preparation for and administration of blood transfusions in a large teaching hospital in Australia. One researcher

conducted unstructured interviews with 19 patients. Each patient was asked to "talk about the experience of having a blood transfusion from the time they were first told about it" (p. 595). Interview tapes were transcribed verbatim and descriptive case studies were written based the patient's telling of the experience. The in-depth interpretive process techniques included the hermeneutic circle, dialogue with the text, and fusion of horizons. A cross-sectional analysis of all transcriptions was used to identify three broad themes of *information*, both giving and receiving; *reactions*, both physical and emotional; and *treatment and care*. Although no statements of generalization were provided, the interpretation richly illuminated these patient's experiences during a blood transfusion.

4. Hyson (2009) conducted an institutional ethnographic study in one medical unit of a large tertiary healthcare facility in Canada. The study focus was transfusion safety. Transfusion practices were observed and nine randomly selected nurses participated in semi-structured interviews to explore their perceptions of transfusion safety. When conducting the fieldwork and during data analysis reflexivity was used to identify and thereby guard against researcher bias. Lincoln and Guba's (1985) criteria for trustworthiness and dependability were met. Blood administration was highly respected by the nurses and was a strictly regulated procedure.

Although quality audits do not meet the scientific rigor of research, the overwhelming majority of published clinical practice findings in the field of transfusion

medicine include direct observations of transfusion practice of nurses and reports of utilization and outcomes of new technologies for blood transfusion therapy are quality improvement projects or quality audits. Many reports of quality audits are classic articles repeatedly referenced in other transfusion literature. The methology, sample, and major findings for four quality audit/improvement reports are presented as they were conducted in the U.S. and are cited numerous times in the following review of the literature on nursing practice and transfusion therapy. Most of the quality reports are based on direct observation of a large number of nurses transfusing blood or provide substantiation of a practice issue in blood transfusion which justifies the use of these quality reports in a description of nurses' blood transfusion practices. In the following review of the literature, efforts were made to differentiate quality articles from research. See Appendix C for a matrix table of selected quality articles relevant to nursing conducted in the U.S. and other countries.

1. Narvios et al. (2004) conducted a quality improvement evaluation of myelosuppression patients in a specialized oncology service of one hospital in Texas who had minor transfusion reactions that were not reported to the hospital's transfusion service during a six month period (n =58). Data was obtained from a questionnaire developed by the nursing staff and transfusion medicine physicians, The questionnaire included the blood component administered, reaction symptoms, premedication used, leukoreduction filter used, first-time reaction, physician notified with action recommended, transfusion resumed, and further reaction; no psychometrics were provided. A

clinical fellow from the blood bank reviewed each patient's medical record to confirm the transfusion reaction and course of events. Nurses reported 29 (50%) of the adverse events to the physician and the physician resumed the transfusion in 27 cases (46.6%). This evaluation substantiated the underreporting of minor transfusion adverse events to the transfusion service.

2. Novis, Miller, Howanitz, Renner, and Walsh (2003) reported on observational audits of transfusion practices conducted in 1994 and 2000. The more recent 2000 audit (n = 4,046 transfusions) is presented throughout this literature review as a snapshot of transfusion practices in the U.S. given that 95.3% (n = 222) of the participating institutions were from the U.S. The objective was to measure the rate of completion of specific transfusion procedures by health care workers. A standard audit tool was used in all institutions to collect data on many measures related to patient identification, vital signs, transporting blood, personnel involved with blood transfusions, cross-checks to match patient identification with the blood product, and practices specified in the hospital's transfusion policy. No psychometrics of the tool was reported. The strength of this audit is that it was based on direct observation of transfusion practices and that data was aggregated from multiple U.S. hospitals.
3. Saxena et al. (2004) reported on a plan-do-check-act (PDCA), quality improvement project of a comprehensive assessment of the blood administration process in a hospital in California. Trained nurse evaluators

directly observed transfusions (n = 982; $\bar{x}$ = 19 per month) over a period of 51 months (1999-2003). A computer scan audit tool was used to document 21 blood transfusion process measures related to informed consent, physician order, blood product request card, patient preparation, blood product issuance, pretransfusion identification checks, blood administration, and posttransfusion checks. No reliability or validity of the tool was provided although the measures were derived from the hospital's transfusion policy and procedure. Data was aggregated quarterly and reported via line graphs that indicated the trend in percent compliance with each of the 21 blood transfusion processes. Observed compliance with safe blood transfusion practices improved over time although the number of months to reach sustained 100% observed compliance varied by process. Safety practices in the critical zone of error, matching the right blood to the right patient were observed to be 100% following 18 months of observation audits.

4. Thomas and Hannon (2010) reported on the incidence of transfusion-related adverse events identified by a medical record audit and subsequent reporting of the adverse event to the physician and transfusion service. The objective was to provide data to address the perspective of transfusion services in the U.S. that many transfusion reactions are unrecognized and unreported by both nurses and physicians. The audit tool conformed to each hospital's criteria for a transfusion reaction as well as to documentation of clinical recognition, management and reporting of the adverse event according to the hospital's

> policy requirements. Data was reported as frequency and proportion of total adverse events, type of adverse event, events reported to the physician, and events reported to the transfusion service. A convenience sample of 3024 transfusion episodes from multiple centers in the U.S. was evaluated. Eighty-eight transfusion events were identified with only 47 (53%) recognized as a transfusion reaction by the clinical staff [nurses] and reported to the physician; of these only 16 (18%) were also reported to the transfusion service. This audit's limitations were the lack of a uniform definition of the measures for all hospitals and sole reliance on documentation in the medication record. The data supported the perspective of underrecognition and underreporting of transfusion reactions. Safety concerns related to patient monitoring were raised.

The recent qualitative research by Adams and Tolich (2011) on patient's experiences and Heddle et al. (2012) on transfusionists in five countries highlight that blood transfusion is a current and relevant issue for nurses. The administration of blood products, a transplant of living liquid tissues, is one of the highest risk procedures performed by nurses. Additionally since patients are passive participants in the transfusion process, the nurse has a critical role as a patient advocate. Although nurses are highly accountable for the safe blood product administration process, substantiation of the practice of U.S. nurses relies on quality audits by non-nurses. It is time for nurses to comprehensively describe the practice of nurses with all aspects of blood transfusion therapy.

Pretransfusion Verification

Nurses from multiple countries have a strong sense of responsibility and accountability for transfusion safety as reported in the Canadian ethnographic study by Hyson (2009) and the international transfusionists study by Heddle et al. (2012). Safety with the pretransfusion verification process, matching the blood to the correct patient was identified as the most critical step in blood administration. The reported practices were consistent with the sense of professional responsibility; two persons were required for the pretransfusion check unless barcode scanning for transfusion verification was available, then a one-person bedside check was employed (Heddle et al., 2012). Despite this well-acknowledged duty of the nurse for patient safety during transfusions, no other recent research substantiates this perspective.

Safety lapses have been reported from direct observations of nurses practices in the U.S. In 2000, direct observation of transfusions (N = 4,046) took place in multiple hospitals. Completion of the patient identification procedures was 97.4% for patients wearing ID wristbands, 75.5% for pretransfusion verification matching the wristband with the blood bag compatibility label, and 42.1% for verification of the patient's stated name to the wristband (Novis et al., 2003). Between 1999 and 2003, 982 transfusions were observed in a hospital in California. Compliance with safety practices improved over time. Consent for transfusion was 80% and rose to 100% within 6 months, and patient identification checked at the bedside which included the patient stating his/her name was initially 50% and rose to 100% within 18 months; once achieved, compliance was sustained at 100% for the remainder of the quality project (Saxena et al., 2004).

These improvements reflect the focus on transfusion safety and the active role of nurses in safe transfusion practices. Although there is universal acceptance that nurses are keenly aware of their responsibility and accountability during blood transfusions, and when questioned state that the pretransfusion verification is the most important step in the bedside transfusion process, yet the observed practice has not substantiated the safety value. Considering the observation of these practices is 7 to 13 years old, there is a gap in the literature in the description of present day nurses' pretransfusion verification safety practices.

Patient Surveillance and Vital Signs

Once the order to transfuse is written and the blood product processed in the transfusion service, the nurse is responsible for the administration of the blood transfusion including the observation and immediate care of the patient. The *Circular of Information* states that "periodic observation and recording of vital signs should occur during and after the transfusion to identify suspected adverse reactions" (AABB, 2009, p. 3). To operationalize this objective, time-specific parameters for processes and assessments have been widely adopted as benchmarks for transfusion safety. Vital signs obtained pretransfusion, within 15 minutes of initiating the transfusion, and at the end of the transfusion; as well as close observation of the patient for the first 15 minutes or first 50mL of the transfusion, and periodically during the transfusion are examples of common safety practices accepted worldwide, practices that are often specified in hospital policies and procedures.

Despite these accepted safety practices inconsistencies in clinical surveillance by nurses during the transfusions have been reported, In the U.S. nationwide audit of blood transfusions (n = 4,046) reported by Novis et al. (2003), observed compliance with vital signs was 98.1% for pretransfusion, 92.7% at 15 minutes, and 95.1% after the first 15 minutes of the transfusion. Saxena et al. (2004) observed blood transfusions (n = 982) in a California hospital. During the 1999 to 2003 observation period, persistent variations in compliance were observed for vital signs, ≈65-95% at 15 minutes or after the first 50mL of blood, and ≈65-90% for vital signs at the end of the transfusion; 100% compliance with the observations and vital signs during a transfusion was not attained until the last 6 months of the 51 month evaluation. The research on patient's experiences with blood transfusions by Fitzgerald et al. (1999) confirmed vital sign inconsistencies as reported by patients. Yet, patients view nurses as attentive and supportive during the blood transfusion (Adams & Tolich, 2011).

Lapses in patient observations place patients at risk for unrecognized or untimely identification of transfusion reactions. Although underreporting was identified in the following two quality reports, conflicting perspectives were expressed regarding the nurses' role in managing versus disregarding the patient's symptoms. In the evaluation of minor transfusions in Texas, Narvios et al (2004) found that only 50% (n = 26) of the minor transfusion reactions recognized by nurses in an oncology unit were reported to the physician; symptoms included chills, fever, hives and itching, nausea and vomiting, and headache. The other 26 minor transfusion reaction cases were managed by the nurse without an interruption in the transfusion. The authors credited the experience and

training of the oncology nurses in recognizing and responding to the signs and symptoms of transfusion reactions. The nurses at the point-of-care incorporated minor blood transfusion management into their practice. Thomas and Hannon (2010) aggregated quality audits of transfusions (n = 3024) from multiple healthcare institutions in the U.S. They identified that 47% of the transfusion reactions were not reported; no differentiation was made between major and minor transfusion reactions. The authors concluded that the clinical staff, i.e. the nurse, was the source of the safety concerns for not recognizing the clinical signs of a transfusion adverse event. Despite the universal belief that nurses are highly responsible and accountable for patient safety with blood transfusions, the published information demonstrates a gap between the belief and actual safe clinical practices.

Opportunity for Error

The theme e*rrors associated with blood transfusions* in which nursing failure was often identified as the source of error and where there was a consensus that errors are underreported was recognized by Wilkinson and Wilkinson (2001) in their 1989 to 1996 review of articles on transfusion error. The theme of *opportunity for error* also emerged from the international qualitative research of transfusionists (Heddle et al., 2012). The nurse transfusion specialists affirmed that both manual and electronic processes are effective for pretransfusion checking but human error could occur with any transfusion if the appropriate process was not followed. Human error increased with distractions and when multiple units for different patients delivered to the clinical area at the same time. Additionally they stated that the nurse's lack of familiarity with the patient and language

barriers promoted error. In the institutional ethnographic study in a Canadian hospital Hyson (2009) identified that blood administration is highly regulated, yet safety is jeopardized with workarounds during blood administration.

Interruptions and distractions are acknowledged to impact the work flow and cognitive processing of nurses. Potter et al. (2005) conducted an ethnographic mixed methods study using field observations and summarative interviews to understand the cognitive work of nursing in an acute care environment in a large tertiary medical center in the Midwest. Two researchers, a human factors engineer and an RN researcher, shadowed consenting staff nurses (n =7) for 4 or 9 continuous hours of patient care activities, resulting in 43 hours of observation. At the end of each period of observation, the two researchers merged data and confirmed their findings. “Data for each RN included a qualitative summary of care activities, a task analysis, cognitive pathway, and computations of interruptions, time spent with patient, omissions in care, and cognitive measures” (p. 329). Although the article does not speak to inference quality and transferability per se, a group of expert clinicians, educators, and researchers interpreted the qualitative data and identified themes which established the believability and accuracy of the conclusions. The findings of the ethnographic study by Potter et al. (2005) substantiated the complex, nonlinear work of nursing where the nurse’s cognitive focus is shifted numerous times during the day due to multiple patient priorities and interruptions that distract the nurse; one nurse experienced 86 cognitive shifts during a 9-hour period. Additionally 7% of the nurse’s time was comprised of interruptions.

The contribution of interruptions and distractions to blood transfusion errors is documented in research studies and reports from multiple countries. Linden, Wagner, Voytovich and Sheehan (2000) reported their analysis of 9-million blood transfusions in New York from 1990 to 1999. Data was obtained from the mandatory reports from all hospitals to the New York State Department of Health, follow-up phone calls and correspondence clarified incomplete or vague reports. Data was imported into Statistical Product and Services Solutions (SPSS) software for analysis. A contributory factor to transfusion-associated errors (n = 462) was interruption of the transfusion procedure by other events.

Liu, Grundgeiger, Sanderson, Jenkins, and Leane (2009) conducted a simulator-based study of the anesthesiologists' ability to detect unexpected events while wearing a head-mounted display of the simulated patient's parameters; retrospective analysis of the video recording evaluated if a bedside transfusion check was omitted following an interruption. The scenario was the surgeon interrupted the anesthesiologist immediately after blood was delivered for a hemorrhaging patient and the nurse took the blood directly to the patient without conducting pretransfusion verification with the anesthesiologist. The video was coded using "the classification scheme . . . based on the Collins et al. taxonomy of distractions plus a "blocking" category absent from their study" (p. 220). Three of the twelve anesthesiologists omitted or did not recognize the absence of a transfusion check due to the surgeon's interruption or multitasking.

Stainsby, Russell, Cohen, and Lilleyman (2008) represented the hemovigilance program Serious Hazards of Transfusion (SHOT) that analyses voluntary quality reports

of blood transfusion errors from hospitals throughout the U.K. Between 1996 and 2003, 2087 adverse events were analyzed; 1393 (67%) were reports of incorrect blood component transfused (IBCT). In their adverse event analysis, the most common error in each annual report was failure to comply with pretransfusion verification. A contributing factor to the failed bedside check was "distraction of nursing staff during the checking process" (p. 10).

Opportunity for error was identified in the historical analysis of a Canadian hospital by Toman (1998) who described how blood administration was incorporated into the accepted scope of practice for nursing. "When nurses take on a technology, it moves from visibility to invisibility and is subsumed into the workload. At that point, it risks being considered as a task instead of gaining recognition as knowledge work" (p. 202). The subsumed blood transfusion tasks or responsibilities compete for the nurses' time and attention amid the myriad of other activities and distractions thereby creating an environment ripe for error. Baffa (2011) stated that the use of non-licensed nursing assistants to obtain transfusion vital signs is reported to be a common practice in many institutions, yet no research, quality data, or general articles on blood transfusion and non-licensed staff document this practice outside of Novis et al. (2003) who reported on the U.S. nationwide audit of blood transfusions (n = 4,046) that non-licensed personnel functioned as blood couriers, The quantifiable measures of blood transfusion safety are time specific. Use of non-licensed staff may assist with meeting the measure benchmarks but opens up other opportunities for error. If the non-licensed personnel have no training germane to their role with blood transfusions and if the nurse is not present to assess the

patient, a safety gap develops. Blood transfusions are liquid tissue transplants with inherent cellular compatibility risks that require critical patient assessments. In addition there are many risks associated with the complex process of blood administration. Lack of compliance with any aspect of recommended practices is consistently highlighted as a safety risk because "transfusion errors are usually rooted in the failure to follow clerical or technical procedures and/or the breakdown in professional practice or judgment" (Dzik et al., 2003, p. 170).

Interactions with the Transfusion Service

Nurse interactions with the transfusion service were cited in several research studies and quality reports. The overarching theme in Hyson's (2009) ethnographic study in a Canadian hospital was *interdepartmental communications* and its potential to compromise transfusion safety; when bedside nurses did not receive adequate communication from the transfusion service regarding the use of a new technology, the blood fridge, the change in appearance and numbering of the blood units, the blood policies, and the rationale for the changes, unintended alterations in the transfusion processes occurred that adversely impacted patient safety. Heddle et al. (2012) identified the theme of *policy*; transfusion policies were primarily changed in response to errors but the changes were poorly communicated to nurses and physicians. Email was commonly used to relay information to nurses, yet was not considered an ideal mode of communication. One of the six sites was unaware of any mechanism to communicate transfusion policy changes to physicians. Only half of the sites provided ready access to the transfusion policies via the hospital's intranet.

From the U.S. nationwide audit, Novis et al. (2003) reported on the proportion of 222 primarily U.S. hospital's transfusion policies that required nurses receive instruction courses on transfusions (93.4%), required blood couriers receive instructions on patient identification (66.5%), and specified that the patient's wristband and blood tag identification be read aloud when blood is administered by more than one transfusionist (86.7%). Transfusion policies also commonly specify the pretransfusion verification procedures, the timing of vital signs and patient observations, and the reporting of adverse reactions; specific activities that reside within the nurses' scope of practice. With changes in policies predicated by transfusion errors, good interdepartmental communication between nursing and the transfusion service is critical to effect changes that improve patient safety.

Nurses and nursing staff directly interact with the transfusion service at the time of blood issue. A cross-check of patient and blood unit identification was performed for 96.6% of blood units issued in the 2000 U.S. nationwide quality observation audit. After issue from the transfusion service or blood bank, the blood unit was primarily transported to the clinical area by nurses or non-licensed nursing couriers (73.5%), and secondarily transported via pneumatic transport systems (10.7%) (Novis et al., 2003).

An organization-level recommendation is to include nurses as members of the hospital's transfusion committee, and to employ a designated transfusion nurse (transfusion practitioner) whose role is to provide transfusion education and promote safe transfusion practices. The diffusion and adoption of this organizational innovation in the U.S. is not known. The theme of *monitoring the transfusion process* was identified in the

qualitative research of Heddle et al. (2012) as both nursing and the transfusion service were actively involved in monitoring processes for patient safety. Nursing and the transfusion service are interconnected in the transfusion process. Interdepartmental communications should be timely. Mutual collaboration in the development of policies and improvement activities is fundamental to improving patient safety with blood transfusions.

Patients and Blood Transfusions

The transfused patient was the research focus of several studies. The common finding is that patients are predominantly passive receivers of blood therapy from the decision to transfuse, to the pretransfusion verification, and through the blood infusion. In the study by Adams and Tolich (2011) of patient's experiences with blood transfusions, the physician's decision to transfuse was not questioned by the patient. There was an absence of meaningful dialogue with the physician that produced patient understanding of the risks, benefits, purpose, and alternatives pertinent to blood transfusion. The patients trusted the nurse to fill in the gaps and clarify information. Although patients expressed concerns about the safety of the blood product related to disease transmission, they were reassured by the nurse's explanation and were not concerned about the transfusion process due to the nurse's attentiveness (Adams & Tolich, 2011). In the international transfusionist study, the passive patient role also occurred in pretransfusion verification with unpredictable patient engagement by the transfusionists in the verification process (Heddle et al., 2012). In the phenomenological study of patient experiences with blood transfusions in Australia, meaningful dialogue with the nurse was

also absent; nurses explained as they worked during the transfusion and rarely invited the patient to offer information or share their concerns (Fitzgerald et al., 1999). Printed material on blood transfusions was never received, not read, or offered following the transfusion (Adams & Tolich, 2011). One-way communication from physicians and nurses to patients is the primary means of providing patients transfusion information. Despite a lack of meaningful, mutual dialogue, patients are not concerned. As passive receivers of blood transfusions, patients trust the physicians and the nurses to make appropriate decisions and provide the necessary observation and care. Albeit there is a lack of patient concern regarding the decision to transfuse and the transfusion process, Adams and Tolich (2011) reinforced the need to provide meaningful information to the patient at every step in the transfusion process.

Education of Nurses on Blood Transfusions

Research on blood transfusion education of post-licensure nurses in the clinical practice environment comes from studies conducted in Europe. These studies support the precept that continuing blood transfusion education for nurses in the practice setting is needed on a regular basis, is important for safe transfusion practices, and is a challenge to provide. Nurses are the bedside transfusionists and as such have a critical role in transfusion safety; yet the blood transfusion knowledge of U.S. nurses is poorly represented in the research.

Saillour-Glenisson et al. (2002) conducted a descriptive, correlation study of knowledge, attitudes, and reported blood transfusions practices of nurses (n = 1090) in France. The nurses were randomly selected with proportional allocation from the 14

participating hospitals. Structured interviews were conducted with a 42 question questionnaire; content validity was established with the nominal group technique by a panel of experts. The experts scored 17 core safety questions for content reflecting potential threat to patient safety with higher scores posing a greater threat; hazard scores were derived from 11 knowledge questions and six practice questions. Univariate and multivariate analysis was conducted. Higher hazardous knowledge scores occurred when the nurse had infrequent experiences with blood transfusions, when the nurse did not feel well informed about transfusion safety, and when the nurse did not engage a second nurse in the compatibility checks. Higher hazardous practice scores occurred when the nurses' training on blood transfusions exceeded three years. A training program for nurses on the theory and practice of blood transfusions was recommended. Concurrent assessment of the patient during a transfusion is critical to safe care. Without adequate preparation and a strong knowledge base on blood transfusion therapy the patients are at greater risk caused by the nurse not recognizing and therefore not responding to adverse events; knowledge is integrally connected to safety in blood transfusions.

Qualitative studies provided insight into the process of competency assessment and training from the perspective of the transfusionist. The mixed methods research of Pirie and Gray (2007) triangulated information on the process of clinical competency assessment of blood transfusions in by means of a content validated questionnaire and semi-structured interviews analyzed using Colazzi's (1978) seven-step framework. The transfusion practitioners (n = 17) represented 47 hospitals in Scotland. Only 4% (2 hospitals) assessed nurse competency. The barriers to competency assessment were

competing obligations for the nurses' time, as well as the lack of competency assessment tools and trained assessors. The qualitative research of Heddle et al. (2012) included a sample of nurse transfusionists from five countries including the U.S. The *training* theme revealed that upon hire different methods were used for blood transfusion training, formal classes with a posttest, e-learning with a posttest, and on-the-job training. The preferred training was one-on-one teaching with the acknowledgement that the person providing the clinical training had a high level of responsibility. Challenges were identified in transforming e-learning information into clinical practice, particularly in areas with infrequent episodes of transfusion. The authors recommended training at regular intervals with more emphasis on transfusion practice and less on transfusion theory.

Hogg, Pirie, and Ker (2006) used triangulation to evaluate a pilot blood transfusion simulation exercise to reinforce learning in a workplace context in Scotland. Post simulation, participants and observers used a semi-structured interview to guide the focus group discussion. Recordings were analyzed but no method of analysis was provided. A self-assessment evaluation with a 5-point Likert was completed by each participant. Feedback was decidedly positive regarding the use of contextual simulation to reinforce safe transfusion practices. Barriers to simulation included the limited number of nurses that can participate, length of time for the exercise, difficulty in nurses being released from clinical patient care, and cost of the exercise. Although the research on the education and training of nurses on blood transfusion therapy is limited, the challenge of pulling nurses away from the clinical area for education was a recurrent finding (Heddle, et al., 2012; and Hogg, Pirie, & Ker, 2006).

Clark, Rennie, and Rawlinson (2001) reported that a structured, comprehensive training program improved documented transfusion safety practices in Scotland. Observational audits of compliance with published national transfusion guidelines were conducted before (n = 148) and eighteen months after (n = 166) the education intervention. Significant improvements at $p < 0.0001$ occurred for identity checked at the bedside, verbal identification of the patient, verification of the identity band, and baseline observations with the post-intervention measures ranging from 92% to 100%. The training program significantly improved safety practices.

Novis et al. (2003) reported on organization-required transfusion education in 233 hospitals primarily located in the U.S. In 2000, nurses were required to receive instruction courses on transfusions in 93.4% of the hospitals and blood couriers were required to receive instructions on patient identification in 66.5% of the hospitals. The content of the training was not described, but this quality report lends support that compulsory blood transfusion education of nurses is common in the U.S. The limited research and published quality reports support the need to bridge the knowledge gap and provide blood transfusion education not only upon hire but also at regular intervals for nurses at the point-of-care.

Hemovigilance

In the U.S., transfusion-related fatalities and donation-related deaths are reported to the Food and Drug Administration (FDA) Center for Biologics Evaluation and Research (CBER), with 40 transfusion fatalities reported in 2010 (U.S. Centers for Disease Control and Prevention, 2011). A yearly survey of transfusion activities including all transfusion

reactions, fatal and non-fatal, is completed by healthcare facilities for the annual National Blood Collection and Utilization Survey Report (NBCUS) (U.S. Department of Health & Human Services, 2011). A leap in innovative technology and processes occurred in 2010 with the launch of the Hemovigilance Module database of the National Healthcare Safety Network (NHSN) at the CDC. Concurrent data entry of the details of each adverse transfusion event, mistransfusion, and near-miss is electronically submitted for analysis. Innovations also occurred in redefining the types and symptoms of transfusion-related adverse reactions. Most notably was the addition of transfusion-associated dyspnea (TAD) as an adverse reaction and the criteria for hypoxemia established as PaO2 / FiO2 ≤ 300 mm Hg, or oxygen saturation < 90% on room air (U.S. Centers for Disease Control and Prevention, 2011). The addition of TAD as a transfusion reaction addressed the importance of adverse respiratory consequences that can occur with blood transfusions. This innovation should be incorporated into education programs for nurses to diffuse the new knowledge into the sphere of nursing. The Hemovigilance Module is a comprehensive program that reflects a robust focus to improve patient safety related to blood transfusions in the U.S. Although nurses do not directly interact with the data reporting system, the data is rich and has the potential for informing nurses of new trends in transfusion therapy and specifically of symptoms of transfusion reactions.

In addition to the U.S. government agencies that establish definitions and criteria for transfusion-related adverse events, the CDC's Hemovigilance Module and the FDA, other authoritative groups address transfusion-related adverse reactions within their practice guidelines. The AABB *Circular of Information* (AABB, 2009) and the American

Red Cross *Practice Guidelines for Blood Transfusion* (Cable et al., 2007) are each research based guidelines yet the categories of adverse reactions have some degree of variability. Since 1996 the hemovigilance program Serious Hazards of Transfusion (SHOT) analyzed adverse transfusion events and annually reported on hemovigilance for the U.K. (Knowles & Cohen, 2011). Inclusion of the SHOT information is important for this review and for U.S. transfusionists because SHOT is recognized as the world vanguard in hemovigilance and because the trends identified in the SHOT report parallel findings in the U.S. Additionally as a resource of information, there are no access restrictions to the annual SHOT reports. Information available to nurses on transfusion-related adverse reactions and their symptoms varies from source to source (see Appendix D). The innovative category of TAD and definition of hypoxemia have not been incorporated into the nursing literature related to blood transfusions.

Underreporting Adverse Transfusion Events

In the U.S. reporting adverse reactions attributed to blood product transfusions is voluntary with significant underreporting and biased reporting assumed (Shander & Popovsky, 2005; Silliman et al., 2003). The reported fatalities directly attributed to blood transfusions are extremely rare (Shander & Popovsky, 2005). The true incidence of transfusion-related adverse reactions including deaths is unknown (Vamvakas & Blajchman, 2009). The report *Biovigilance: Efforts to Bridge a Critical Gap in Patient Safety and Donor Health*, drew attention to the critical gap of underreporting of adverse transfusion events, a gap that hinges on the nurse's clinical recognition of a potential transfusion reaction (Public Health Service (PHS) Biovigilance Working Group (BWG),

(2009). The core of the problem is at the point-of-care with failure of the nurse to recognize the adverse signs and symptoms as a possible transfusion reaction, and failure of the nurses and physicians to report the event to the transfusion service. One research study and three quality reports support the widely held perspective that transfusion-related adverse events are under recognized and underreported.

Hodgkinson, Fitzgerald, Borbasi, and Walsh. (1999) evaluated 704 transfusion episodes within 24 hours of transfusion in a large metropolitain hospital in South Australia. Data was obtained from the medical record, patient notes, and patient interviews; 13 transfusion reactions were identified by the nurses but only 23% (3/13) were reported to the transfusion service.

Rowe and Doughty (2000) conducted a retrospective review of 100 transfusion episodes in a National Health Service Trust hospital in England. The clinical audit committee and the Trust research and development department approved and supported the audit. The aim was to identify strengths and weaknesses of the current bedside transfusion practices. The clinical audit tool was jointly developed by the practice development team and the haematology department. The 100 transfusions episodes were selected by purposive nonprobability sampling to represent medicine, surgery and specialized care units. Of the 17 transfusion reactions identified; only 47% (n = 8) were recognized by the nurse with merely 29% (n = 5) reported to the physician.

In the quality study of 58 minor transfusion reactions in a cancer hospital in Texas by Narvios et al. (2004) the nurse only reported 50% (n = 29) of the adverse symptoms to the physician. The transfusion was stopped in 22.4% (n = 13) but the physician did not

report these reactions to the transfusion service. This quality evaluation demonstrated that both nurses and physicians contribute to the underreporting of adverse transfusion events. Thomas and Hannon's (2010) quality audit of transfusion episodes (n = 3024) in the U.S. identified 88 adverse transfusion events, 53% (n = 47) were reported to the physician with only 18% (n = 16) reported to the transfusion service.

The underrecognition and underreporting of adverse transfusion events at the patient care level makes it impossible to know the prevalence and therefore the true risk of adverse events with blood transfusions in the U.S. Reporting possible transfusions is a shared responsibility of the physicians and the nurses. Reporting can only occur if the nurse first cognitively connects the patient's symptoms to a potential transfusion reaction.

Technology and Safety Innovations

Innovative technologies are available to address the unsafe blood transfusion practices but proper use of the technology is critical to achieve the desired improvement in safe blood transfusions. Technologies that improve one or more aspects of the transfusion process that involve nurses providing patient care are reviewed.

Blood Unit Storage and Delivery

Bedside coolers have been used for many years to provide multiple units of blood for a patient in the emergency department, critical care, labor and delivery, and operating room. The challenge is maintaining the cooler within the safe temperature range for longer than 4 to 6 hours. One innovative technology is the Thermal Wizard Red Shield cooler that maintains the temperature between 1 to 6 degrees Celsius for up to 24 hours. The cooler is designated as a single patient use device. The second innovative technology

is the automated courier robot called TUG that delivers specimens to the lab and brings units of blood to the clinical area. Safety mechanisms require an electronic code to access the TUG. Just pressing the "go" button automatically sends the TUG back to the blood bank (Lum & D'Amarino, 2009).

A satellite medical refrigerator or "blood fridge" is an accepted practice in some clinical areas in the U.K. and Canada (Burgess, 2006; Hyson, 2009). Potential safety risks with the blood fridge are that it may contain multiple units of blood for different patients. The necessity to obtain blood when the blood bank is closed, when a laboratory technologist is not available to check the blood prior to issue, or when the transfusion is to occur in a remote clinical area are real-world clinical challenges. A technological innovation is the blood vending machine. BloodTrack HemoSafe is a dispensing blood refrigerator system with a capacity of 150 units, each stored in their own compartment. The blood dispensed for each patient is either autologous or previously matched by type and screen, computer compatible via electronic ABO/Rh match, or universally compatible O-negative (Neoteric, 2010). Pagliaro and Turdo (2008) reported on their experience with merging technologies of the HemoSafe automated refrigerator located in an outpatient clinic with a computer crossmatch. During a period of four months, 43 patients were transfused with a total of 235 RBC units and no transfusion errors occurred. The diffusion of this innovation in U.S. hospitals is unknown.

Facilitating quick delivery of blood to the clinical area is a priority since refrigerated components must be initiated within thirty minutes of leaving refrigeration. Despite this universal principle, the 2009 annual report from the Serious Hazards of Transfusion

(SHOT) voluntary hemovigilance program in the U.K. documented 31 cases of expired blood being transfused (Taylor et al., 2010). Similarly, Novis et al. (2003) documented potential problems with timely administration of blood products in their observational audit of 4,046 transfusions primarily in U.S. hospitals. Instead of direct pickup and delivery of the blood to the clinical area, interim stops were made by the courier in 4.1% of the blood deliveries. Additionally, in only 38.3% of the cases the blood was delivered directly to the transfusionist. Mechanisms to expedite transport of the blood to the patient are warranted. Tanley, Wallas, Abram, and Richardson (1987) evaluated the effect of transportation via a pneumatic tube on the blood specimens and blood products. Blood sent through the pneumatic tube was compared to a its own control stored in the laboratory; no important differences were identified for whole blood, packed red blood cells, plasma, and platelets. The authors concluded that pneumatic tubes were an expeditious means of delivering blood products to the clinical area. Novis et al. (2003) found mechanical/pneumatic transport systems were used in only 2.3% (n = 12) of 519 surveyed hospitals in 1994; the percentage increased to 10.7% (n = 25) of 233 hospitals in 2000. Massachusetts General Hospital (2005) routinely transports all types of blood components through the pneumatic tube. The AABB (2004) published *Guidelines for Pneumatic Tube Delivery Systems: Validation and Use to Transport Blood* to ensure blood product safety. The degree of diffusion of this technology into hospital practices has not been evaluated in the last ten years.

Patient Identification Systems

Patient identification is integral to the first and last of Dzik's (2007) three zones of error, specimen collection and bedside pretransfusion verification. Non-electronic and electronic technologies augment safety by using unique identification wristbands or number/data systems to match the blood product to the patient. Non-electronic technology includes the use of a special wristbands specific for blood collection and transfusion. The blood band has unique numbers that must match with numbers on the blood bag and/or tag (e.g. Bio-logics Blood ID Band, Conf-ID-ent™ blood bands, Ident-A™ blood band, and Securline® blood bands). Barrier systems are also non-electronic yet they provide higher level of safety in that the blood is locked inside a clear plastic bag that can only be unlocked by using a code taken from the patient's wristband (e.g. BloodLoc and Typenex™ FinalCheck) (Brooks, 2005; Dzik, 2005; Dzik et al., 2003).

Electronic systems include barcode scanning and radio frequency identification (RFID). Both establish positive patient identification (PPID) by the wristband's unique barcode or RFID data tag. With barcode blood band systems, the wristband and the blood bag are scanned for a match, e.g. I-Track Plus, Securline® BarCode blood band, and Typenex™ Barcode blood band. The barcode wrist band may be a separate blood band or the patient's primary barcode identification wristband, e.g. Pyxis CareFusion Transfusion Verification (CareFusion, 2013). Radio frequency identification (RFID) wristbands have embedded data tags that are read by radio receivers without requiring line-of-sight scanning, e.g. Smart Band® RFID (Brooks, 2005; Dzik, 2005; Dzik et al., 2003).

Dzik's (2007) first zone of error is specimen collection. If the incorrect patient label is affixed to a tube of blood for the blood bank, a wrong-blood-in-tube error occurs. "Errors in blood sample collection are especially dangerous as they can initiate a process which is wrong from the first step" (Dzik, 2007, p. 183). Linden et al. (2000) identified that in New York State during a span of ten years, 13% of the mistransfusions, wrong blood transfused, were due to phlebotomy error. The creation of specimen labels at the bedside via hand held printers improves patient safety; a caveat is that no duplicate wristband labels are available.

Koppel, Wetterneck, Telles, and Karsh (2008) conducted a mixed methods study of barcode medication (BCMA) administration systems in a Midwestern academic tertiary hospital and in four hospital health care system on the East Coast from 2003 to 2006. Data sources included 62 structured observations and 31 nurses who were shadowed from multiple types of clinical units on day and night shifts; structured and semistructured interviews with three groups of nurses and nurse leaders; and author participation in hospital staff meetings on medication administration; a failure mode effects analysis (FMEA) of medication use and BCMA; and the BCMA override log. Iiterative and multiple methods of data analysis were used to define fifteen workaround types and place them into three broad categorized of omission of process steps, steps performed out of sequence, and unauthorized BCMA process steps. This study is has important implications for transfusion safety in that it documented workarounds where duplicate patient ID barcode labels were located in a variety of places, such as the chart, bedside table, or doorjamb, and effectively circumvented safety while the nurses had the

misperception of improved efficiency. Workarounds can lead to wrong blood in tube collection errors and wrong blood administered mistransfusion errors.

Using wireless handheld devices to scan the patient's wristband barcode identification label is fundamental to many technological advances that promote transfusion safety. Positive patient identification (PPID) is established by the unique barcode on the patient's wristband. Scanning barcode wristbands and the blood unit for a match is the most common form of electronic pretransfusion verification. A. W. Bracey (personal communication February 16, 2012) stated that caution must be exercised to understand the capabilities of a barcode scanning system and its ability to truly match the patient to an individual blood product unit. Scanning the unit of blood and the patient's armband with some electronic documentation systems only documents the blood product unit in the patient's electronic medical record but does not insure a match of the individual blood product to the patient. The efficacy of electronic scanning systems that positively match the blood product unit to the patient to prevent mistransfusions of incompatible blood is consistently confirmed by quality audits from hospitals around the world.

Turner, Casbard, and Murphy (2003) compared the standard manual process to barcode technology for compatibility specimen collection (n = 30 in each group), and for transfusion verification with clinical observations (n = 51 in each group). Audits of compliance with the U.K. hospital's transfusion policies and procedures were obtained at baseline and at 1-month following education and training on the barcode system.

Significant improvements in safe practices ($p \leq 0.0001$) were observed in specimen collection and in administration of blood with the barcode processes.

Zero mistransfusions, transfusion of the wrong blood, occurred in thousands of transfusions when electronic barcode pretransfusion verification was used, 26,000 transfusions in China (Chan et al., 2004), 42,068 transfusions in Japan (Ohsaka, Kobayashi, & Abe, 2008), and 132,132 transfusions in Texas (Aulbach et al., 2010). Pagliaro, Turdo, and Capuzzo (2009) reported on five years of I-TRAC Plus barcode PPID for blood transfusions in Italy. The system prevented 12 cases of misidentification of which 10 cases were wrong blood in tube and two were outpatients with the wrong wristbands; no mistransfusions occurred. Barcode systems for transfusion verification were reported from other hospitals, all with significant improvements in transfusion safety and no mistransfusions of wrong blood (Askeland et al., 2008; Askeland, McGrane, Reifert, & Kemp, 2009; Davies, Staves, Kay et al., 2006; Kemp, 2009; Miyata et al., 2004). Considering that for years all blood products have been barcode labeled using an international standard and that barcode-based transfusion systems are reported to be 15-20 times safer than manual systems (Askeland et al., 2009), wireless PPID barcode transfusion verification has been slow to diffuse into practice settings (Pagliaro, Turdo, & Capuzzo, 2009).

Anders et al. (2011) evaluated two commercial barcode scan PPID systems for blood transfusion and determined that both systems were immature from the usability perspective with a lack of fit to the natural workflow with blood transfusions. Their rejection of this technology is in keeping with Roger's diffusion of innovations theory

which states that the process of diffusion of an innovation includes a decision step; a new technology is tried and then adopted or rejected based on local fit within an institution. Although barcode ID is the most widely used system for PPID in healthcare (Murphy & Kay, 2004) comprehensive transfusion barcode systems as yet have limited diffusion into the blood transfusion practice settings.

Radio frequency identification (RFID) is another technology with promise for transfusion verification. The RFID system communicates between a PPID encoded wristband and a radio receiver. In theory, line of sight is not necessary but that is dependent on the strength of the radio wave. RFID would have particular application in the operating rooms since line-of-light scanning is not required. At present the technology is more expensive than barcode systems and is primarily used for supply inventory management. Aguilar, van der Putten, and Maguire (2006) identified various methods PPID used in hospitals and provided a good description of RFID technology. Several innovative hospitals in the U.S. and Europe have employed RFID for blood transfusions (Dzik, S., 2007), most use a handheld RFID reader and one used proximity tags that read the blood RFID tag and patient RFID tag via antennae attached to the bedside computer. As RFID technology matures and becomes less expensive it is likely to be applied to transfusion medicine and therefore will be incorporated into the transfusion practices of nurses.

IV Pumps, Pulse Oximetry and Blood Filters

The final technologies presented in this review of the literature are not high-tech advances, but devices used on a daily basis by nurses who practice in hospitals and

outpatient clinics, intravenous (IV) volume pumps, pulse oximetry, and blood filters. The use of IV pumps for blood transfusion is not a requirement of the practice guidelines or regulatory agencies, but it is a common technology used by nurses in multiple settings. Pump manufacturers have confirmed that there is no damage to the cellular blood components when administered through a pump. The quality improvement project of Houck and Whiteford (2007) was conducted in an inpatient oncology unit and outpatient infusion unit of a large community hospital in the Mid-Atlantic region of the U.S. The transfusion practice was to use gravity flow through a peripheral intravenous catheter for all transfusions. The focus was to evaluate the infusion of blood through an existing peripherally inserted central catheter (PICC) and thereby avoid additional venipunctures and to evaluate the use of an infusion pump to avoid clotting in the PICC. Data on nurses' preferences, time to transfuse, and PICC patency were obtained. The sample was 169 transfusions of which 33 were infused via a PICC. This project validated that use of IV pumps allows efficient, non-complicated transfusion through a peripherally inserted central catheter (PICC). The nurses preferred the controlled infusion through a pump; transfusions were completed within the desired time and pump alarms of flow obstruction prompted immediate nurse intervention which minimized infusion delays. Additionally the use of the existing PICC was cost saving in nursing time and equipment.

The second common technology is measuring oxygen saturation via pulse oximetry. Pulse oximetry monitoring began in operating suites, spread to the recovery rooms and intensive care areas, and is now diffusing into the acute care setting. Oxygen saturation is not a required vital sign for blood transfusion, however as of 1999 a required symptom

for a TRALI diagnosis is the presence of hypoxia defined by as an oxygen saturation < 90% (Division of Healthcare Quality Promotion, 2010). These two technologies of pulse oximetry and use of IV pumps facilitate nursing assessment and patient care during blood transfusions. The use of enhanced technology to advance transfusion safety is gaining ground however the successful adoption of a technology that is applied at the bedside is highly dependent on the nurse who is at the point-of-care. Technologies that facilitate the work of nurses at the bedside and eliminate the opportunity for distractions and interruptions to create opportunities for error will enhance patient safety. Technology however cannot replace the important cognitive role of the nurse in transfusion safety.

The third common technology is filtered blood administration sets. All blood products are infused via filtered administration sets to remove clots and debris. The traditional duration of use of a filtered blood set is 4-hours yet evidence to support this time frame does not exist. Confounding the issue for U.S. nurses is that the AABB states to refer to the manufacturer's package insert for instructions for use of administration sets (AABB, 2009), yet the manufacturer's package inserts state to follow the AABB guidelines for duration of use of the filtered blood set. The 2002 CDC guidelines were equally vague (Centers for Disease Control and Prevention, 2002). A 12-hour duration is common in many countries (World Health Organization, n.d.; Australian and New Zealand Society of Blood Transfusion LTD, & Royal College of Nursing Australia, 2011). In 2011, the CDC revised their guidelines and recommended to "replace tubing used to administer blood, blood products, or fat emulsions . . . within 24 hours of initiating the infusion" (U.S. Department of Health and Human Services, CDC, 2011).

Changing nursing practice to align with the evidence or lack of evidence is critical to advancing the profession of nursing. Although the 4-hour duration of use for blood tubing is hard-wired into many nurses, it is not supported by evidence. Nurses' time is critical and the extending the duration of use of a filtered blood administration set is warranted.

Conclusion

The nurse is fundamentally involved with blood transfusions and therefore is integrally connected to transfusion safety. The role of the nurse with blood transfusions evolved from a technical assistant to the point-of-care assessor of the patient and administrator of the transfusion. The research on nurses' practices with blood transfusion from across the world is primarily descriptive with frequent use of interviews or surveys as sources of data. Contributions from studies conducted in the U.S. are minimal. Except for the recent qualitative studies that provided rich insights into blood transfusions from the perspective of the nurse transfusionist (Heddle et al., 2012) and patient (Adams & Tolich, 2011), no other research was identified that aimed to describe or understand the transfusion education, practices, and technology used by U.S. nurses. Quality audits with concurrent observations of nurses during blood transfusions supplement descriptions of nurses' transfusion practices.

The literature reviewed affirmed that nurses are highly accountable for patient safety with blood transfusions but the established safe practices are often less than desirable in the complex clinical environment. The potential for errors associated with blood transfusions was a recurrent theme, particularly with pretransfusion verification and with ongoing patient observations and vital signs; distractions, interruptions, and

workarounds were cited as having a negative impact on patient safety. Collaborative interdepartmental communications between the nursing and the transfusion services was identified as very important to the blood transfusion process and patient safety. Patients were recognized as passive receivers of blood transfusion therapy with no involvement in the decision to transfuse and insufficient information relayed to them verbally or through printed materials regarding the blood transfusion. The research on nursing and blood transfusions consistently identified the need to strengthen nurse education regarding blood transfusions. Hemovigilance monitoring and reporting is area of extreme importance in the U.S. Nurses are repeatedly cited as a source for the underrecognition and underreporting of adverse transfusion events in the medical literature, yet this topic is underrepresented in the nursing literature.

Innovations in transfusion therapy are published almost exclusively in medical and pathology journals not accessible to nurses. The primary technological innovation for bedside transfusion safety is barcode PPID transfusion verification which eliminates mistransfusions and when used for specimen collection can eliminate wrong blood in tube errors. Other technologies such as RFID are on the horizon. Despite these advances the diffusion and adoption of innovations in health care occurs at a slow pace (Balas & Boren, 2000; Berwick, 2003).

Gaps in the literature exist related to all forms of nursing research on blood transfusions, particularly on research of transfusion practices of nurses in the U.S. Identifying the proportion of transfusion innovations adopted into nursing practice is

important in describing the state of the science of U.S. nurses' blood transfusion practices.

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

To describe the state of the science of medical-surgical acute care nurses' practices with blood transfusion therapy, this study used a non-experimental cross-sectional exploratory design. A random selection of U.S. hospitals with a nurse executive or leader who is a member of the American Organization of Nurse Executives (AONE) was contacted by postal letter to participate in the study. The data was collected with a validated instrument, Nurses Practices with Blood Transfusion, Medical-Surgical Acute Care, a web-based survey developed by the author and administered via PsychData. Descriptive statistics were used to analyze the data.

Setting

Data collection occurred in the naturalistic work setting of the medical-surgical hospital. Collected data pertained to practices of nurses in medical-surgical patient care units and not to practices of nurses in the intensive care units, operating rooms, emergency departments, dialysis, or labor and delivery, etc. The respondent selected a convenient location within the hospital that had internet access to enter the data in the web-based survey.

Population and Sample

The population was acute care medical-surgical hospitals in the U.S., approximately 6000, that care for an adult patient population and have a nurse executive, chief nursing officer (CNO), or leader as a member of the American Organization of Nurse Executives (AONE).

Inclusion and Exclusion Criteria

The population included urban and rural hospitals of less than 100 to more than 500 inpatient beds; investor-owned, non-government community, and state or local government community; teaching and non-teaching facilities; and hospitals with and without Magnet Recognition for Nursing. Critical access hospitals which are limited to 25 or less inpatient or swing beds for skilled nursing care (U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services, 2012) were excluded as they represent a unique category of hospitals that may not be congruent with medical-surgical hospitals. Transfusions in pediatric and neonatal populations have unique practices related to the small aliquots of blood administered and therefore these institutions were excluded. Psychiatric, chemical dependency, long-term acute care, rehabilitation hospitals, outpatient dialysis centers, military, and federal government hospitals were also excluded.

Sample Size

The sample size was designed to yield results with a confidence level of 95% and a margin of error of plus or minus 5% with the actual size determined after sampling criteria were applied, see the Sampling section below. There were 2082 hospitals that met

criteria. To have a CI 95% ±5% a sample of 322 is required for a population of 2000 (Dillman, 2000). Survey research requires an increase in the recruitment number to adjust for response rates. The mean response rate from a convenience sample of five nationwide nurse surveys was 61.3% with individual reported response rates of 21%, 66%, 69.4%, 70%, and 80.3% respectively (Sarna, Bialous, Wells, Kotlerman, Wewers, & Forelicher, 2009; Magid, Sullivan, Cleary, Rao, Gordon, & Kaushal, et al., 2009; Kovner, Brewer, Yingrengreung, & Fairchild, 2010; White, 1990; Roche, Diers, Kuffield, & Catling-Paull, 2010). White (1990) contacted chief nurses in midsize hospitals in the U.S. and had a response rate of 70%. A moderate response rate of 40-45% was anticipated for this research and therefore a random sample of 800 hospitals comprised the sample.

The method for determining a minimum sample size was changed as a result of only a 12% response rate at two months following the mailing of 807 recruitment letters and reminder postcards. See the Data Collection section for a complete description of recruitment measures employed. A revised sample size was determined using G*Power (v3.1) to calculate a χ^2 sample size, the minimum sample size needed for analysis was 143 based on a moderate effect size of 0.3, alpha of 0.05, and a minimum power of 0.80 (Faul, Erdfelder, Lang, & Buchner, 2007). Following four months of data collection, 148 valid responses were entered into PsychData yielding a response rate of 18.3%.

Sampling

Purposive and simple random sampling was used to select a representative sample of medical-surgical hospitals. Purposive sampling using the AONE membership list to identify acute care hospitals was anticipated to facilitate survey completion since AONE

members are likely to advance nursing research. The AONE membership list, provided as an Excel document, consisted of 8,509 nurse leaders in the U.S. When exclusion criteria and duplicate entries for a hospital were removed the list was reduced to 2,082 eligible CNOs or other nurse leaders, one leader per hospital, from which the sample was randomly drawn.

Removal of duplicate entries from one hospital was an unexpected challenge. Most hospitals had multiple nurse leaders as AONE members; the largest number was 160 from one hospital. A simple sorting by name and deleting all but one entry was not possible because the hospital names were not the same. The AONE list was generated from the applications of individual nurse leaders. Variations occurred in the name, spelling, or punctuation of the hospital, e.g. St (no punctuation) vs. St. vs. Saint, etc. Additionally many hospitals were entities of larger health systems and the hospital name in the AONE list included the health system name at the beginning, end, or not at all, e.g. Bon Secours St. Francis Medical Center, St. Francis Bon Secours, vs. St. Francis Medical Center. Some AONE members listed their hospital by their abbreviation or prefaced the name with “The”. Some hospitals had the same name but were located in different cities or different states. An additional confounding condition was that some AONE members listed the hospital address and others their personal home address; on occasion the CNO lived in a different city or state than the hospital.

The AONE list was sorted by name, city and state to remove obvious duplications. The names and addresses were clarified from the hospital’s website and phone calls; the hospital names were retyped for congruency. When clearly identifiable, the entry with the

CNO or nurse leader was retained as the single entry for that hospital; when the CNO was not clearly identified, a phone call was made to the hospital to clarify the current CNO. Removing duplicate hospitals, hospitals that met the exclusion criteria, as well as AONE members who did not work in hospitals, e.g. consultants and university professors reduced the original AONE list from 8,509 entries to 2,082 hospitals.

The population worksheet of 2,082 medical-surgical hospitals was used for randomization. Random numbers were assigned with Excel; the randomization column was copied in the worksheet, saved as a fixed value, and then sorted from smallest to largest. The top 800 hospitals were initially selected as the sample. An additional 65 hospitals were incorporated into the sample when a previously selected hospital was eliminated based on inclusion or exclusion criteria. The CNO was identified and if that role was not designated on the AONE list, the hospital was contacted by phone to identify the CNO. A considerable number of hospitals had different CNOs than the name on the AONE list. Approximately 70 to 75% of the hospitals were contacted by phone to validate the name, address and CNO, nurse executive, or nurse leader of the hospital. A recruitment letter was sent to the identified nurse leader of 807 randomly selected facilities.

Protection of Human Subjects

Permission to conduct this study was obtained from the Texas Woman's University Institutional Review Board Houston Center (see Appendix E). The survey, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care,* was hosted by PsychData in a secure survey environment (SSE) that protected against a third party

viewing the data, prevented a participant from retrieving data from their personal computer, did not use cached versions of the survey, and encouraged the participants to close the browser upon completion of the survey. During transmission, the questions and responses were encrypted using 256-bit secure socket layer (SSL) technology which is equivalent to that used for transmission of credit card information. The survey data was held in an isolated database on a PsychData server that may only be accessed by the research team. Confidentiality and anonymity were protected by not requesting any personal identifying information in the survey *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care* and by not collecting linking ID, respondent ID, and IP address at the time of survey data download.

Upon completion of the N*urses' Practices with Blood Transfusions: Medical-Surgical Acute Care* survey, the participant had the option of advancing to a separate PsychData survey to enter name, address, and hospital size to be used to select lottery recipients for one of four $200 education grants, one awarded in each hospital size category. The survey N*urses' Practices with Blood Transfusions: Medical-Surgical Acute Care* could not be connected to the second set of data obtained to award the education grants.

Two hospitals required separate submissions to their IRB committees prior to participating in this research project. Several hospitals requested a copy of the IRB approval letter from TWU while most accepted the statement of IRB approval included in the recruitment letter.

Instrument

The instrument, *Nurses Practices with Blood Transfusion, Medical-Surgical Acute Care*, is a web-based survey developed by the author and administered via PsychData. PsychData is a robust platform for online surveys within a secure survey environment (SSE) (PsychData™, LLC, 2006). Instrument development occurred in two phases, Phase I in 2010 and Phase II in 2011. The final survey of 72 questions, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care* is organized into the following sections: hospital demographics, transfusion orders and policy, technology and safety measures, bedside transfusion practices in medical-surgical (non-ICU) areas, nurses and nursing staff preparation, patient and family instructions, and nursing and the transfusion service (blood bank). *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care* is a robust and comprehensive representation of nurses' practices with blood transfusions with a scale content validity index (S-CVI) of 0.963. Cohen's kappa of 0.797 and raw agreement of 0.855 establish that the instrument is a very stable and reliable tool.

Validity

Content validity was evaluated twice during the instrument development by a convenience sample of experts. Fourteen blood transfusion experts from across the U.S. comprised the first panel of judges. The panel of experts was robust with a wide diversity in clinical focus, roles, and geographic representation that provided nationwide perspective regarding validating content for nurses' practices and blood transfusions. Seven of the first panel of experts comprised the second content validation panel. This panel retained the diversity in clinical focus and roles however all seven experts worked

in large Texas hospitals with inpatient beds of 500 or more. The panel of experts evaluated the instrument and assigned a relevancy score to each question using a 4-point ordinal rating scale (Lynn, 1986). The 72 question instrument had I-CVI scores of 0.8 to 1 and retained an S-CVI/Ave of 0.962 which confirmed the instrument, *Nurses' Practices with Blood Transfusion: Medical-Surgical Acute Care*, as a robust representation of nurses' involvement and practices with blood transfusions.

Reliability

Stability reliability of the instrument was established via intrarater test-retest. Fourteen nurse experts completed the web-based survey for test-retest evaluation; two of the experts were also content validators. Six experts also completed a second round of test-retest which included selected revised or new questions. The sample of experts was robust in representation of the diversity of hospitals, including geographic locale and hospital characteristics, and therefore was an excellent sample to pilot the web-based survey on nursing transfusion practices in acute medical-surgical hospitals throughout the U.S.

Formulas in Excel were created for Cohen's non-weighted kappa and for raw agreement, a proportion of agreement. "Cohen's kappa, which in the case of intrarater reliability, is an estimate of the agreement between the scores assigned by the rater at two different times" (Fawcett & Garity, 2009, p.174). The formula for Cohen's non-weighted kappa was used since the responses were dichotomous and nominal. Many survey questions had the option of multiple responses to a question, and therefore kappa was calculated for each potential response. Cohen's kappa will not calculate when responses

are homogenous, e.g. all responses to a question were exactly the same; or when one response must be selected from an option of three or more, e.g. yes, no, unsure; or red, white, blue. As a result, "kappa may be low even though there are high levels of agreement and even though individual ratings are accurate" (Uebersax, 2009). Raw agreement is a simple proportion of the same response in the test and retest and incorporated responses with 100% agreement among all 14 survey pairs into the calculation of reliability for the survey. The reliability for the 72 question survey, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care* is described in Table 1.

Table 1

Stability Reliability with Test-Retest for Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care

Test-retest reliability for instrument	Count	Range	Mean	Median	Mode
Cohen's Kappa	195	0.25 to 1	0.793	0.810	1
Raw Agreement	251	0.5 to 1	0.846	0.857	0.7857

Different authors vary in the evaluation criteria for reliability coefficients; Fawcett and Garity (2009) state that a score of 0.7 or greater has acceptable reliability, and Landis and Koch (1977) are widely referenced for their scale that 0.61 to 0.8 is substantial reliability and 0.81 to 1 has almost perfect reliability. The Cohen's unweighted kappa of 0.793 and a raw agreement of 0.846 confirm that the survey *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care* is a reliable instrument.

Data Collection

Recruitment Procedures

A recruitment postal letter requesting participation in the study was sent to the Chief Nursing Officer (CNO) of the 807 randomly selected hospitals. The letter included the incentive of an opportunity for a $200 educational grant, the recommendation that a nurse who is knowledgeable about hospital routines, policies, and staff education related to blood transfusions in medical-surgical patient care units complete the survey, and instructions for accessing a copy of the survey to facilitate data gathering at http://myweb.twu.edu/~raulbach/BloodSurvey2012.pdf. The letter included the anticipated time required to gather the information and enter the data in the web-based survey at 45 to 90 minutes.

The response rate was slow with only 36 completed surveys after the first month, 99 after the second month, 135 after the third month, and 148 after the fourth month. Additional recruitment methods were used to enhance the response rate. Three weeks following the postal recruitment letter, a reminder postcard was mailed to the CNO of the selected sample hospitals. Between two and three months after the initial recruitment letter reminder emails were sent to approximately 100 CNOs or their executive assistant. The email included attachments of the TWU IRB approval letter and a copy of the survey, *Nurses Practices' with Blood Transfusions: Medical-Surgical Acute Care* to facilitate gathering information. The email also included a hyperlink directly to the survey in PsychData. Email addresses were obtained from phone calls to the CNOs office at the hospitals.

Data Collection

The CNO designated a hospital representative, presumably a nurse, to gather the requested information and complete the survey, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care*. Once the information was acquired, the representative entered their hospital's responses in the web-based survey located within the PsychData secure website. Although instructions to obtain a print copy of the survey via the TWU MyWeb home page were included in the recruitment letter, this required the respondent type the URL into the web browser address bar. If the researcher was contacted by a potential respondent, the email address was obtained and a copy of the survey was attached in a follow-up email to the hospital's representative.

Education Grant

As described in the section on protection of human subjects, upon completion of response entry in the web-based survey, the hospital representative had the option to voluntarily enter contact information for inclusion in a drawing for a $200 education grant in a separate PsychData survey, *Education Grant Lottery - Nurses' Practices with Blood Transfusion.* Of the 148 hospitals that completed the survey, 122 participants entered the education grant lottery. One grant was awarded for each of the four hospital size categories to participants from Connecticut, Illinois, Texas, and Wyoming.

Pilot Study

A pilot study was conducted prior to the large study. Eighteen nurses from 11 states across the nation completed the web-based survey *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care.* A worksheet copy of the survey was

provided as an email attachment to gather the required information and then answer the web-based survey questions in PsychData. Seventeen nurses participated in a post-survey semi-structured telephone interview with the researcher to obtain information on the feasibility, efficiency, comprehensiveness, and speediness of the survey (Fawcett & Garity, 2009; Polit & Beck, 2012).

The instructions for survey completion and access to the survey in PsychData were clear and the process was simple. Entry of data went smoothly in one session given that each participant had a printed copy of the survey. A postal letter was recommended as the optimal initial point of contact with the CNO, nurse researcher, or director of nursing education. The opportunity for a financial incentive was identified as a nice way to acknowledge the time commitment of the responder, but was not felt to be essential to participation. A particularly positive finding was the time required to gather and enter information in the online survey, anticipated at 90 minutes, was less than 45 minutes.

An executive assistant to a CNO reviewed the proposed recruitment letter and suggested revisions that might enhance a CNO's attention to the letter. The assistant also reviewed the telephone script intended to reach the CNO's assistant to clarify the name, title and email of the CNO.

The pilot supported that the study methods and procedures were feasible to implement. Access to a worksheet copy of the instrument to use as the respondent gathered data was identified as essential to successful completion of the survey. This prompted the researcher to identify a way to access a web site from which a copy of the survey could be printed. Fortunately the TWU MyWeb home page provided an easy

solution since access did not require a university logon. A direct link to a pdf copy of the survey *Nurses Practices' with Blood Transfusions: Medical-Surgical Acute Care* could be directly obtained from http://myweb.twu.edu/~raulbach/BloodSurvey2012.pdf. The recruitment letter included the following,

NOTE: the "tilde" symbol (~) must be correctly placed without spaces, to facilitate correct URL entry.

Treatment of Data

This cross-sectional, exploratory study employed univariate and comparative analysis to describe the blood transfusion practices of nurses in medical-surgical acute care hospitals in the U.S. Descriptive statistics identified the characteristics of the population. For research questions one through five, the data was analyzed as follows. The majority of the items in the survey were measured on the nominal scale and therefore frequencies, and percentages (proportion) were used to describe the data; margins of error were calculated. The ordinal data was described as above. Interval/ratio data was described with frequencies, percentages (proportion), and means with standard deviations; confidence intervals were calculated. For research questions six and seven, comparative descriptions using Chi Square (χ^2) test of independence was obtained to identify differences in reported blood transfusion practices based on hospital size or Magnet recognition.

CHAPTER IV

ANALYSIS OF DATA

The study Nurses' Practices with Blood Transfusions in Medical-Surgical Patient Care Units of Acute Care U.S. Hospitals is a descriptive study of multiple aspects of nurses' involvement with blood transfusions. Following a description of the sample, the chapter's content is organized according to the seven research questions. Within each research question section, survey question results are grouped with related content. The results are described with text and tables. The text highlights the key findings while the tables provide comprehensive results. The number of the responses for each question is presented in the tables since not every question was answered by every participant. The tables report margins of error for nominal and ordinal data, and confidence intervals for interval-ratio data based on a 95% confidence level. The comparative analysis of hospital size and Magnet recognition to each survey question is provided in Tables 40 to 49 and 50 to 59 respectively, (see Appendixes G and H).

Description of the Sample

The sample consisted of responses from 148 acute medical-surgical hospitals located in communities of varying size from 41 states in the U.S. (see Appendix I for a distribution of states with participating hospitals). Hospitals located in the Midwest and Southern states comprised 62.4% of the sample. Rural towns and large urban cities were represented with most hospitals located in communities of 15,000 to 99,999 (n = 50,

33.8%) and 100,000 to 500,000 (*n* = 43, 29.1%). Large and small hospitals were included in the sample with hospitals of 100-249 and 250-499 inpatient beds each having equal representation in the sample (*n* = 46, 31.1%). The majority of the hospitals were identified as non-teaching, not providing training for medical students or resident physicians (*n* = 82, 55.4%). Most were non-government community hospitals (*n* = 103, 69.6%) and did not have ANCC Magnet Recognition (*n* = 102, 68.9%). See Table 2 for demographic characteristics of the hospitals in the sample.

Table 2

Demographic Characteristics of the Hospitals by Number of Inpatient Beds

Demographic characteristic	Inpatient beds				Total *f*	Percentage
	25-99	100-249	250-499	500 or more		
Population						
<15,000	18	4	2	0	24	16.2%
15,000-99,999	7	30	8	4	49	33.8%
100,000-500,000	3	8	23	9	43	29.1%
>500,000	1	3	13	13	30	20.3%
Hospital type						
Non-government community	19	32	34	17	103	69.6%
Investor-owned	3	11	6	1	21	14.2%
State or local government	7	2	4	5	18	12.2%
Teaching	8	9	24	21	62	41.9%
Magnet	3	10	17	16	46	31.1%

Findings

Blood Transfusion Practices

The first research question asked what the reported blood transfusion practices of nurses in medical-surgical patient care units in U.S. hospitals were. Blood transfusion practices included obtaining signatures for informed consents, transfusion orders, blood specimen collection, acquisition of the blood unit, transfusion verification, transfusion vital signs, notification of transfusion reactions, and transport of a patient with blood infusing to diagnostic tests and procedures.

A majority of the hospitals reported that all of the time or most of the time nurses obtained the patient's signature for informed consent for blood transfusion (n = 83, 59.7%) and (n = 23, 16.5%) respectively, (Table 3). Most hospitals (55.8%) reported that nurses completed the clinical indication on the transfusion order all of the time, most of the time, or occasionally because the physician did not specify the indication, however sixty-four hospitals (44.1%) reported that nurses never specified the clinical indication for the transfusion, (Table 3). In many hospitals non-licensed staff never entered transfusion orders into the laboratory information system (LIS) (n = 66, 44.6%); the practice was variable in the other hospitals.

Table 3

Nursing Staff Involvement with Informed Consent and Blood Transfusion Orders

Transfusion Order Practices	*n*	*f*	Percentage	Margin of Error
Nurses obtain signatures for informed consent for blood transfusions	139			
All of the time		83	59.7%	±8.2%
Most of the time		23	16.5%	±6.2%
Occasionally		8	5.8%	±3.9%
Never		25	18.0%	±6.4%
Nurses complete clinical indication on the transfusion order because physician did not specify	145			
All of the time		4	2.8%	±2.7%
Most of the time		25	17.2%	±6.1%
Occasionally		52	35.9%	±7.8%
Never		64	44.1%	±8.1%
Non-licensed staff enter non-CPOE orders for blood transfusion in the laboratory information system	148			
All of the time		24	16.2%	±5.9%
Most of the time		30	20.3%	±6.5%
Occasionally		28	18.9%	±6.3%
Never		66	44.6%	±8.0%

Personnel who obtained blood specimens for type and screen compatibility testing were primarily RNs (*n* = 117, 79.1%) and non-nursing phlebotomists (*n* = 127, 85.8%), (Table 4).

Table 4

Personnel Who Obtain Blood Specimens for Type and Screen

Personnel	*n*	*f*	Percentage	Margin of Error
Personnel who obtain blood specimens for type and screen	148			
Non-licensed nursing staff		33	22.3%	±6.7%
LPN/LVN		45	30.4%	±7.4%
RN		117	79.1%	±6.6%
Other (non-nursing phlebotomist)		127	85.8%	±5.6%

Licensed staff are most likely to pick up blood products from the transfusion service or blood bank in a majority of the hospitals (n = 81, 55.1%) yet non-licensed staff (n = 66, 44.9%) were also highly utilized as blood couriers (Table 5). A blood transport request form is required to obtain blood issued from the transfusion service or blood bank (n = 96, 65.8%), (Table 5). Most hospitals did not allow a staff member to pick up blood products for different patients at the same time (n = 119, 82.6%), (Table 5).

Table 5

Pick-up and Transport of Blood Products

Pickup and Transport Variable	*n*	*f*	Percentage	Margin of Error
Transporter of Blood Products	147			
Non-licensed staff		66	44.9%	±8.0%
Licensed staff		81	55.1%	±8.0%
Paperwork required to pick-up blood	146			
No paperwork required		17	11.6%	±5.2%
Transfusion order		33	22.6%	±6.8%
Blood transport request (Pick-up slip, Blood Card, etc.)		96	65.8%	±7.7%
Pick-up blood for different patients at the same time	144			
Yes		25	17.4%	±6.2%
No		119	82.6%	±6.2%

Transfusion vital sign parameters regularly included temperature, blood pressure, pulse and respiratory rate. In less than half of the hospitals, oxygen saturation was included as a vital sign during blood transfusions (*n* = 71, 48%), (Table 6). Vital signs obtained pretransfusion (*n* = 146, 98.6%), at 10-15 minutes after initiation of the transfusion (*n* = 143, 96.6%), and at the end of the transfusion (*n* = 127, 85.8%) were obtained by most hospitals with vital signs during the transfusion variably reported, (Table 6). A quarter of the hospitals obtained vital signs 30 minutes after the end of the transfusion (*n* = 37, 25%), (Table 6). Most hospitals maintained the patient's standard vital sign frequency in the post transfusion period (*n* = 131, 88.5%), (Table 6). Delegation of transfusion vital signs to non-licensed staff in medical-surgical areas occurred in almost three fourths of the hospitals (*n* = 107, 72.3%), (Table 7).

Table 6

Transfusion Vital Sign Practices

Transfusion Vital Sign Measures	*n*	*f*	Percentage	Margin of Error
Parameters of transfusion vital signs	148			
Temperature		148	100%	0%
Blood pressure		147	99.3%	±1.3%
Pulse		147	99.3%	±1.3%
Respiratory rate		142	95.9%	±3.2%
Oxygen saturation		71	48.0%	±8.0%
Timing of transfusion vital signs	148			
Pre-transfusion		146	98.6%	±1.9%
10-15 minutes after initiation		143	96.6%	±2.9%
Every 30 minutes		36	24.3%	±6.9%
Every 60 minutes		72	48.6%	±8.1%
End of transfusion		127	85.8%	±5.7%
30 minutes post transfusion		37	25.0%	±7.0%
Post-transfusion vital signs are more frequent than patient's standard vital signs	148			
Yes		17	11.4%	±5.1%
No		131	88.5%	±5.1%

Table 7

Delegation of Transfusion Vital Sign to Non-licensed Staff

Delegation to Non-licensed Staff	*n*	*f*	Percentage	Margin of Error
Delegation of transfusion vital signs to non-licensed staff	148			
Yes		107	72.3%	±7.2%
No		41	27.7%	±7.2%

The infusion rate for the first 15 minutes of the transfusion was established by hospital policy for over half of the hospitals (n = 85, 57.8%). After the first 15 minutes,

the nurse or transfusionist determined the infusion rate (*n* = 72, 49%), (Table 8). The rate specified by the transfusion policy had a bimodal distribution (*Mo* = 50 to 75, 100 to 120), (Table 9). The distribution was negatively skewed (Range = 2 to 200, *Mdn* = 100, *M = 83.8*, 95% CI [72.3, 95.3]), (Table 9).

Table 8

Method for Determining Infusion Rate of Blood Transfusion

Method for Determining Infusion Rates	*n*	*f*	Percentage	Margin of Error
First 15 minutes	147			
Policy		85	57.8%	±8.0%
Doctor's order		11	7.5%	±4.3%
Nurse or transfusionist		51	34.7%	±7.7%
After the first 15 minutes	147			
Policy		44	29.9%	±7.4%
Doctor's order		31	21.1%	±6.6%
Nurse or transfusionist		72	49.0%	±8.2%

Table 9

Rate Specified in Policy for the First 15 Minutes

Infusion rate per policy	*f*	Percentage	*Median*	*Mean*	*SD*	95% CI
	141					
Not specified in policy	64	45.4%				
Rate for first 15 minutes			100	83.8	51.3	72.3 to 95.3
2 mL/hr	3	2.1%				
5 mL/hr	1	0.7%				
15 mL/hr	2	1.4%				
20 mL/hr	1	0.7%				
40 mL/hr	1	0.7%				
50 mL/hr	11	7.8%				
60 mL/hr	10	7.1%				
75 mL/hr	9	6.4%				
80 mL/hr	1	0.7%				
90 mL/hr	2	1.4%				
100 mL/hr	13	9.2%				
120 mL/hr	18	12.8%				
125 mL/hr	2	1.4%				
180 mL/hr	2	1.4%				
200 mL/hr	1	0.7%				

The majority of the hospitals specified in their transfusion policy that 4 hours was the maximum time a single filtered blood administration set may be in use (n = 126, 85.1%, *Mo* = 4, *Mdn* = 4, M = 4.6, SD = 3.5, 95% CI [4.0, 5.2]), (Table 10).

Table 10

Blood Administration Set Hours of Use

Hours of Use of Filtered Administration Set per Policy	*f*	*Percentage*	*Median*	*Mean*	*SD*	95% CI
Maximum hours per set	148		4	4.6	3.5	3.7 to 4.9
Not specified in policy	10	6.8%				
2 hours	1	0.7%				
3 hours	4	2.7%				
4 hours	126	85.1%				
8 hours	3	2.0%				
24 hours	4	2.7%				

In most hospitals the first person notified by the nurse of a possible transfusion reaction was the ordering or covering physician (*n* = 73, 49.3%) and (*n* = 45, 30.4%), respectively; the transfusion service was notified first in 17 hospitals (11.5%), (Table 11). The decision to report a possible transfusion reaction to the Transfusion Service was specified in the transfusion policy in most hospitals (*n* = 113, 76.9%), (Table 11).

Table 11

Notifications of Transfusion Reaction

Notifications of Transfusion Reaction	*n*	*f*	Percentage	Margin of Error
Notified first by nurse of possible transfusion reaction	148			
Transfusion Service, Blood Bank, or Laboratory		17	11.5%	±5.1%
Ordering physician		73	49.3%	±8.1%
Covering physician		45	30.4%	±7.4%
Attending physician		13	8.8%	±4.6%
Who determines if a possible transfusion reaction is reported to the transfusion service (blood bank)	147			
Physician		11	7.4%	±4.2%
Nurse		23	15.6%	±5.9%
Stated in Policy		113	76.9%	±6.8%

During the first 15 minutes of the transfusion nursing staff stay at the patient's bedside with all or most transfusions (n = 91, 61.5%) and (n = 23, 18.9%), respectively, (Table 12, Figure 23). The level of staff at the bedside during this initial 15 minutes was predominantly the RN (n = 143, 97.3%), (Table 12).

Table 12

Nursing Staff at the Bedside during the First 15-Minutes of a Blood Transfusion

Staff at Bedside during Transfusion	*n*	*f*	Percentage	Margin of Error
Staff at bedside first 15-minutes	148			
All of the time		91	61.5%	±7.8%
Most of the time		23	18.9%	±6/3%
Occasionally		24	16.2%	±5.9%
Never		5	3.4%	±2.9%
Level of personnel at bedside first 15-minutes	147			
RN		143	97.3%	±2.6%
LPN/LVN		1	0.7%	±1.3%
Non-licensed staff		3	2.0%	±2.0%

Patients were transported out of the patient care unit for tests and procedures with blood transfusions in progress in most hospitals (*n* = 103, 69.6%), (Table 13). During transport to the test or procedure area, the RN primarily observed the patient receiving a blood transfusion (*n* = 72, 70.6%) and in almost a quarter of the hospitals the transport staff observed the patient (*n* = 23, 22.5%), (Table 13). During the test or procedure, either the test or procedure area RN (*n* = 55, 53.9%) or the medical-surgical unit RN (*n* = 30, 20.3%) observed the patient, (Table 14).

Table 13

Blood Transfusion during Tests and Procedures

Transfusion During Test or Procedure	*n*	*f*	Percentage	Margin of Error
Patients are transported to test or procedure areas with blood infusing	148			
Yes		103	69.6%	±7.4%
No		45	30.4%	±7.4%
Who observes patient with blood transfusion during transportation	102			
RN		72	70.6%	±8.8%
LPN/LVN		3	2.9%	±3.3%
Non-licensed nursing staff		2	2.0%	±2.7%
Transportation staff		23	22.5%	±8.1%
Physician		1	1.0%	±1.9%
Who observes patient with blood transfusion during the test or procedure	102			
Test/Procedure RN		55	53.9%	±9.7%
Test/Procedure technician		16	15.7%	±7.1%
Medical-Surgical unit RN		30	29.4%	±8.8%
Medical-Surgical unit LPN/LVN		1	1.0%	±1.9%
Physician		0		

Adopted Innovations in Technology and Processes

The second research question asked what innovations in technology and processes were adopted by nurses in medical-surgical patient care units in U.S. hospitals. Technological innovations included computerized provider order entry (CPOE), automated systems for transporting blood products to the clinical area, equipment for infusion rate control, specimen collection verification equipment, electronic transfusion verification scanning equipment, blood wristbands, and automatic devices for vital signs

and use of pulse oximetry. Process innovations encompassed handoff communication, number of staff required for electronic pretransfusion verification, double check at the point of blood product issue, hemovigilance reporting, employment of transfusion safety nurses, and nurse representation on the Transfusion committee.

The use of computerized provider order entry (CPOE) was fully or almost fully implemented (75% or greater) in a majority of the hospitals (*n* = 78, 52.7%). Zero implementation of CPOE occurred in 43 hospitals (29.1%), (Table 14).

Table 14

Computerized Provider Order Entry (CPOE) Used for Transfusion Orders

CPOE Implementation	*n*	*f*	Percentage	Margin of Error
Computer Provider Order Entry (CPOE)	148			
Fully or almost fully implemented (75% or greater)		78	52.7%	±8.0%
Partially implemented (less than 75%)		27	18.2%	±6.2%
Not current ordering process (0%)		43	29.1%	±7.3%

Two innovative practices addressed the process of verifying the identification match of the patient and the label on the blood specimen collected for type and screen. In the majority of hospitals the person who obtained the sample individually verified the specimen was obtained from the correct patient (*n* = 89, 60.4%). Other hospitals required a second person to verify the match of the patient to the type and screen specimen (*n* = 58, 39.5%), (Table 15).

Table 15

Blood Specimens for Type and Screen

Blood Specimen for Type and Screen	*n*	*f*	Percentage	Margin of Error
Number of persons to verify specimen for type and screen	147			
Two persons		58	39.4%	±7.9%
One person		89	60.5%	±7.9%
A second blood sample to confirm blood type	148			
Yes		39	26.4%	±7.1%
No		109	73.6%	±7.1%

Several questions addressed innovations in safety related to identification wristbands and use of electronic identification (ID) systems. A majority of the hospitals reported use of an additional unique patient wristband specific for blood transfusion in addition to the standard ID wristband (*n* = 84, 56.8%). Electronic ID systems were used in a majority of the hospitals (*n* = 90, 60.8%). Medication administration was the primary electronic ID application (*n* = 84, 93.3%). Hospitals not using electronic ID technologies (*n* = 58, 39.2%) primarily used the standard patient wristband for pretransfusion verification (*n* = 34, 58.6%). See Table 16 for a complete description.

Table 16

Technology and Safety Measures Used

Technology and Safety Measures	*n*	*f*	Percentage	Margin of Error
Unique patient wristband for blood transfusion (blood band)	148			
Yes		84	56.8%	±8.0%
No		64	43.2%	±8.0%
Electronic identification (ID) systems used by nurses (hand-held scanners, computer wands, etc)	148			
Yes		90	60.8%	±7.9%
No		58	39.2%	±7.9%
Electronic ID systems used for:	90			
Medications		84	93.3%	±5.2%
Positive patient identification (PPID)		62	68.9%	±9.6%
Bedside transfusion verification		37	41.1%	±10.2%
Specimen collection for blood compatibility test		30	33.3%	±9.7%
Specimen collection for general labs		28	31.1%	±9.61%
Non-electronic ID methods used for pretransfusion verification	58			
Standard patient ID wristband		34	58.6%	±10.2%
Unique non-electronic blood band (Identa-A-Band, Secureline, etc.)		21	36.2%	±9.9%
Barrier system (BloodLoc, Typenex FinalCheck, etc.)		3	5.2%	±4.6%

During pretransfusion verification with an electronic system all 37 hospitals scanned the blood bag as part of the process, (Tables 16 and 17). Barcode technology was the primarily electronic method used for transfusion verification (*n* = 27, 73%). Despite 27 hospitals reporting use of barcode technology for transfusion verification, few delineated the specific type. Two licensed staff members were required to complete electronic

pretransfusion verification in most hospitals (*n* = 36, 90%); fewer hospitals reported use of only one licensed staff plus the electronic system for pretransfusion verification (*n* = 4, 10%). See Table 17 for a complete description.

Table 17

Electronic Technologies Used During Transfusion Verification

Electronic Technologies	*n*	*f*	Percentage	Margin of Error
Blood bag scanned during electronic transfusion verification	90			
Yes		37	41.1%	±10.2%
No		53	58.9%	±10.2%
Type of bedside electronic ID system used for pretransfusion verification	37			
Barcode		27	73%	±14.3%
RFID tag		10	27%	±14.3%
QR Code		0		
Wireless proximity tag		0		
Type of barcode wristband used for pretransfusion verification	27			
Standard barcode patient ID wristband		4	15%	±13.5%
Unique barcode blood band (I-Track Plus, Secureline, Typenex, etc.)		0		
Missing data		23	85%	±13.5%
Number of licensed staff required to complete pre-transfusion verification	40			
One person		4	10%	±9.3%
Two persons		36	90%	±9.3%

A hospital may use multiple conveyances to transport blood products from the transfusion service to the medical-surgical clinical area. The use of personnel primarily nursing personnel (*n* = 133, 89.9%) was the most common means of transporting blood

products. Pneumatic tubes were used in a third of the hospitals (*n* = 49, 33.1%) and a single hospital (*n* = 1, 0.7%) reported use of a robot to deliver the blood products, (Table 18). A majority of hospitals do not allow storage or dispensing of blood products at the point-of-care in the medical surgical areas (*n* = 138, 93.2%). A few hospitals however permit the use of portable blood coolers with ice packs that provide several hours of cooling in the medical-surgical areas (*n* = 8, 5.4%). The Thermal Wizard Red Shield blood cooler (*n* = 1, 0.7%) that provides up to 24-hours of cooling and a satellite blood refrigerator (*n* = 1, 0.7%) were each reported as used in medical-surgical areas. No hospital reported use of a blood bank vending machine in the medical-surgical areas, (Table 18).

Table 18

Acquisition and Storage of Blood Products in Medical-Surgical Areas

Methods to Obtain Blood Products	*n*	*f*	Percentage	Margin of Error
Methods used to transport blood products to the clinical areas	148			
Nursing personnel		133	89.9%	±4.9%
Other hospital personnel		78	52.7%	±8.0%
Pneumatic tube		49	33.1%	±7.6%
Robot		1	0.7%	±1.3%
Equipment used to store or dispense blood products at the point-of-care in medical-surgical areas	148			
Not applicable		138	93.2%	±4.1%
Portable blood cooler		8	5.4%	±3.6%
Thermal Wizard Red Shield		1	0.7%	±1.3%
Satellite Blood refrigerator		1	0.7%	±1.3%
Blood vending machine		0	0%	

Several questions addressed the use of medical equipment used by nurses during the administration of blood products. Non-invasive BP (NIPB) was used all of the time (*n* = 84, 56.8%) or most of the time (*n* = 52, 35.1%) during blood transfusions, (Table 19). Few hospitals automatically integrated the vital signs from the NIBP into the electronic medical record (*n* = 16, 10.8%), (Table 19). Infusion pumps were used to control blood infusion rate in most hospitals (*n* = 144, 97.3%) and were used all of the time in a majority of the hospitals (*n* = 124, 84.9%), (Table 19). The use of a pulse oximeter during blood transfusions was variable; responses were all of the time (*n* = 62, 41.9%), most of the time (*n* = 26, 17.6%), occasionally (*n* = 52, 35.1%), and never (*n* = 8, 5.4%), (Table 19). Blood warmers were occasionally used in medical-surgical areas of almost half the hospitals (*n* = 72, 48.6%), while most hospitals did not use blood warmers in the medical-surgical areas (*n* = 76, 51.4%), (Table 19).

Table 19

Technology Devices Used During Blood Transfusions in Medical-Surgical Areas

Technology Devices	*n*	*f*	Percentage	Margin of Error
Non-invasive BP (NIBP) used	148			
All of the time		84	56.8%	±8.0%
Most of the time		52	35.1%	±7.7%
Occasionally		7	4.7%	±3.4%
Never		5	3.4%	±2.9%
NIBP vital signs auto-downloaded into electronic medical record (EMR)	148			
Yes		16	10.8%	±5.0%
No		132	89.2%	±5.0%
Flow rate regulation methods	148			
Infusion pump		144	97.3%	±2. 6%
Roller clamp on filtered administration set		20	13.5%	±5.5%
Flow regulating device (Dial-a-Flow, Control-a-Flo etc.)		2	1.4%	±1.9%
Infusion pump used	146			
All of the time		124	84.9%	±5.8%
Most of the time		16	11.0%	±5.0%
Occasionally		4	2.7%	±2.6%
Never		2	1.4%	±1.9%
Pulse oximeter used	148			
All of the time		62	41.9%	±7.9%
Most of the time		26	17.6%	±6.1%
Occasionally		52	35.1%	±7.7%
Never		8	5.4%	±3.6%
Blood warmers occasionally used	148			
Yes		72	48.6%	±8.1%
No		76	51.4%	±8.1%

The majority of hospitals incorporated handoff communication innovations by conducting double checks with two persons at the time of blood issue from the blood bank. The blood product label was double checked (*n* = 125, 85.6%), and the blood product was compared to the order or pick-up form (*n* = 126, 86.3%). Only five (3.4%) hospitals did not use double checks at time of issue of the blood, (Table 20). Most hospitals did not require a recheck of infusing blood during caregiver handoff (*n* = 118, 79.7%), (Table 20).

Table 20

Handoff Communication Double Checks

Double Checks	*n*	*f*	Percentage	Margin of Error
Double check by two persons at time of blood product issue	146			
Blood product labeled correctly		125	85.6%	±5.7%
Blood product compared to Order/pick-up form before issue		126	86.3%	±5.6%
No double check		5	3.4%	±2.9%
During caregiver handoff communication infusing blood is rechecked for match to the patient	148			
Yes		30	20.3%	±6.5%
No		118	79.7%	±6.5%

Innovative practices of the hospital's transfusion service included voluntary participation in the Hemovigilance Network which includes reporting all transfusion related adverse events to the national database of the network (*n* = 93, 66%). Nurses had representation on most hospital transfusion committees (*n* = 83, 57.2%) with a direct relationship between hospital size category and the proportion of hospitals with nurse

representation on the committee. However few hospitals (*n* = 18, 12.4%) employed a transfusion service nurse specialist or blood utilization nurse, (Table 21).

Table 21

Innovative Practices between Transfusion Service and Nurses

Innovations in Transfusion Services	*n*	*f*	Percentage	Margin of Error
Hospital voluntarily reports transfusion related adverse events to the Biovigilance Network	141			
Yes		93	66.0%	±7.8%
No		48	34.0%	±7.8%
Hospital employs a transfusion nurse specialist or blood utilization nurse	145			
Yes		18	12.4%	±5.4%
No		127	87.6%	±5.4%
Nurse representative on the hospital's transfusion committee	145			
Yes		83	57.2%	±8.1%
No		62	42.8%	±8.1%

Hospital Education Related to Administration of Blood Products

The third research question asked what education content and methods of communication were used in the hospital-based preparation of medical-surgical nurses and nursing staff related to the administration of blood products. During orientation of new employees, education on blood transfusions was provided to almost all RNs (*n* = 144, 98%) while fewer LPN/LVNs (*n* = 84, 57%) and non-licensed staff (*n* = 53, 36%) received blood transfusion education, (Table 22).

Table 22

Blood Transfusion Preparation of Nurses and Nursing Staff during Orientation

Recipients of Transfusion Education	*n*	*f*	Percentage	Margin of Error
Education during orientation	147			
RN		144	98.0%	±2.3%
LPN or LVN		84	57.1%	±8.0%
Non-licensed		53	36.1%	±7.8%
Blood transfusion not covered in orientation		3	2.0%	±2.3%

Content on blood transfusions provided to RNs predominantly focused on hospital transfusion procedures (*n* = 144, 98%), transfusion reaction symptoms (*n* = 141, 95.9%), and patient management during a transfusion reaction (*n* = 132, 89.8%). Only one of the content areas, blood conservation (*n* = 57, 38.8%), was provided in fewer than 70% of the hospitals, (Table 23). Packed red blood cells (*n* = 146, 99.3%), platelets (*n* = 136, 92.5%), and fresh frozen plasma (*n* = 136, 92.5%) were the primary blood products include in the RN blood transfusion education, (Table 24).

Table 23

Content Included in RN Blood Transfusion Education during Orientation

Transfusion Education Content	*n*	*f*	Percentage	Margin of Error
	147			
Hospital procedures		144	98.0%	±2.3%
Symptoms of transfusion reaction		141	95.9%	±3.2%
Patient management of transfusion reaction		132	89.8%	±4.9%
Equipment for transfusion		129	87.8%	±5.3%
Transportation of blood		125	85.0%	±5.8%
Types of blood products and blood filters		123	83.7%	±6.0%
Infusion rates/duration		122	83.0%	±6.1%
Types of transfusion reactions		120	81.6%	±6.3%
Blood wastage (blood bag not returned to the blood bank within time limit)		106	72.1%	±7.3%
Blood conservation		57	38.8%	±7.9%

Table 24

Blood Products Included in RN Orientation

Blood Products	*n*	*f*	Percentage	Margin of Error
	147			
Packed RBCs		146	99.3%	±1.3%
Platelets		136	92.5%	±4.3%
Fresh frozen plasma		136	92.5%	±4.3%
Whole blood		84	57.1%	±8.0%
Special products (irradiated, leukoreduced)		83	56.5%	±8.0%
Cryoprecipitate		81	55.1%	±8.0%

The rank of transfusion content provided to LPN/LVNs was similar to the RNs however the percentage of hospitals providing content to the LPN/LVNs was less than for the RNs. Primary content areas for the LPN/LVN was on hospital transfusion procedures (*n* = 93, 63.3%), and transfusion reaction symptoms (*n* = 90, 61.2%). See Table 25 for a complete description of the content provided to LPN/LVNs. For non-licensed staff, the prevailing response was that no blood transfusion education (*n* = 65, 44.2%) was provided during new employee orientation. When provided, non-licensed staff were primarily educated on hospital procedures (*n* = 59, 40.1%) and symptoms of transfusion reactions (*n* = 31, 21.1%). See Table 26 for a complete description of the content provided to non-licensed staff.

Table 25

Content in LPN/LVN Blood Transfusion Education during Orientation

Transfusion Education Content	*n*	*f*	Percentage	Margin of Error
	147			
Hospital procedures		93	63.3%	±7.8%
Symptoms of transfusion reaction		90	61.2%	±7.9%
Patient management of transfusion reaction		83	56.5%	±8.0%
Infusion rates/duration		72	49.0%	±8.1%
Equipment for transfusion		72	49.0%	±8.1%
Transportation of blood		74	50.3%	±8.1%
Types of blood products and blood filters		71	48.3%	±8.1%
Types of transfusion reactions		69	46.9%	±8.1%
Blood wastage (blood bag not returned to the blood bank within time limit)		58	39.5%	±7.9%
Blood conservation		36	24.5%	±7.0%

Table 26

Orientation Content on Blood Transfusion for Non-licensed Staff

Transfusion Content	*n*	*f*	Percentage	Margin of Error
	147			
Not taught to non-licensed staff		65	44.2%	±8.0%
Hospital Procedures		59	40.1%	±7.9%
Transportation of Blood		55	37.4%	±7.8%
Symptoms of transfusion reaction		31	21.1%	±6.6%
Responsibilities during a transfusion reaction		30	20.4%	±6.5%
Different blood products		13	8.8%	±4.6%

The types of transfusion reactions included in the RN education were primarily allergic (*n* = 142, 96.6%), acute hemolytic (*n* = 111, 75.5%), and febrile (*n* = 105, 71.4%). See Table 27 for a complete description of the types of transfusion reactions included in RN education. The rank order of clinical symptoms of a transfusion reaction was similar for RNs, LPN/LVNs, and non-licensed staff. The four most common symptoms were fever (RN, *n* = 144, 98%; LPN/LVN, *n* = 91, 61.9%; and non-licensed staff, *n* = 36, 24.5%), chills/rigors (RN, *n* = 141, 95.9%; LPN/LVN, *n* = 87, 59.2%; and non-licensed staff, *n* = 36, 24.5%), shortness of breath (RN, *n* = 134, 91.2%; LPN/LVN, *n* = 82, 55.8%; and non-licensed staff, *n* = 36, 24.5%), and itching (RN, *n* = 132, 89.8%; LPN/LVN, *n* = 80, 54.4%; non-licensed staff, *n* = 30, 20.4%). Ninety-nine hospitals (67.3%) did not provide transfusion reaction symptom education to non-licensed staff. See Tables 27, 28, 29, and 30for full descriptions of transfusion reactions symptoms included in the education for each level of nursing personnel.

Table 27

Transfusion Reactions Included in RN Orientation

Types of Transfusion Reactions	*n*	*f*	Percentage	Margin of Error
	147			
Allergic		142	96.6%	±2.9%
Acute hemolytic		111	75.5%	±7.0%
Febrile		105	71.4%	±7.3%
TACO		87	59.2%	±7.9%
Hypotensive		78	53.1%	±8.1%
Infection		75	51.0%	±8.1%
TRALI		70	47.6%	±8.1%
TAD dyspnea		68	46.3%	±8.1%
Delayed hemolytic		65	42.2%	±8.0%
Graft vs. host disease		34	23.1%	±6.8%

Table 28

Symptoms of Transfusion Reactions Included in RN Transfusion Education

Symptoms of Transfusion Reaction	*n*	*f*	Percentage	Margin of Error
Symptoms in RN Education	147			
Fever		144	98.0%	±2.3%
Chills/rigors		141	95.9%	±3.2%
Shortness of breath		134	91.2%	±4.6%
Itching		132	89.8%	±4.9%
Hives		128	87.1%	±5.5%
BP decrease		122	83.0%	±6.1%
Flushing		121	82.3%	±6.2%
Tachycardia		119	81.0%	±6.4%
Chest pain		114	77.6%	±6.8%
Back pain		113	76.9%	±6.9%
BP increase		111	75.5%	±7.0%
Nausea/vomiting		109	74.1%	±7.2%
Shock		104	70.7%	±7.4%
Wheezing		103	70.1%	±7.5%
Urticaria		100	68.0%	±7.6%
Infusion site pain		95	64.6%	±7.8%
Flank pain		95	64.6%	±7.8%
Headache		86	58.5%	±8.0%
Hypoxemia		83	56.5%	±8.1%
Edema		81	55.1%	±8.1%
Other rash		77	52.4%	±8.2%
Abdominal pain		70	47.6%	±8.2%
Hematuria		70	47.6%	±8.2%
Cough		68	46.3%	±8.1%
Bradycardia		67	45.6%	±8.1%
Oliguria		65	36.7%	±7.9%
Dark urine		58	39.5%	±8.0%
Diffuse hemorrhage		54	36.7%	±7.9%
Jaundice		48	32.7%	±7.7%
Other pain		47	32.0%	±7.6%
Positive antibody screen		40	27.2%	±7.3%
Hemoglobinuria		38	25.9%	±7.2%
Infiltrates on chest x-ray		33	22.4%	±6.8%

Table 29

Symptoms of Transfusion Reactions Included in LPN/LVN Transfusion Education

Symptoms of Transfusion Reaction	*n*	*f*	Percentage	Margin of Error
Symptoms in LPN/LVN education	147			
Fever		91	61.9%	±7.9%
Chills/rigors		87	59.2%	±7.9%
Shortness of breath		82	55.8%	±8.0%
Itching		80	54.4%	±8.1%
Hives		75	51.0%	±8.1%
BP decrease		76	51.7%	±8.1%
Flushing		73	49.7%	±8.1%
Tachycardia		75	51.0%	±8.1%
Chest pain		67	45.6%	±8.1%
Back pain		68	46.3%	±8.1%
BP increase		70	47.6%	±8.1%
Nausea/vomiting		67	45.6%	±8.1%
Shock		65	44.2%	±8.0%
Wheezing		58	39.5%	±7.9%
Urticaria		60	40.8%	±7.9%
Infusion site pain		54	36.7%	±7.8%
Flank pain		55	37.4%	±7.8%
Headache		51	34.7%	±7.7%
Hypoxemia		43	29.3%	±7.4%
Edema		50	34.0%	±7.7%
Other rash		46	31.3%	±7.5%
Abdominal pain		42	28.6%	±7.3%
Hematuria		38	25.9%	±7.0%
Cough		43	29.3%	±6.7%
Bradycardia		47	32.0%	±7.5%
Oliguria		33	22.4%	±6.7%
Dark urine		32	21.8%	±6.7%
Diffuse hemorrhage		31	21.1%	±6.6%
Jaundice		27	18.4%	±6.3%
Other pain		27	18.4%	±6.3%
Positive antibody screen		22	15.0%	±5.8%
Hemoglobinemia		22	15.0%	±5.8%
Infiltrates on chest x-ray		23	15.6%	±5.9%
Hospitals with no response		56	38.1%	

Table 30

Symptoms of Transfusion Reactions Included in Non-licensed Nursing Staff Education

Transfusion Reaction Symptoms	*n*	*f*	Percentage	Margin of Error
Symptoms in non-licensed education	145			
Fever		36	24.5%	±7.0%
Chills		36	24.5%	±7.0%
Shortness of breath		34	23.1%	±6.9%
Itching		30	20.4%	±6.6%
Hives		27	18.4%	±6.3%
BP decrease		25	17.0%	±6.1%
Flushing		21	14.3%	±5.7%
Tachycardia		22	15.0%	±5.8%
Chest pain		22	15.0%	±5.8%
Back pain		21	14.3%	±5.7%
BP increase		20	13.6%	±5.6%
Nausea/vomiting		20	13.6%	±5.6%
Shock		15	10.2%	±4.9%
Wheezing		22	15.0%	±5.8%
Urticaria		16	10.9%	±5.1%
Infusion site pain		14	9.5%	±4.8%
Flank pain		17	11.6%	±5.2%
Headache		14	9.5%	±4. 8%
Hypoxemia		14	9.5%	±4.8%
Edema		13	8.8%	±4.6%
Other rash		13	8.8%	±4.6%
Abdominal pain		14	9.5%	±4.8%
Bloody urine		12	8.2%	±4.5%
Cough		19	12.9%	±5.5%
Bradycardia		13	8.8%	±4.6%
Dark urine		9	6.1%	±3.9%
Diffuse hemorrhage (bleeding)		6	4.1%	±3.2%
Jaundice		9	6.1%	±3.9%
Other pain		6	4.1%	±3.2%
NA – transfusion reaction symptoms not taught to non-licensed staff		99	67.3%	±7.6%

The primary methods of instruction during new employee orientation were review of the hospital transfusion policy (*n* = 100, 68%) and classroom instruction (*n* = 96, 64.5%). Online modules (*n* = 71, 48.3%) and competency skills validation (*n* = 67, 45.6%) were used in many hospitals, (Table 31). During recurring education, online learning modules (*n* = 86, 58.5%) and review of the hospital's transfusion policy (*n* = 65, 44.2%) were the primary instruction methods with competency skills validation (*n* = 54, 37.6%) in over a third of the hospitals, (Table 32). Other methods were less frequently utilized in orientation and in recurring transfusion education, (Tables 31 and 32).

Table 31

Methods of Instruction for Education on Blood Transfusions during Orientation

Methods of Instruction	*n*	*f*	Percentage	Margin of Error
	147			
Read transfusion policy		100	68.0%	±7.5%
Classroom presentation		96	64.9%	±7.7%
Online module		71	48.3%	±8.2%
Competency skills validation		67	45.6%	±8.1%
Self-learning module		41	29.9%	±7.4%
Simulation plus discussion		25	17.0%	±6.1%
Video		12	8.2%	±4.4%
Case Studies		6	4.2%	±3.2%

Table 32

Instructional Methods for Recurring Education on Blood Transfusions

Instructional Methods	*n*	*f*	Percentage	Margin of Error
	147			
Online learning (e-learning)		86	58.5%	±8.0%
Read transfusion policy		65	44.2%	±8.0%
Competency skills validation		54	37.6%	±7.8%
Inservice		41	27.9%	±7.3%
Self-learning module		32	21.8%	±6.7%
Classroom presentation		28	19.0%	±6.2%
Blended learning (online plus discussion)		15	10.2%	±4.9%
Simulation plus discussion		13	8.8%	±4.6%
Case studies		8	5.4%	±3.7%
Video		6	4.1%	±3.2%

Recurring blood transfusion education for RNs and LPN/LVNs primarily occurred on a yearly basis (n = 116, 80.6%), M = 0.88, 95% CI [0.808, 0.955] and (n = 75, 61%), M = 0.66, 95% CI [0.566, 0.751] respectively. Most non-licensed staff were not required to receive ongoing blood transfusion education (n = 106, 76.8%), M = 0.23, 95% CI [0.161, 0.303]. See Table 33 for further descriptions.

Table 33

Occurrence of Recurring Education on Blood Transfusions

Occurrence of Recurring Transfusion Education	*n*	*f*	Percentage	Mean	Standard Deviation	95% Confidence Interval
RNs	144			0.88	0.450	0.080 to 0.955
Not required		23	16.0%			
Every 1 year		116	80.6%			
Every 2 years		4	2.8%			
Every 3 years		1	0.7%			
LPNs or LVNs	123			0.66	0.525	0.566 to 0.751
Not required		45	36.6%			
Every 1 year		75	61.0%			
Every 2 years		3	2.4%			
Every 3 years		0				
Non-licensed staff	138			0.23	0.424	0.161 to 0.303
Not required		106	76.8%			
Every 1 year		32	23.2%			
Every 2 years		0				
Every 3 years		0				

Influential Information Sources

The fourth research question asked about internal and external sources of information that influence the communication and diffusion of blood transfusion practices of nurses in medical-surgical units in U.S. hospitals. The primary source of information within the hospital that influenced medical-surgical nurses' blood transfusion practices was the hospital's blood transfusion policy (n = 136, 92%). The transfusion service (blood bank) staff was the second most influential source (n = 89, 60.5%). Nurses in the clinical area ranked third and fourth as influences on transfusion practices, staff

nurses (*n* = 84, 37.1%) and nurse managers (*n* = 80, 54.4%). See Table 34 for other hospital personnel that influenced nurses' transfusion practices. Sources of information external to the hospital that influenced medical-surgical nurses' blood transfusion practices were most commonly journal articles (*n* = 70, 47.6%), then subscribed online sources (*n* = 49, 33.3%) such as Mosby Skills or Consults, etc. The AABB (*n* = 45, 30.6%), general internet search engines (*n* = 38, 25.9%), and other internet sources (*n* = 36, 24.5%) were also utilized for current transfusion information. See Table 35 for other external resources used by medical-surgical nurses to obtain current information on blood transfusion practices.

Table 34

Internal Resources with Strong Influence on Nurses' Blood Transfusion Practices

Internal Resources	*n*	*f*	Percentage	Margin of Error
	147			
Hospital transfusion policy		136	92.5%	±4.3%
Staff from the blood bank or transfusion service		89	60.5%	±7.9%
Staff nurse		84	57.1%	±8.0%
Nurse manager		80	54.4%	±8.1%
Nurse education specialist		70	47.6%	±8.1%
Physician		44	29.9%	±7.4%
Clinical nurse specialist or nurse practitioner		38	25.9%	±7.1%
Transfusion safety medical officer		10	6.8%	±4.1%
Transfusion safety nurse		9	6.1%	±3.9%

Table 35

External Resources used by Nurses for Current Information on Blood Transfusions

External Resources	*n*	*f*	Percentage	Margin of Error
	147			
Journal articles		70	47.6%	±8.1%
Subscribed online sources (e.g. Mosby Skills or Consults, etc.		49	33.3%	±7.6%
AABB		45	30.6%	±7.4%
Search engines, e.g. Google		38	25.9%	±7.1%
Other internet sources		36	24.5%	±7.0%
Textbooks		27	18.4%	±6.3%
Circular of Information		26	17.7%	±6.2%
Webinars on blood transfusion		25	17.0%	±6.1%
Medscape (free electronic newsletter or nursing education CE, etc.		24	16.3%	±6.0%
Listserv subscriptions		14	9.5%	±4.7%

Patient and Family Instructions

The fifth research question asked how patients and their families were instructed about symptoms to report during a blood transfusion in medical-surgical patient care units in U.S. hospitals. Patients were verbally informed of symptoms to report during a blood transfusion all of the time (*n* = 91, 62.3%), most of the time (*n* = 45, 30.4%), and occasionally (*n* = 10, 6.8%). Written patient education materials, pamphlets or information sheets, were provided to the patient prior to the transfusion all of the time (*n* = 37, 25.2%), most of the time (*n* = 19, 12.9%), and occasionally (*n* = 35, 23.8%); the predominant response was that written material on blood transfusions was never provided to the patient prior to transfusion (*n* = 56, 37.8%), (Table 36). The written materials were primarily developed by employees of the hospital or healthcare system (*n* = 51, 57.3%)

and slightly less frequently by commercial sources outside the hospital (n = 38, 42.7%) such as Krames Patient Education, Patient Education Institute, or Micromedex CareNotes, etc. Most written transfusion education materials included symptoms the patient should report to the nurse during the transfusion (n = 86, 96.6%) and were available in more than one language (n = 58, 65.9%). See Table 37 for more complete descriptions.

Table 36

Patient and Family Blood Transfusion Instructions

Blood Transfusion Instructions	*n*	*f*	Percentage	Margin of Error
Patient verbally informed by the nurse of symptoms to report	146			
All of the time		91	62.3%	±7.9%
Most of the time		45	30.4%	±7.5%
Occasionally		10	6.8%	±4.1%
Never		0		
Blood transfusion pamphlet of information sheet given to the patient prior to transfusion	147			
All of the time		37	25.2%	±7.0%
Most of the time		19	12.9%	±5.4%
Occasionally		35	23.8%	±6.9%
Never		56	37.8%	±7.8%

Table 37

Blood Transfusion Pamphlet or Information Sheet

Pamphlet or Information Sheet	*n*	*f*	Percentage	Margin of Error
Developer	89			
In-house (employee of hospital or healthcare system)		51	57.3%	±10.3%
Outside source		38	42.7%	±10.3%
Symptoms to report included	89			
Yes		86	96.6%	±3.8%
No		3	3.4%	±3.8%
Available in more than one language	88			
Yes		58	65.9%	±9.9%
No		30	34.1%	±9.9%

Hospital Size and Differences in Blood Transfusions

The sixth research question asked if reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differed based on hospital size. All data was evaluated by means of the Chi square test of independence (see Appendix G for Tables of associations of each question to hospital size). Due to the 524 hypothesis tests performed, $p = 0.0000954$ was required for significance. The comparative analysis yielded only two significant associations, use of the pneumatic tube for transporting blood and education of RNs that edema may be a symptom of a transfusion reaction. Crosstabulation tables are provided for the two associations that met the significance requirement, (Tables 38 and 39). The use of pneumatic tubes to deliver blood products to the clinical area was an innovation significantly related to hospital size, χ^2 (3, $n = 147$) = 26.053, $p = 0.000009$, (Table 38). The inclusion of edema as a transfusion reaction symptom in the RN

education was significantly related to hospital size, χ^2 (3, n = 146) = 25.727, p = 0.0000109, (Table 39). There were no associations that met the required level of significance between blood transfusion practices, influential sources, or patient and family instructions and hospital size.

Table 38

Crosstabulation Table of Use of a Pneumatic Tube and Hospital Size

Inpatient beds	Pneumatic tube to deliver blood product to the clinical area					
	Yes	No	Total	χ^2	*df*	*p*
500 or more	17	9	26	26.053	3	**.000009**[a]
250 to 499	20	26	46			
100 to 249	10	36	46			
25 to 99	2	27	29			
Total	49	98	147			

a. Significant at 0.0000954

Table 39

Crosstabulation Table of RN Education of Edema as a Transfusion Reaction and Hospital Size

Inpatient beds	Edema taught as a transfusion reaction symptom					
	Yes	No	Total	χ^2	*df*	*p*
500 or more	22	4	26	25.727	3	**.0000109**[a]
250 to 499	30	16	46			
100 to 249	12	33	45			
25 to 99	16	13	29			
Total	80	66	146			

a. Significant at 0.0000954

Magnet Recognition and Differences in Blood Transfusions

The seventh research question asked if reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differed based on Magnet recognition. All data was evaluated by means of the Chi square test of independence (see Appendix H for Tables of associations of each question to Magnet recognition). As with hospital size, a significant association to Magnet recognition required a $p = 0.0000954$. There were no significant associations to Magnet recognition.

Summary of the Findings

Blood Transfusion Practices

Practices related to the blood product order included two practices with physician accountability yet were performed by staff nurses in the medical-surgical area. In most hospitals (76.2%) nurses obtained the patient's signature on the informed consent for blood transfusion, all of the time (59.7%) and most of the time (16.5%). When the physician did not specify the patient's clinical indication for the blood transfusion in the blood product order, in 55.8% of the hospitals nurses completed the clinical indication. The nurses never filled in the clinical indication in 17.2% of the hospitals. With non-CPOE blood transfusion orders, non-licensed staff transcribed the physician's blood product order into the LIS in almost half (44.6%) of the hospitals.

Many levels of personnel were permitted to collect the blood specimen for type and screen. The most frequent were RNs (79.1%) and non-nursing phlebotomists (85.8%)

with LPN/LVNs (30.4%) and non-licensed nursing staff (22.3%) also obtaining the blood specimen.

The both non-licensed (44.9%) and licensed (55.1%) staff picked up blood and transported the blood product to the clinical area. To pick up the blood in most hospitals (65.8%), a blood transport request document was brought to the transfusion service or blood bank. Most hospitals (82.6%) did not allow one staff person to pickup blood on more than one patient at the same time.

Transfusion vital sign parameters were fairly standardized with temperature (100%), pulse (99.3%), blood pressure (99.3%) and respiratory rate (95.9%). Pulse ox to measure oxygen saturation was only incorporated as a transfusion vital sign in 48% of the hospitals. The timing of transfusion vital signs also showed a level of consistency among the hospitals with pre-transfusion (98.6%), 10-15 minutes after initiation of the transfusion (96.6%), and at the end of the transfusion (85.8%). Only 25% of the hospital measured vital signs at 30 minutes post transfusion. Most hospitals (88.5%) reverted to the patient's standard vital signs once the transfusion ended. A common practice (72.3%) was to delegate transfusion vital signs to non-licensed staff in the medical-surgical patient care units.

The infusion rate for the first 15 minutes was specified in hospital policy in most hospitals (57.8%). The RN determined the rate a third of the hospitals (34.7%) and the physician specified the rate in 7.5% of the hospitals. The milliliter per hour rate specified in policy had a bimodal distribution (*Mo* = 50 to 75, 100 to 120). After the first 15 minutes, the most common practice was for the nurse or transfusionist to determine the

infusion rate (49%). The predominant duration of use for a single filtered blood administration set was 4-hours (85.1%).

In the medical-surgical acute care patient care areas, the practice of having a staff member stay with the patient for the first 15 minutes of the transfusion occurred all the time in a majority of hospitals (61.5%) with variations in practice in the other hospitals. The RN was the primary person who stayed with the patient (97.3%).

With a suspected transfusion reaction, the first to be notified by the RN is ordering physician (49.3%) or the covering physician (30.4%). The transfusion service is first to be notified in only (11.5%) of the hospitals. The determination of who to notify first is established in hospital policy in 76.9% of the hospitals.

Patients were commonly transported out of the patient care unit for tests or procedures with blood actively infusing (69.6%). During patient transport, the RN (70.6%) or non-licensed transport staff (22.5%) observed the patient. During the test or procedure, the RN who worked in the test or procedure area (53.9%) observed the patient or the medical-surgical unit RN stayed to observe the patient (29.4%); in 15.7% of the hospitals the technician in test or procedure area was responsible for patient observations.

Adoption of Innovations in Technology and Processes

The adoption of computerized provider order entry (CPOE) for blood transfusion orders was fully implemented in 52.7% of the hospitals and partially implemented in 18.2%. In almost a third of the hospitals (29.1%) CPOE was not part of the ordering process.

Many innovations centered on methods of identification (ID) for the patient, blood specimens, and blood products. A second wristband specific for blood transfusion, a blood band, was used in 56.8% of the hospitals. Electronic ID systems were used by nurses in 60.8% (n = 90) of the hospitals. Medication administration was the primary electronic application (n = 84, 93.3%). Electronic ID used during specimen collection for type and cross compatibility and for general labs was (n = 30, 33.3%) and (n = 28, 31.1%), respectively. An electronic ID system was used by 37 hospitals at the time of bedside pretransfusion verification which included scanning the blood bag during the verification process. Barcode was the primary electronic ID type used for transfusion verification in 27 hospitals and radio frequency ID (RFID) was used in 10 hospitals. Most hospitals with electronic ID continued to require two persons for the pretransfusion verification; only 4 hospitals required one person plus the electronic ID system for pretransfusion verification.

Non-electronic ID methods were used for pretransfusion verification in 58 (39.2%) hospitals. The patient's standard ID wristband was used in 34 hospitals, a non-electronic blood band in 21 hospitals, and barrier systems in 3 hospitals.

Innovative practices intended to assure correct type and screen blood collection and application of the correct blood tube label included the use of two person verification of the collected blood specimen for type and screen (39.5%), or a second phlebotomy specimen for blood type confirmation (26.4%).

Several equipment innovations were commercially available at the time of the study to transport or store blood products. Pneumatic tubes were used in 49 (33.1%) hospitals

and a robot was used in one hospital to deliver blood products to the clinical area. In the majority of the hospitals (n = 138, 93.2%) blood products were not stored or dispensed at the point-of-care. A few hospitals (n = 8, 5.4%) permitted portable blood coolers, one used the Thermal Wizard Red Shield for blood storage up to 24-hours, and one had a satellite blood refrigerator in the medical-surgical patient care areas. No hospital reported use of a blood vending machine.

During the blood transfusion a NIBP was used all (56.8%) or most (35.1%) of the time. In only 16 hospitals (10.8%) the vital signs obtained via the NIBP were automatically downloaded into the electronic medical record. The adoption of infusion pumps to regulate the blood infusion rate was 97.3% (n = 144); 84.9% of the hospitals used infusion pumps all the time. Although 94.6% of the hospitals reported some use of pulse oximeters during blood transfusions, the consistency of reported use was variable, 41.9% all of the time, 17.6% most of the time, and 35.1% occasionally. Only eight hospitals (5.4%) never measured oxygen saturation during blood transfusions. Occasional use of blood warmers in medical-surgical areas was reported by 48.6% of the hospitals.

The requirement to conduct a two person double check of infusing blood with caregiver handoff communication is a process innovation. Thirty hospitals (20.3%) had adopted this safety practice. Another innovation in process and technology was the hospital's voluntary participation in the Hemovigilance Network in which all transfusion related events were electronically reported into the national database of the network. Ninety-three hospitals (66%) participated in this reporting innovation. Although 57% had

nurse representation on the hospital's transfusion committee, only 12% employed a transfusion nurse specialist or blood utilization nurse.

Hospital Education Related to Administration of Blood Products

Almost all hospitals (98%) provided education on blood transfusions for RNs during orientation while LPN/LVNs and non-licensed staff received the transfusion education in fewer hospitals, 57% and 36%, respectively. The ranking of education content topics for RNs and LPN/LVNS was similar, predominantly focused on hospital transfusion procedures (98% and 63%), transfusion reaction symptoms (96% and 61%), and patient management during transfusion reaction (90% and 57%) respectively. Most hospitals did not provide blood transfusion education to non-licensed staff (44%). When the non-licensed staff received blood transfusion education, the primary content areas were hospital procedures (40%), transportation of blood (37%), and symptoms of a transfusion reaction (21%). RN education content on the types of blood products was focused on packed RBCs, platelets, and fresh frozen plasma 99%, 93%, and 93%, respectively. Content on less frequently administered products, whole blood, special products such as irradiated and leukoreduced blood, and cryoprecipitate were only include in the education 57%, 57%, and 55%, respectively.

The comprehensive list of 33 symptoms of a transfusion reaction from the Biovigilance Network was only incorporated into the education program of RNs in 22% of the hospitals. The same rank of transfusion reaction symptoms occurred for all three groups, with fever, chills/rigors, shortness of breath, and itching topping the symptom list. The proportion of hospitals that included BP decrease, BP increase, hypoxemia and

cough in the transfusion content were: RNs (83%, 76%, 57%, and 46%); LPN/LVNs (52%, 48%, 29%, and 29%); and non-licensed staff (17%, 14%, 10%, 13%), respectively.

During orientation of new employees the primary methods of instruction were the requirement to read the hospital's transfusion policy (68%), classroom presentation (65%), online learning (48%) and competency skills validation (46%). During recurring education online learning was the predominant method in 59% of the hospitals with the requirement to read the transfusion policy (44%) and competency skills validation (38%) also used. In all groups the predominant frequency of education was annual (RNs, 81%; LPN/LVNs, 61%; and non-licensed staff 23%). Some hospitals did not provide recurring education on blood transfusions (RNs, 16%; LPN/LVNs, 37%; and non-licensed staff, 77%).

Influential Information Sources

Sources of information and valued resources within the hospital and external to the hospital influence the communication and diffusion of healthcare practices. The transfusion policy was identified by 92% of the hospitals as the primary influence on nurses' transfusion practices. Within the hospital personnel also had strong influences on transfusion practices. The proportion of hospitals that identified specific personnel resources were the transfusion service or blood bank staff (60.5%), staff nurses (57.1%), nurse managers (54.4%), and nurse education specialists (47.6%). Less than one-third of the hospitals (29.9%) reported the physician as having a strong influence on nurses' transfusion practices.

The primary external source of influence on nurses' transfusion practices was journal articles, reported by 47.6% of the hospitals. Subscribed online sources such as Mosby Skills, etc., were reported by 33.3% and the AABB by 30.6% of the hospitals. One-fourth of the hospitals reported general search engines and other internet sources as influential. The Circular of Information was identified as an influential external source by only 17.7% of the hospitals.

Patient and Family Instructions

Patient and family instructions on blood transfusion were primarily verbal instructions provided by the nurse. The consistency of providing verbal information on symptoms the patient should report to the nurse was 62.3% of the hospitals gave verbal instructions all of the time and 30.4% most of the time. Printed materials on blood transfusions were provided less frequently, 25.2% of the hospitals provided information materials all of the time, 12.9% most of the time, and 23.8% occasionally; 37.8% of the hospitals never provided patients print material on blood transfusions. The pamphlets or information sheets were primarily developed by employees of the hospital (57.3%), included symptoms the patient should report to the nurse (96.6%), and were available in more than one language (65.9%).

Differences in Blood Transfusions based on Hospital Size and Magnet Recognition

The statistical results from the chi square calculations that compared hospital size and Magnet recognition to each of the survey questions yielded only two significant associations for hospital size and none for Magnet recognition. The Bonferroni correction for the 524 test comparisons required level of significance was $p = 0.0000954$ for each

test. The use of pneumatic tubes to deliver the blood products and the inclusion of edema as a symptom of a transfusion reaction in the RN education had significant associations to hospital size at a $p = 0.0000954$.

CHAPTER V

SUMMARY OF THE STUDY

The national focus on transfusion safety has promoted advancements in the safety of the blood supply and in transfusion management. Recommendations for further improvements consistently point to a safety gap in the blood administration process, a process that is primarily within the domain of nursing. The U.S. Department of Health & Human Services (April 25, 2010) stated that research is needed to identify knowledge gaps that thwart effective surveillance and reporting of transfusion adverse events, and to propose strategies close these gaps. Unfortunately there is a paucity of nursing research in the U.S. on blood transfusion practices.

For this descriptive study using a non-experimental cross-sectional exploratory design, the population was acute care hospitals in the U.S. whose nurse leader was a member of the American Organization of Nurse Executives (AONE). To describe the state of the science of medical-surgical acute care nurses' practices with blood transfusion, seven research questions were evaluated:

1. What are the reported blood transfusion practices of nurses in medical-surgical patient care units in U.S. hospitals?
2. What innovations in technology and processes have been adopted by nurses in medical-surgical patient care units in U.S. hospitals?

3. What education content and methods of communication are used in the hospital-based preparation of medical-surgical nurses and nursing staff related to the administration of blood products?
4. What internal and external sources of information influence the communication and diffusion of blood transfusion practices of nurses in medical-surgical units in U.S. hospitals?
5. How are patients and their families instructed about symptoms to report during a blood transfusion in medical-surgical patient care units in U.S. hospitals?
6. Do reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differ based on hospital size?
7. Do reported blood transfusion practices, adoption of innovations in technology and processes, hospital-based nurse preparation, sources of influence, or patient and family instructions differ based on Magnet status?

Summary

To describe the state of the science of medical-surgical acute care nurses' practices with blood transfusion therapy, this study relied on a nurse to complete a web-based survey reporting the practices related to medical-surgical nurses of that hospital. Only one survey was completed per hospital. The 72 question survey developed by the author, *Nurses' Practices with Blood Transfusions: Medical-Surgical Acute Care,* was a comprehensive representation of nurses' practices with blood transfusions and addressed

all research questions of the study. The scale content validity index (S-CVI) of 0.963 and Cohen's kappa of 0.797 established the instrument as a valid and reliable tool. A random selection of U.S. hospitals with a nurse executive or leader who was a member of the American Organization of Nurse Executives (AONE) (N = 2082, n = 807) were contacted by postal letter to participate in the study. The data was collected via the web-based survey administered via PsychData. Following four months of data collection, 148 valid responses were obtained in PsychData yielding a response rate of 18.3%.

Discussion of the Findings

In the following discussion, the findings are primarily organized to align with the research questions. When findings are integrated from two research questions such as blood transfusion practices and adoptions of innovations, the synthesized discussion is only presented in one question category.

Blood Transfusion Practices

Nurses perform many common place practices in the clinical environment related to blood transfusions. Although widely adopted as routine practices, they are primarily based on long-standing practices, patient surveillance, or efficiencies in care.

Informed consent. Informed consent for blood transfusion is intended to be a patient-centered activity that involves a discussion between the physician or authorized provider and the patient, with clear communication and mutual understanding of the relevant risks, benefits, and alternatives to blood transfusion. Blood consent is therefore integrally connected with education of the patient. Consent for transfusions is often incorporated into a discussion of another plan for treatment or surgery, or is incorporated

into a general consent for admission and treatment in the hospital. As a result, a meaningful discussion of the risks and alternatives to transfusion is often lacking (Adams & Tolich, 2011; Friedman et al., 2012) and patients rely on the nurse to fill in the gaps and clarify transfusion information (Adams & Tolich, 2011). This study confirmed that nurses are commonly involved with obtaining the patient's signature to document consent. Patients and families may pose transfusion-related questions at the time the nurse is formalizing documentation of consent. These questions can create a conflict for the nurse between the patient's need for education and the nurse's role of a witness of a consenting signature. The timing disconnection between the consent discussion and consent signature place the nurse in the midst of a physician-accountable process. Efforts to facilitate the physician obtaining the patient's consent signature at the same time of the transfusion consent discussion unify the process for the patient and remove potential areas of personal conflict for nurses.

Infusion rates for blood transfusion. Nurses as transfusionists are aware of the impact of infusion rates on transfusion safety. The AABB states that the initial infusion rate for blood transfusions should be slow and that the blood transfusion must be completed within four hours, but no specific infusion rates are specified in the *Circular of Information* (2009). In this study most hospitals specified the infusion rate for the first 15-minutes in the policy although in other hospitals the nurse determined the rate. The range of rates was considerable with 50-75mL/hr and 100-120mL/hr being most common. After the first 15 minutes, the most common practice was for the nurse transfusionist to adjust the infusion rate. Transfusion therapy is highly regulated yet

deference for nursing judgment is clearly evident. Nurses have high respect for blood transfusions and are aware of the need to adjust the infusion rate based on the patient's age and other co-morbid conditions while still completing the infusion within specified time limits.

In this study infusion pumps were used for blood transfusions by almost all hospitals although their use is not required by any regulating or accrediting body. Houck and Whiteford (2007) also identified nurses' preference for infusing blood via an infusion pump. These findings indicate that nurses are cognizant of the importance of rate control for safe blood administration and that infusion pumps have almost universal adoption for intravenous administration.

Administration set replacement. The duration of use for a filtered blood administration is defined in the hospital's transfusion policy which is based on an understanding of the national standard designed to protect the patient from infection risk during a transfusion. The maximum of 4-hours for blood administration tubing is common and was supported in this study as the predominant duration of use. Nurses often interpret this 4-hour limit as a fixed rule of practice yet there is no evidence to support a 4-hour maximum. A 12-hour maximum for use of a blood administration set is the standard of practice in Australia, New Zealand, and many other countries (World Health Organization, n.d.; Australian and New Zealand Society of Blood Transfusion LTD & Royal College of Nursing Australia, 2011). In 2011, the CDC revised their *guidelines for the prevention of intravascular catheter-related infections* and recommended to "replace tubing used to administer blood, blood products, or fat

emulsions . . . within 24 hours of initiating the infusion" (U.S. Department of Health and Human Services, CDC, 2011). As yet, this information has not diffused into the hospital transfusion policies which specify many transfusion practices of nurses. The 4-hour duration of use for a blood administration set is ingrained in nursing transfusion practices. In accordance with Rogers theory of diffusion of innovations, to align this practice with the evidence and extend the duration of use for filtered blood administration sets it will take a concerted effort at mobilizing all sources of influence. Specific attention should address the opinion leaders and gatekeepers at the unit level who have great influence on the final adoption of an innovation.

Transfusion vital signs. Transfusion vital signs are used as a measure of patient surveillance. Nursing research (Fitzgerald et al., 1999) and quality audits (Hodgkinson et al., 1999; Novis et al., 2003; Parris & Grant-Casey, 2007; Row & Doughty, 2000) reported variable compliance with the recommended vital sign frequencies. In this study the uniformity among hospitals in transfusion vital signs obtained pretransfusion, at 10-15 minutes post initiation, and at the end of the transfusion indicated their adoption as the standard of practice. The return to the patient's standard vital sign frequency immediately post transfusion might indicate low diffusion of the importance of close surveillance in the post transfusion period, particularly as it related to TRALI.

Due to the risk for life threatening reactions following small volumes of blood (AABB, 2009) direct observation of the patient from the initiation of the transfusion to the first set of vital signs at 10-15 minutes is a common safety practice. Although the RN was the predominant person to stay with the patient during this period, the practice was

only reported by slightly over half of the hospitals in this study. Time constraints of the nurses in medical-surgical units may influence their decisions to leave the bedside once a transfusion is started. The basis for vital signs equating surveillance is contingent upon the observational skills of the person taking the vital signs. This study identified that non-licensed staff are often delegated transfusion vital signs which may mitigate the quality of the observations while obtaining vital signs, especially if the non-licensed staff do not receive special instructions on specific patient symptoms that should be immediately reported to the nurse.

Nurses embrace the use of technology in their practice if the technology is simple and aids in the work of bedside nursing. In this study non-invasive BP devices were used all or most of the time the large majority of hospitals, yet rarely were the vital signs integrated with the EHR. Innovations that reduce the documentation burden of the bedside nurse will free the nurse for other aspects of assessment and care. Unfortunately the integration of various electronic technologies within a hospital is an information technology challenge.

Non-licensed staff and blood transfusions. In medical-surgical acute care units due to the nurse-to-patient ratios as well as private and semiprivate rooms, patients receiving blood are not directly visible to the nurse for the duration of the transfusion. Baffa (2011) commented in a webinar that the use of non-licensed nursing assistants to obtain vital signs was a common practice in many institutions. No studies or quality audits were identified that addressed the preparation or practice of non-licensed staff outside of blood transportation and patient identification for specimen collection. This study was the

first to report two key findings concerning non-licensed nursing personnel and the blood administration phase. The first was that this study substantiated the perception that transfusion vital signs were delegated to non-licensed staff. Almost three-fourths of the hospitals including hospitals in all size categories delegated transfusion vital signs to non-licensed staff. The second was that despite delegation of these vital signs almost half of the hospitals did not provide blood transfusion education to non-licensed staff; less than a quarter of the hospitals taught symptoms of a transfusion reaction to non-licensed staff. Non-licensed personnel are trained to report any unusual findings to the nurse, however according to John Lubbock (n.d.), "What we see depends mainly on what we look for." The astuteness of observations are based upon what the nursing personnel knows and what the patient reports. These findings confirm a knowledge-gap with non-licensed nursing personnel that are frequently at the patient's bedside during a blood transfusion.

Transportation of patients with infusing blood. In this study, patients with a transfusion in progress were commonly transported off the patient care unit for tests and procedures. Usually RNs were responsible for patient observations during transportation and during the test, but in a quarter of the hospitals only transportation staff accompany the patient. Often the RN from the medical-surgical area transported the patient and if a procedure area RN is not available, also stayed with the patient for the duration of the test or procedure. The likely consequence in these circumstances is that another nurse on the medical-surgical unit must "cover" the transporting nurse's patients. The practice of having an RN transport the patient and stay with the patient if needed supports the high level of accountability and responsibility nurses have for patient safety during blood

transfusions. Unfortunately this practice may also place other patients at risk due to the heavier patient load of the "covering" nurse. Nurses who work in test or procedure areas should be included in blood transfusion education. All non-licensed personnel who interact with patients receiving blood should also be given appropriate education specific to blood transfusions.

Reporting of adverse transfusion events. The underreporting of adverse transfusion events first to the hospital transfusion services and second to a national database is widely accepted (U.S. Department of Health and Human Services, April 25, 2011; Vamvakas & Blajchman, 2009). This underreporting is a direct consequence of the nurses' underrecognition of a potential transfusion reaction (Narvios et al., 2004; Public Health Service (PHS) Biovigilance Working Group (BWG), 2009; Thomas & Hannon, 2010). Once potential transfusion reaction symptoms are recognized by the nurse, who the nurse notifies first may make a difference in the accuracy of transfusion event reporting. Narvios et al. (2004) studied minor transfusion reactions and found that transfusion reactions were first reported to the physicians who chose to not report 50% the occurrences to the transfusion service. In this study, hospital policy specified who should be notified first of a transfusion reaction and most hospitals first notified the ordering or covering physician with only a few hospitals reporting first to the transfusion service. Reporting first to the transfusion service and second to the ordering or covering physician removes the opportunity for the physician to mitigate reporting thereby facilitating accurate investigation of the potential transfusion reaction and ultimately accurate reporting. Although two-thirds of the hospitals in this study participated in

reporting to the Biovigilance Network national database, underreporting may still occur. Nurses are not the only source for underreporting of adverse transfusion events.

Innovations in Technology and Processes

According to Rogers (2003) an innovation can be an idea, technological device, or process that is perceived a new by an individual or group regardless of the actual lapse of time from its discovery. In this study, some innovations in blood transfusion practices were new technologies while other innovations were not new discoveries but new to use with blood transfusions.

Orders for blood transfusion. One of the three zones of errors in blood transfusions is the decision to transfuse (Dzik, 2007) and inherent with the decision is an appropriately communicated transfusion order. Computerized provider order entry (CPOE) for blood transfusion promotes transfusion safety because the order is clearly communicated directly to the transfusion service or blood bank. Non-CPOE handwritten orders require nursing personnel to interpret the order and correctly enter it into the laboratory information system (LIS), a practice often reported in this study. Additionally, in this study nurses in more than half of the hospitals completed the indication for transfusion so that the order would be accepted in the LIS. The intermediary step of order transcription is a potential source for error. In this study most hospitals were in the process of CPOE implementation for blood transfusion orders. With the rapid rate of adoption of CPOE, order entry by nursing personnel into the LIS will decrease thereby removing a source of error.

Blood transport and storage. In this study the predominant method to obtain blood products was for nursing personnel, mostly licensed staff, to leave the clinical area and become blood couriers. Additionally blood products could only be picked up for one patient at a time. These are examples of the high level of awareness of nurses and hospitals for safe conveyance of blood products, yet it takes nurse and nursing personnel out of the clinical area which might lead to safety concerns for other patients.

The adoption of pneumatic tubes for blood transport occurred in 33.1% (n = 49) of the hospitals in this study and the adoption of this technology innovation was statistically associated with larger size hospitals. In 2000 only 10.7% of hospitals used pneumatic tubes for blood transport (Novis et al., 2003). Although the safety of pneumatic tubes for blood delivery was established in the late 1980s (Tanley, Wallas, Abram, & Richardson, 1987), its gradual adoption has taken a predictable path according to Rogers' diffusion of innovations theory. The AABB endorsed the use of pneumatic tubes for blood delivery for many years but did not publish *Guidelines for Pneumatic Tube Delivery Systems: Validation and Use to Transport Blood* until 2004 (AABB). The adoption of pneumatic tubes to transport blood is an innovation with a direct impact on patient safety; blood products are delivered to the clinical area faster and more efficiently (Massachusetts General Hospital, 2005) which promotes adherence to the strict timing for initiating the transfusion. Additionally nursing personnel remain in the clinical area to care for patients. The practicability of adopting this innovation in other hospitals will be influenced by hospital size; the distance and travel time between the clinical areas and the blood bank directly influences the length of time the nursing personnel are away from the

clinical area. Other devices for blood transport and storage such as robots and blood vending machines are new innovations with negligible adoption by the hospitals in this study.

Pretransfusion verification. One of three zones of error identified by W.H. Dzik (2007) is collection of the specimen for type and screen. Three safety practices focus on the prevention of wrong-blood-in-tube errors due to mislabeled or miscollected specimens (Dzik, 2003). The safety practices include collection of a second specimen to confirm blood type, require a second person double check of the patient identification (ID) and the specimen label, and use bedside electronic patient ID for blood specimen collection which commonly includes specimen label generation at the bedside. This study found that all three safety practices were employed with each utilized by only a quarter to half of the hospitals. Barcode armbands are widely used for electronic documentation of medications and the diffusion of this application to specimen collection ID is expected to increase. The use of confirmatory specimens and double checks at the time of specimen collection are likely to decrease as electronic technologies for patient ID, barcode armbands or RFID tags imbedded in the armbands become more prevalent.

Another of W.H. Dzik's (2007) zones of error is pretransfusion verification which is the final check to guarantee the right blood is given to the right patient. A variety of methods are used to assure a match of the blood product to the patient. The addition of a blood band, second wristband with unique numbers that must be matched to the blood bag or blood tag was a common practice in this study. Blood bands are available for electronic and non-electronic ID systems (Brooks, 2005; Dzik, 2005, Dzik et al., 2003).

The patient's standard barcode wristband may also be used to positively match the blood bag with the patient ID in some systems (CareFusion, 2013). Barcode systems when specifically designed for transfusion verification improve transfusion safety by preventing mistransfusions (Chan et al., 2004; Aulbach, et al., 2010; Pagliaro, Turdo, & Capuzzo, 2009). In accordance with Rogers' theory, as electronic ID systems are more widely adopted, individual hospitals will weigh the relative advantages of continuing or discontinuing the use of blood bands as a safety companion to electronic ID systems.

Although scanning the blood bag and the patient barcode wristband may be perceived as providing a positive match between the patient and the blood, some of the CMS certified EHR systems only document the blood number and the patient ID but do not assure a positive match. The Joint Commission states that pretransfusion verification may use "a one-person verification process accompanied by automated identification technology such as bar coding" (The Joint Commission, 2011, p. 3). The technology for electronic transfusion verification is more complex than the technology required for medication administration. The barcode is the same for every package of a dose of medication. In contrast, each individual blood bag has unique barcodes that must be matched to the patient. It is critical that the nurse knows whether or not the electronic ID system positively matches the individual blood bag to the patient or merely documents blood administration. In this study, 37 hospitals used electronic scanning during pretransfusion verification and 33 continued to use two persons in the verification process; no information was gathered in this study on the specific type of electronic system used during transfusion verification. As the adoption of EHR expands, risks to

transfusion safety may increase if nurses assume electronic ID of the blood bag and patient ID equals positive transfusion verification.

Pulse oximetry. Over the last 30 years, the use of pulse oximetry has expanded from the operating room, to the recovery rooms and intensive care units, and now is adopted as a technology in many medical surgical units as well as home health (Pulse oximetry, 2013). In this study almost all of the hospitals measured oxygen saturation at least occasionally during blood transfusions, yet only half of the hospitals included hypoxemia as a transfusion reaction symptom in RN transfusion education. Communication of the importance of oxygen saturation evaluation during blood transfusions has only moderately diffused into transfusion practices. Now that the technical capability of pulse oximetry is widely available, it is important to promote the adoption of oxygen saturation as a fifth transfusion vital sign.

Handoff communication double checks. Double checks to match the blood product with the blood pickup slip at the time of blood issue were standard procedures in most hospitals in this study. At the time of a change in caregiver, handoff communication double check of infusing blood to reverify the blood and patient match is a relative new safety practice that had limited adoption in this study. Although pretransfusion verification should positively match the right blood to the right patient, human error increases with interruptions, distractions and workarounds which compromise safety and lead to transfusion errors (Aulbach, 2010; Hyson, 2009; Linden et al., 2000; Liu et al, 2009; Stainsby et al., 2008; Tucker & Spear, 2006; Turner et al., 2003). Handoff communication double check provides an extra safety measure to assure the right blood is

infusing in the right patient and if a mistransfusion occurred, to limit the amount of mismatched blood transfused.

Nursing Staff Education

Special training of staff on blood transfusions is a requirement of many agencies that accredit hospitals and pathology services. This study confirmed compliance with these standards with almost all hospitals reporting annual compulsory education of RNs. In May 2012, the Centers for Medicare and Medicaid Services (CMS) removed the requirement of special training for non-physicians [nurses] who administer blood products. Although the CMS modifications were intended to remove burdensome regulations, this change has the potential to reduce the safety of transfusions. Saillour-Glenisson et al. (2002) found that higher hazardous blood transfusion practice scores occurred when nurses' training exceeded three years. Heddle et al. (2012) recommended transfusion training at regular intervals. If the CMS position to remove the requirement for special training for non-physician transfusionists is adopted by other regulatory agencies, and hospitals do not independently require this training, nurses may not consistently receive updated information on blood transfusions. A decrease of transfusion education especially for nurses who infrequently administer blood may result in unsafe practices or a lack of awareness of symptoms of a transfusion reaction.

Online learning. Prior to this study, only one research study was identified that included U.S. nurses in an evaluation of blood transfusion training and the education component was limited to frequency and methods of training upon hire (Heddle et al., 2012). In this study, online learning modules were the third most frequent learning

method for orientation of new employees and the primary method for recurring education. The innovation of online learning for education has rapidly diffused through healthcare. The logic behind the rapid adoption of online learning is the ease of use, consistency of information, 24/7 availability, reduced classroom presentations that require the presence of an instructor, and compliance tracking. The rapid adoption of e-learning is consistent with Rogers' diffusion of innovations theory in that hospital leaders and educators identified relative advantages and compliance incentives favoring adoption of e-learning.

Billings and Halstead (2005) reported that online learning is effective, particularly when it is interactive. Heddle et al. (2012) identified that nurses preferred one-on-one training from a highly credible clinician and that transferring e-learning information into clinical practice was a challenge. The number of e-learning courses required annually in a hospital can present an independent challenge to effective learning in that nursing staff may rush through the modules to get to the posttest questions and not fully digest the information. Despite these concerns the rate of adoption of e-learning is poised to increase. The developers of e-learning blood transfusion education for nurses and nursing personnel should strive to improve the interactive aspects of the course to enhance learning and therefore foster transfusion safety. The use of case studies to tell a story in e-learning programs would make the information on blood transfusions relatable and engaging for the nurse.

Transfusion content. In this study, the scope of the transfusion content provided was comprehensive. Unfortunately of only a third of the hospitals that reported

participation in the Hemovigilance Network also included all 33 symptoms of a transfusion reaction identified in the Biovigilance Module in the RN transfusion education program. This gap is an example of silos of information and a lack of interdepartmental communication between the transfusion service and nurses. Nurses cannot provide optimum surveillance of the patient unless they are aware of the current information regarding adverse transfusion events. Only a few symptoms, fever, chills/rigors, shortness of breath, and itching, were taught in ninety percent of the hospitals. Hypoxemia, a key symptom of TRALI, the number one cause of transfusion fatality in the U.S., was only included in slightly more than half of the hospitals education programs. Based on Rogers' diffusion of innovations theory, this comprehensive list of transfusion reaction symptoms is new content for nurses and therefore an innovation of information with a low to moderate rate of adoption.

Since nurses are at the point-of-care and therefore the first to identify symptoms of a potential transfusion reaction, enhanced communication to nurses of all the possible symptoms of a transfusion reaction is essential to support the national initiative of improved surveillance and reporting of transfusion reactions. This communication needs to come from multiple influential sources within and external to the hospital.

Influential Sources of Information

Sources of information were different in their influence on nurses' blood transfusion knowledge and practices. According to Rogers (2003) the sources outside the local social system, e.g. the Internet or sources outside the hospital, have more importance in obtaining knowledge while the sources from within the local social system, e.g. sources

within the hospital, have more persuasive influence on adoption of practices. In this study, both the blood transfusion knowledge and influence on practices came primarily from key resources within the hospital.

Internal sources of influence. In this study, the most common influence on the nurses' transfusion practice was the transfusion policy, followed by the blood bank staff and then other nurses in various roles. Transfusion policies are detailed and establish rules or standard operating procedures for blood administration. The policy dictates desired nursing transfusion practice and accordingly should address common questions of nurses and be up-to-date, e.g. include all 33 symptoms of a transfusion reaction. The persons who write and update the policy therefore have great power over the desired transfusion practices of nurses. The theme of *policy* was identified in a qualitative study of transfusionists' perspective on the pretransfusion checking process; patient safety was adversely impacted by poor communication of policy changes (Heddle et al., 2012). According to Rogers' diffusion of innovations theory, sharing information until a mutual understanding is reached is the desired outcome of the process of communication. The power of the policy to prescribe nursing practice is dependent on how effectively the policy and changes to the policy are communicated to nurses who administer blood transfusions.

The blood bank personnel's rank as the second most common influence is inherently problematic. The medical technologists in the blood bank are not trained to administer blood, yet they are consulted by nurses for clinical blood administration practice concerns. A transfusion nurse specialist would be the ideal resource for nurses instead of

blood bank staff. In this study, other nurses ranked third as an internal resource. The importance of peer-to-peer conversations and influence of opinion leaders are very important to the innovation-decision process (Rogers, 2001; Robinson, 2009). Consultation with a nurse peer has great impact on the transfusion safety practices of nurses.

Two influential nurse roles qualified as innovations. The role of transfusion nurse specialist was created over 20 years ago in Great Britain and has been adopted in other countries (Barbara, Regan, & Contreras, 2008). In the U.S., adoption of this role has been slow despite the endorsement of the AABB. Consistent with Rogers' theory, diffusion of the relative advantage of the role of a transfusion nurse specialist has not been sufficient at the local level to influence the leadership and management of the hospital to adopt and financially support this new role. Only a few hospitals in this study employed a nurse as a transfusion nurse specialist indicating a low rate of adoption.

The importance of having a nurse spokesperson on the transfusion committee is the second influential innovative role. Internal communications are critically important to the diffusion and adoption of new ideas. Nurses in more than half of the hospitals in this study had nurse representation and therefore a voice on the medical service transfusion committee. It is very important for nurses to participate in transfusion practice discussions and decisions to adopt new practices or technologies that impact nurses who are at the point-of-care during blood transfusions.

External sources of influence. In this study, nurses obtain most of their blood transfusion information from influential sources within the hospital and very little from

external sources. Rogers (2003) equated the Internet with mass communication that has the potential to increase the diffusion of innovations. Even though the Internet is widely used as a rapid source of information on many topics, in this study the Internet was not commonly accessed for information on blood transfusions. This may be related to the nurses' seeking authoritative versus general sources for current information on blood transfusions.

The predominant external influential source was journal articles. There is no one nursing journal that houses articles on the most recent advances in transfusion therapy that impact nursing. Blood transfusion articles are dispersed throughout the many nursing journals with different readerships; therefore the diffusion of innovations in transfusion therapy is inconsistent and unpredictable in reaching bedside nurses. Silos of information exist so that memberships in transfusion organizations such as the AABB are needed to access the latest research or innovations in transfusion practices that might impact the nurse transfusionist. Synthesized information of updates in blood transfusion therapy should be published in nursing journals with a wide readership on a regular basis.

Patient Education on Blood Transfusions

Verbal instructions from the nurse were the primary method of providing transfusion education reported in this study. Although the content of the discussion is unknown, variability between nurses is likely. Fitzgerald et al. (1999) found that nurses explained as they worked during the transfusion and rarely invited the patient to offer information or share their concerns. Inadequate patient education on blood transfusions was identified by Hodgkinson et al. (1999) who found that only 69% of patients

perceived they were adequately informed of the blood transfusion. The evidence-based guideline on effective patient education teaching strategies and delivery methods stated that reliance on verbal instructions alone is an ineffective teaching strategy (Friedman et al., 2009). In this study, patient education materials on blood transfusion were provided in less than half of the hospitals all or most of the time, with many never providing written education materials. These findings are consistent with Adams and Tolich's (2011) findings that printed material on blood transfusions was never received, not read, or offered following the transfusion to patients with blood transfusion. Patient safety is enhanced when the patient has knowledge of symptoms that should be promptly reported to the nurse during a transfusion reaction. Supplementing the verbal instructions with written materials on blood transfusions designed at an appropriate reading level would provide a guide for the nurse's discussion with the patient and reference material for the patient and family.

Hospital Size or Magnet Recognition Associations to Transfusion Practices

Only two practices were significantly associated to hospital size, use of pneumatic tubes to transport blood products, and edema identified as a transfusion reaction symptom in the RN education program. There were no statistically significant associations with Magnet status. The ability to identify significant associations was greatly reduced due to a naïve plan to compare hospital size and magnet status to each variable. The level of significance was corrected resulting in $p = 0.0000954$ for each test. Had hospital size and Magnet status been compared to only select variables, other statistical associations might

have been identified particularly in relation to the education of staff, technological innovations, and sources of influence within a hospital.

Conclusions and Implications

The administration of blood products, a transplant of living liquid tissues, is one of the highest risk procedures performed by nurses. Nurses are integrally connected to transfusion safety at two points-of-care, specimen collection for type and screen and administration of the blood product. Despite decades of direct involvement and responsibilities with blood transfusions, research and documentation of the scope of nurses' involvement is lacking. This description of nurses' practices with blood transfusion in medical-surgical patient care units U.S. was comprehensive in scope. The following conclusions are based on a sample of 148; although a responses to few questions had margins of error of 1-3%, most question responses had margins of error of 5-8%. Despite this limitation due to the moderate sample size, the findings of this study provide a snapshot nurses' involvement with transfusions.

Conclusions

The following conclusions were based on the findings of the nationwide survey of nurses' practices with blood transfusions in medical-surgical areas of acute care hospitals.

Nurses' transfusion practices.

1. Nurses have a high level of responsibility for patient safety associated with blood transfusions because they are at the point-of-care for specimen collection, blood administration, patient surveillance, and adverse event reporting.

2. Nurses are critical participants in completing accountability measures for blood transfusion such as documentation for informed consent or indications for transfusion.
3. Nurses utilize safe practices when blood is issued for transfusion.
4. Hospital transfusion policies and procedures prescribe nursing transfusion practices.
    a. Nationwide consensus exists with regard to obtaining transfusion vital signs pretransfusion, 15 minutes post transfusion, and at the end of the transfusion. However, variable practices occur with vital signs obtained during and post transfusion.
    b. Nurses commonly determined the rate of infusion for blood based on their clinical judgment.
    c. Blood product administration set replacement at 4-hours is a deep-rooted practice not supported by evidence.
5. Patient surveillance during blood transfusions may be in jeopardy in medical-surgical areas due to a variety of factors.
    a. Nurses are not informed of all the symptoms of a transfusion reaction and therefore might not correlate the symptom to the transfusion.
    b. Non-licensed nursing personnel are delegated transfusion vital signs, yet are not instructed on specific symptoms of a transfusion reaction that should be immediately reported to the nurse.

c. Some nurses in medical-surgical units do not remain at the bedside for the first 15 minutes of a blood transfusion.
d. Patients with a transfusion in progress are transported off the patient care unit to test and procedure areas by personnel that might not be trained to observe patients with transfusions.

Innovations in technology and process.

1. Electronic technologies for blood transfusions are in the process of adoption.
    a. The implementation of computerized provider order entry (CPOE) for blood transfusion is well underway.
    b. The use of electronic identification for transfusion safety lags behind the use of electronic identification for medication administration.
    c. The use of one person plus the electronic system for transfusion verification is not widely adopted by hospitals with electronic systems.
    d. Nurses embrace technologies that improve safety, accuracy, efficiency of work.
2. Redundant technologies and practices layered onto core processes foster transfusion safety.
3. Oxygen saturation monitoring with blood transfusions is diffusing through hospitals in the U.S. but is not a universal practice.

Nursing staff education.

1. RNs across the nation receive similar blood transfusion education that is comprehensive in scope of topics but not current on symptoms and types of transfusion reactions.
2. Non-licensed personnel are inadequately prepared to assist in the care of patients with blood transfusions.
3. Computer-based education is the primary mode of learning for recurring education on blood transfusions.

Sources of influence.

1. Nurses' transfusion practices are almost entirely determined by the influences within the hospital particularly the hospital's transfusion policy.
    a. The persons who write and update the policy have great influence over the desired transfusion practices of nurses.
    b. The power of the policy to prescribe nursing practice is dependent on how effectively policy changes are communicated to the nurses who administer blood transfusions.
2. Transfusion service personnel are commonly consulted for nurses' blood administration questions.
3. Nurses inform and influence others when there is a nurse representative on the hospital's medical transfusion committee.

Patient education.

1. Patients are not adequately informed about blood transfusions.

2. Patient education materials on blood transfusions are not commonly given to patients.

Associations to hospital size.

1. Blood is transported via pneumatic tubes in larger hospitals.
2. Edema is recognized as a symptom of a blood transfusion reaction in larger hospitals.

Associations to Magnet recognition.

1. Magnet recognition does not influence blood transfusion practices.

Implications

The implications emanating from the findings and conclusions of this study are as follows:

1. Blood transfusion education programs for nurses and nursing personnel should be revised for up-to-date content and interactive learning. The requirement for transfusion education programs for the nurse transfusionist is at risk due to CMS removing the requirement for special training for non-physician transfusionists, but recurring education should continue on an annual basis. All hospital staff who have direct interactions with patients receiving transfusions including staff in test and procedure areas should receive appropriate education. In particular, non-licensed personnel who are frequently delegated to obtain transfusion vital signs or transport patients with blood infusing should be informed of symptoms to report to the nurse.

2. Nurses need to be cognizant of the capabilities of the electronic documentation system to truly verify a match of the blood product to the patient. Systems that only document that a blood product was administered but not actually match the blood product to the patient increase transfusion risk by the creation of a false sense of security in the system. In order to promote transfusion safety, the continued use of two-person double checks during pretransfusion verification may continue even with electronic documentation.
3. Silos of information between the hospital's transfusion service and nurses lead to gaps in information and safe practices. Transfusion services need to fully communicate with nurses and share the latest information on surveillance and reporting of adverse effects of a blood transfusion. Transfusion policy and procedure development should be a joint endeavor of the transfusion service and nurses who understand and can represent the challenges and concerns of the nurse who administers the blood transfusion. Hospitals should consider the employment of a transfusion safety nurse to address transfusion quality concerns that relate to nurses and to be the primary resource for the bedside nurse regarding transfusion practice concerns. Nurses need to be an active partner with the transfusion service in the development of the transfusion policy and procedure and have a voice on the hospital's medical transfusion committee.

4. Access to the hospital's transfusion policy and procedure should be immediately available at the point-of-care via the hospital's intranet, or ideally via a link on the nurse's PDA.
5. Now that the technical capability of pulse oximetry is widely available, it is important to promote the adoption of oxygen saturation as a fifth transfusion vital sign.
6. An overhaul is needed regarding patient education on blood transfusions; learning methods and transfusion content should engage the patient and thereby provide patient-centered care. Consolidating the discussion of informed consent for blood transfusion with obtaining the patient's consent signature has the potential to engage the patient as an active participant in decision to transfuse.

Recommendations for Further Study

Based on findings of this study, research is recommended to address the knowledge gap in following areas:

1. Qualitative and mixed methods research is warranted to evaluate adverse reaction recognition and reporting by nurses, to evaluate patient perceptions of an adverse reaction during a blood transfusion, and to correlate nurse recognition, patient perceptions, documentation, and reporting of adverse transfusion reactions in order to address the nationally recognized gap in surveillance and adverse event reporting.

2. Research is needed to evaluate the effectiveness of online education to impart blood transfusion information to nurses in light of the increased adoption of online learning for nurses.
3. Research is needed to evaluate patient education learning methods and materials on blood transfusion therapy in order to engage the patient in the blood transfusion process.
4. Qualitative research is warranted to explore nurses' perceptions of transfusion safety with new technologies in order to facilitate technology adoption and adaptation to the realities of patient care.
5. Research is needed to evaluate the predictive value of oxygen saturation measured via pulse oximetry to identify and predict hypoxemia-related transfusion reactions in order to promote the adoption of oxygen saturation as a fifth transfusion vital sign. This research could be multidisciplinary with investigators representing nursing, transfusion medicine, and respiratory care.
6. A secondary analysis of this data using only a subset of variables, such as education of RNs, or education of non-licensed personnel, is warranted to identify associations to hospital size or Magnet status.

Concluding Summary

The overarching theme of this descriptive study of the nurses' practices with blood transfusions in medical-surgical acute care units is that nurses have a high level of responsibility for patient safety associated with blood transfusions because they are at the point-of-care for specimen collection, blood administration, patient surveillance, and adverse event reporting. Nurses' practices in transfusion processes are by and large similar across the country with the hospital's transfusion policy providing the specifics for many nursing practices. Surveillance of the patient during blood transfusions may be in jeopardy in medical-surgical areas due to the lack of current information on adverse event recognition included in the education programs, delegation of transfusion vital signs to non-licensed staff who were not educated on symptoms of a transfusion reaction, and transportation patients with blood infusing to tests and procedures by personnel that may not be trained for observation and care of patients with a blood transfusions. Innovations in technologies and processes to promote safe transfusions are variably adopted by U.S. hospitals. Oxygen saturation monitoring is gradually being adopted but is not a universal practice. Hospitals in this study were in the process of adopting electronic technologies to reduce or eliminate wrong-blood-in-tube errors or wrong blood administered mistransfusion errors. The implications for nursing emanating from this study were the need to collaborate with the transfusion service to update information in the transfusion policy and the blood transfusion education programs; include non-licensed staff and other test and procedure staff in compulsory blood transfusion education; and closely evaluate the capabilities of an electronic documentation system to

truly match the patient to the blood product. This descriptive study provided a foundation for future research focused on nurses with blood transfusions.

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APPENDIX A

Permission for Use of the Bass Model Figure

Aulbach, Rebecca

From: Les Robinson [les@enablingchange.com.au]
Sent: Wednesday, October 19, 2011 3:06 PM
To: Aulbach, Rebecca
Subject: Re: Permission to use Bass Model figure in dissertation

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: Folder: Cabinet\Meetings Scheduled\TWU

Hi Rebecca,

Yes, you have my permission to reproduce this diagram. Best wishes with your dissertation proposal. It sounds very interesting. - Les Robinson

On 20/10/2011, at 4:01 AM, Aulbach, Rebecca wrote:

Mr. Robinson,
I am a PhD Nursing Student at Texas Woman's University in Houston. I am requesting your permission to use the following figure in my doctoral dissertation proposal. I am describing nurses' practices with blood transfusions and my theoretical framework is E.M. Rogers' Diffusion of Innovations theory.

The image is from your internet document *Enabling Change* at http://www.enablingchange.com.au/Summary_Diffusion_Theory.pdf
<image002.png>
Source: Mahajan, Muller and Bass (1990) as reproduced in Rogers, E.M.(2003) p210.

Please respond by email regarding your granting or not granding permission for use of your image. If you grant permission, I will followup with the proper permission release document when I discover what is required by my school.

Thanks in advance for considering my request.

Rebecca K. Aulbach, MS, ACNS-BC, CVRN II
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APPENDIX B

Matrix of Research on Nurses and Blood Transfusions

Matrix of Research on Nurses and Blood Transfusions

Melnyk Pyramid of Evidence:

Level 1 - Systematic review & meta-analysis of randomized controlled trials; clinical guidelines based on systematic reviews or meta-analyses
Level 2 - One or more randomized controlled trials
Level 3 -Controlled trial (no randomization)
Level 4 - Case-control or cohort study
Level 5 -Systematic review of descriptive & qualitative studies
Level 6 -Single descriptive or qualitative study
Level 7 - Expert opinion

Source: Melnyk, B.M., & Fineout-Overholt, E. (2011).

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
REVIEW OF THE LITERATURE					
Wilkinson & Wilkinson (2001), *Journal of Clinical Nursing*, United Kingdom	Search of the literature published in English for the words "blood transfusion" and "error".	CINAHL and Medline 1989-1996	8 articles: 1 research; 3 analysis of incident reports; 1 quality improvement on new equipment; 1 national analysis of errors; 1 survey of laboratories; 1 prospective audit of patients	Themes: 1) errors associated with blood transfusions 2) recommendations for good practice for transfused patients and for blood transfusion processes	5

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
EXPERIMENTAL					
Ingrand, Surer-Pierres, Houssay, & Salmi, (1998), *Transfusion* France	Evaluate the utility of bedside agglutination testing with Bristol cards for pretransfusion ABO compatibility.	Observed outcome compared expected outcome.	48 nurse Stratified random sample	Bedside pretransfusion compatibility testing is not safe.	2
QUALITATIVE - Phenomenological					
Adams & Tolich (2011), *AJN*, United States	Describe patient's experiences with blood transfusions.	Semi-structured interview	1 Hospital 21 patients	Themes: 1. paternalism and decision making 2. patient knowledge 3. blood safety 4. nurses role	6
Fitzgerald, Hodgkinson, & Thorp (1999), *Journal of Clinical Nursing*, Australia	Interpret patients' experiences of blood transfusion.	Interview questions not described.	1 Hospital 19 patients	Themes: 1. information-(giving and receiving) 2. reactions (physical and emotional) 3. treatment and care	6

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
Pirie & Gray (2007), *Nurse Education in Practice* Scotland	Triangulation: • Pilot tool • Identify number of hospitals doing competency assessment of transfusion practice. • Explore assessors and nurses experience of formal competency assessment.	Competency Assessment Questionnaire Content validity established by 3 subject experts, 5 educators and 17 transfusion practioners Colazzi's method for interview analysis	17 [nurses] transfusion specialists who oversaw the transfusion practices in 47 hospitals	2 of 46 hospitals (4%) formally assessed transfusion clinical competence of nurses. Barriers: 1) competing staff commitments 2) lack of trained assessors 3) no tool.	6
QUALITATIVE					
Heddle et al. (2012), *Transfusion*, Canada, Italy, Norway, United Kingdom, United States	Understand the pretransfusion checking process from the perspective of the transfusionist, and identify common concerns and safety improvement opportunities.	Discussion guide - validated.	65 nurses; 7 physicians	Themes: 1) pretransfusion checking 2) policy 3) training 4)opportunity for error 5) monitoring the transfusion process	6

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
QUALITATIVE – Institutional Ethnographic					
Hyson (2009), Master's thesis Canada	Explore the process of blood administration safety and to gain an understanding of how transfusion safety was perceived by nurses.	Semi-structured interviews and observations of transfusion practices	9 nurses from 1 medical day unit	Themes: 1) institutional relations 2) inter-departmental communication , 3) acquisition of a remote blood fridge	6
QUALITATIVE - Historical Analysis					
Toman (1998), Master's thesis Canada	Historically analyze how blood transfusions were incorporated into nursing practice.	Authenticity and accuracy of historical data established by oral histories, archives, memoirs, institutional histories, nursing studies, and popular Canadian literature	1 Hospital	Nurses' roles with blood transfusion evolved from assisting, to specialized, to routine. As technology is assimilated, it moves from highly visible to invisible.	6

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
QUANTITATIVE - Descriptive					
Bayraktar & Erdil (2000), *Journal of Intravenous Nursing,* Turkey	Evaluate the knowledge and clinical practice of nurses administering blood transfusions.	Observation checklist and Interview questionnaire No reliability or validity statistics were reported.	100 nurses from 3 randomly selected hospitals	Transfusion knowledge and observed practices were very low; median scores were 31-40%. 98 nurses had never received in-service training on blood transfusion	6
de Graaf, Kajja, Bimenya, Postma, & Sibinga (2009), *Asian J Transfusion Science,* Uganda ; The Netherlands	Analyze the strengths, weaknesses, opportunities, and threats (SWOT) on the basis of observation in the clinical environment.	Clinical observations plus two questionnaires No reliability or validity data provided.	*n* = 41 Randomly selected patients in Uganda; no sample size for The Netherlands. One hospital in each country	Poor transfusion practices in a developing country due to a lack of guidelines, training, equipment, and clinical supervision when compared to a western country.	6

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
Hijji, Parahoo, Hossani, Barr, & Murray (2010), *Journal of Clinical Nursing*, United Arab Emirates	Describe nurses practices with blood transfusions	Non-participant structured observation tool, modified from tool of Bayraktar & Erdil (2000). Face and content validity. Reliability - Kappa of 1	2 Hospitals 49 nurses Random sample	Compliance with recommend safe transfusion practices, was less than 50% (*n* = 37, 75%); and 52-62% (*n* = 12, 24%). 38 nurses 79% never received in-service training on blood transfusions. Safety risks due to lack of observations during the transfusion were identified.	6
Hogg, Pirie, & Ker (2006), *Nursing Education in Practice*, Scotland	Triangulation Describe the development and results of a pilot simulated exercise designed to reinforce and contextualize learning regarding blood transfusions.	Focused groups developed 5 blood transfusion scenarios. Simulated patient and intermediate fidelity simulator. Focused group evaluation and questionnaire	6 nurses	Simulation is effective method to reinforce safe transfusion practices but constraints were the time away from the clinical area, and the equipment and human resources	6

Study author/ year/ journal/ country	Aim/purpose/ or question	Instrument/ analysis	Sample	Findings	Level of evidence
Reza, Aziz, Ali, Marjan, & Reza (2009), *Asian Journal of Transfusion Science,* Iran	Evaluate healthcare workers' knowledge of proper methods for blood transfusion.	Structured interview questionnaire No reliability or validity provided.	Multiple hospitals in one city. 122 health-care workers (92 nurses 3 midwives, 10 OR techs 17 others) Random sampling	Knowledge of blood transfusions was assessed as good (51.5%), moderate (22.2%), and weak (26.2%).	6
Saillour-Glenisson et al. (2002), *International Journal for Quality in Health Care,* France	1) "Describe knowledge, attitudes and reported practice of blood transfusion of nurses. 2) Correlate potential safety threat for patient safety of poor transfusion-related knowledge and practice. 3) Identify factors associated with poor knowledge and practice."	Structured closed response interviews Core safety questions (40%) addressed knowledge and practice. Content validity via nominal group method.	14 Hospitals 1090 nurses Random sample, proportional allocation	Higher hazard knowledge scores occurred with infrequent transfusions, feeling uninformed and lack of information on transfusion safety. Higher hazard practice scores occurred when training was over 3 years and feeling uninformed.	6
Shuriquie, While, & Fitzpatrick, (2008), *Journal of Clinical Nursing,* Jordan	Describe nurses' perception of nursing work.	Questionnaire Only 1 of the 84 questions addressed blood transfusions. Content validity, Test/retest reliability	3 Hospitals 384 nurses, non-probability quota sampling	332 (93%) perceived checking and giving blood transfusion as part of nursing work.	6

APPENDIX C

Matrix of Quality Audits or Improvement Projects of Nurses and Blood Transfusions

Matrix of Quality Audits or Improvement Projects of Nurses and Blood Transfusions

Author/year/ journal/country	Aim/purpose	Method	Sample
Burgess (2006), *Emergency Nurse,* England	Describe the blood transfusion knowledge in an emergency department staff.	60 staff: 45 nurses, 3 support staff, 12 physicians from 1 Hospital Audit questionnaire on blood transfusion knowledge Face validity no reliability	Poor knowledge of blood handling better knowledge of bedside practices. Knowledge deficits in nurses and physicians.
Clark, Rennie, & Rawlinson. (2001). *British Medical Journal* United Kingdom	Objective: to determine whether a training program for staff improve identification and monitoring of patients for transfusion.	Retrospective chart review, of compliance with national guidelines pre and post an training program	Pre: *n* = 148 charts Post *n* = 166 charts
Hodgkinson, Fitzgerald, Borbasi & Walsh (1999), *Journal of Quality in Clinical Practice,* Australia	Describe the current state of practice with blood transfusions.	Cluster sampling, 5 transfusions per week for 51 weeks. 365 patients, 704 RBC transfusions Concurrent audit (within 24 hours of transfusion) Questionnaire in handheld computer; data from review of the medical record, and patient interviews and observations No reliability or validity reported.	Patient perceptions of being informed exceeded documentation of informed consent. ID wrist bands (96%). Start blood within 30 minutes (82%) Baseline vital signs (78%) Observations during the transfusion (47%)
Houck & Whiteford, (2007). *Journal of Infusion Nursing,* United States	Adult inpatient and outpatient oncology unit. U.S.	Cost, nursing time, and catheter patency described No reliability or validity of data collection tools.	*n* = 169 units of blood products *n* = 117 with IV pumps (33 PICC) *n* = 52 without IV pumps (all non-PICCs)

Author/year/ journal/country	Aim/purpose	Method	Sample
Narvios, Lichtiger, & Newman. (2004). *Medscape General Medicine,* United States	Evaluate minor transfusions reactions that were not reported to the transfusion service	Questionnaire of 10 items completed when a transfusion adverse event was not reported to the Transfusion Service. No reliability/validity	*n* = 58 cases of unreported transfusion events in a specialized oncology unit
Novis, et al. (2003). *Archives of Pathology & Laboratory Medicine* *United States Canada Australia United Kingdom New Zealand Spain South Korea	Two multicenter audits of 660 institutions primarily from U.S. (97% in 1994), (95.3% in 2000). Other participants from Canada, Australia, UK, New Zealand, Spain, South Korea. Descriptive and comparative analysis of the two periods of data collection.	Prospective observation of blood transportation, transfusion verification, and vital signs for the first 20 minutes. Detailed questionnaire on institutions transfusion policies. The content of questions was the same in both studies. No report of reliability or validity of the questionnaire.	*n* = 16,494 non-emergent transfusions: *n* = 12,448 in 1994 study *n* = 4046 in 2000 study 660 participating institutions: *n* = 519 in 1994 study *n* = 233 in 2000 study *n* = 92 in both 1994 and 2000
Parris & Grant-Casey. (2007), Nursing Standard. United Kingdom	Examine the practice of pretransfusion identification verification and patient monitoring during RBC transfusions.	Organizational audit and a clinical observation audit.	*n = 270 hospitals, convenience sample* *n = 8,054 transfusions*

Author/year/ journal/country	Aim/purpose	Method	Sample
Rowe & Doughty. (2000), *British Journal of Nursing* United Kingdom	Identify current bedside transfusion practices in one hospital.	Retrospective chart review with a validated proforma (instrument). The published source of the instrument validation was provided but no reliability or validity statistics were reported in this article.	*n* = 100 consecutive patients with two or more transfusions within six, 20 from each of five directorates (clinical areas). Quota sampling Non-probability sampling
Saxena, Ramer, & Shulman (2004) *Transfusion* California.	Plan-do-check-act (PDCA), quality improvement project of a comprehensive assessment of the blood administration.	Trained nurse evaluators directly observed transfusions	One hospital in California. *n* = 982 transfusions; $\bar{x}$ = 19 per month over a period of 51 months (1999-2003).
Thomas & Hannon. (2010), *Transfusion* United States.	Evaluate the incidence of transfusion reactions.	Retrospective review of transfusion episodes with chart audit if transfusion reaction criteria were met. Criteria for transfusion reactions were based on each hospital's criteria No reliability or validity of data collection tool.	*n* = 3024 transfusion episodes

APPENDIX D

Comparison of Adverse Transfusion Events by Organization

Comparison of Adverse Transfusion Events by Organization

Transfusion Reactions or Adverse Events	AABB Circular of Information[1]	U.S. CDC NHSN[2]	U.S. 2009 NBCUS[3]	American Red Cross Practice Guidelines[4]	U.K. SHOT [5]
Immunologic - Acute					
Hemolytic (AHTR) • ABO • Non-ABO	X	X	 X X	X	X
Acute Transfusion Reaction (anaphylactic, angioedema, allergic with bronchospasm, hypotensive, supraventricular tachycardia with fever)					X
Febrile non-hemolytic transfusion reaction (NFHTR)	X	X	X	X	
Immune-mediated platelet destruction	X			X	
Allergic Reaction	X	X	X	X	
Anaphylaxis Reaction	X			X	
Transfusion-related acute lung injury (TRALI)	X	X	X	X	X
Immunologic - Delayed					
Delayed hemolytic transfusion reaction (DHTR)	X	X		X	
Delayed serologic transfusion reaction (DSTR)		X	X		
Alloimmunization post transfusion	X			X	
Posttransfusion purpura (PTP)	X	X	X	X	X
Transfusion-associated graft vs. host disease (TAGVHD)	X	X	X	X	X
Nonimmunologic Complications					
Transfusion-transmitted Infectious (TTI)	X	X	X	X	X
Bacterial contamination/sepsis	X		X	X	
Transfusion-associated circulatory overload (TACO)	X	X	X	X	X
Hypothermia	X			X	
Metabolic complications (e.g. citrate toxicity, acidosis or alkalosis)	X			X	
Hypotensive transfusion reaction		X			
Transfusion-associated dyspnea (TAD)		X	X		X
Iron overload	X			X	
Incorrect blood component transfused (IBCT)					X
Inappropriate and unnecessary transfusion (I&U)					X
Anti-D events					X
Handling and storage errors (HSE)					X

1. Circular of Information for the Use of Human Blood and Blood Components. AABB (2009)
2. The National Healthcare Safety Network (NHSN) Manual, Biovigilance Component - Hemovigilance Module.U.S. Centers for Disease Control and Prevention (2011)
3. U.S. 2009 National Blood Collection and Utilization Survey Report. Department of Health & Human Services (2011).
4. American Red Cross Practice Guidelines for Blood Transfusion. Cable, et al. (2007)
5. The 2010 Annual SHOT Report.Knowles, S. (Ed.), & Cohen, H. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. (2011).

APPENDIX E

Letters of TWU Institutional Review Board (IRB) Approval

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

April 24, 2012

Ms. Rebecca K. Aulbach
College of Nursing
6700 Fannin Street
Houston, TX 77030

Dear Ms. Aulbach:

Re: *Nurses' Practices with Blood Transfusions in Medical-Surgical Patient Care Units of Acute Care U.S. Hospitals - The State of the Science (Protocol #: 17642)*

The above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and was determined to be exempt from further review.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Carolyn Kelley

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston

TWU INSTITUTIONAL REVIEW BOARD (IRB)

MODIFICATION REQUEST FORM

Complete this form when you would like to request a change on an approved study. This change could be a change in the research team, data collection sites, protocol (e.g., compensation, study procedures, etc.), and/or the informed consent. Submit this signed form along with copies of any new or modified materials you describe below to the IRB. NOTE: You may not implement any changes to an IRB-approved study until your Modification Request has been approved.

PRINCIPAL INVESTIGATOR: Rebecca K. Aulbach

DATE APPROVED BY IRB (most recent): April 24, 2012

TITLE OF STUDY: Nurses' Practices with Blood Transfusions in Medical-Surgical Care Units of Acute Care U.S. Hospitals - The State of the Science. (Protocol #: 17042)

Provide a detailed description of the modification(s) requested:

A different participant recruitment letter is attached. The incorrect letter was previously attached to the original IRB application.

Provide a list of any new or modified documents materials and attach these items to this form:

Recruitment Letter to CNO

Principal Investigator Assurance: I certify that the revised information provided for this project is correct and that no other procedures or forms will be used. I confirm that no changes will be implemented until I receive written approval for the changes from the TWU IRB.

Rebecca K. Aulbach
Signature of Principal Investigator

4-26-2012
Date

APPROVED:

Cindy Kelly
Signature of IRB Chair / Co-Chair

5-1-12
Date

APPENDIX F

Nurses Practices' with Blood Transfusions: Medical-Surgical Acute Care

Web-based Survey

Nurses Practices' with Blood Transfusions: Medical-Surgical Acute Care Web-based Survey

Hospital Demographics

1. What is the size (number of staffed inpatient beds) of your hospital?
   - ○ 500 or more acute care beds
   - ○ 250 to 499 acute-care beds
   - ○ 100 to 249 acute care beds
   - ○ 25 to 99 acute care beds

2. In what state is your hospital located? [Drop-down box: _____]

3. What is the population size of the city or town where your hospital is located?
   - ○ More than 500,000
   - ○ 100,000 to 500,000
   - ○ 15,000 to 99,999
   - ○ Less than 15,000

4. How would you describe your hospital? Select one in each category.
   Community or Federal
   - ○ Non-government community hospital
   - ○ Investor-owned community hospital
   - ○ State or local government community hospital
   - ○ Federal government hospital

   Teaching (training for medical students and resident physicians) or Non-teaching
   - ○ Teaching
   - ○ Non-teaching

5. Does your hospital have Magnet Recognition awarded by the American Nurses Credentialing Center (ANCC)?
   - ○ Yes
   - ○ No

Transfusion Orders & Policy

6. For blood transfusion orders, Computer Provider Order Entry (CPOE) is *
   Computer Provider Order Entry (CPOE) allows the physician or provider to directly enter orders into a computer. No transcription of the order is needed by other healthcare staff.
   - ○ Fully or almost fully implemented (75% or greater)
   - ○ Partially implemented (less than 75%)
   - ○ Not part of the current routine ordering process (0%)

7. How often do nurses complete the clinical indication for a blood transfusion order because the indication was not specified by the physician?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

8. How frequently do non-licensed staff in medical-surgical units enter non-CPOE orders for blood transfusion into the laboratory information or computer system?

    Non-CPOE orders are those NOT ordered directly in a computer system.

    Non-licensed staff includes Secretaries, Patient care assistants (PCA), Patient care technicians (PCT), Certified nursing assistants (CNA), etc.
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

9. Who may obtain blood samples for type and screen?
   Check all that apply.
    - ○ RN
    - ○ LPN/LVN
    - ○ Non-licensed nursing staff
    - ○ Phlebotomist

10. How many persons are required to verify a blood specimen collected for type and screen (compatibility testing)?
    - ○ Two persons must verify the blood tube label / patient match
    - ○ Only the person drawing the blood verifies the blood tube label / patient match

11. Is a second blood sample required to confirm blood type prior to blood transfusion?
    Confirmatory blood typing is a second phlebotomy sample to confirm the blood type match prior to administration.
    - ○ Yes
    - ○ No

12. What parameters are assessed with blood transfusion vital signs?
    - ○ BP
    - ○ Pulse
    - ○ Respiratory Rate
    - ○ Temperature
    - ○ Pulse Ox (oxygen saturation)

13. Per hospital policy, when are transfusion vital signs obtained?
    Check only those specified in policy.
    - ○ Pretransfusion
    - ○ 10-15 minutes after initiation of transfusion
    - ○ Every 30 minutes during transfusion
    - ○ Every 60 minutes during transfusion
    - ○ At the end of transfusion
    - ○ 30 minutes post transfusion

14. Post-transfusion, are vital signs monitored more frequently than the patient's standard vital signs?
    - ○ Yes
    - ○ No

15. What is the primary method for determining the RATE of infusion for the FIRST 15 minutes of a blood transfusion?
    - ○ Specified in policy
    - ○ Specified in the transfusion order
    - ○ Determined by the nurse or transfusionist

16. What rate (mL/hr) is specified in policy for the first 15 minutes?
    Enter "0" if not specified in policy
    Text box (ten-character limit) [____]

17. How is the infusion RATE after the first 15 minutes determined?
    - ○ Specified in policy
    - ○ Specified in the transfusion order
    - ○ Determined by the nurse or transfusionist

18. Per hospital policy, what is the maximum number of HOURS one blood administration set (filtered blood tubing) may be used?
    Enter "0" if not specified in policy.
    Text box (two-character limit) [____]

19. Per hospital policy, during handoff communication with a change in caregiver, is the blood product infusing rechecked for identification match to the patient?
    - ○ Yes
    - ○ No

20. In clinical practice, who does the nurse notify FIRST if there is a possible blood transfusion reaction?
    - ○ Transfusion Service (Blood Bank / Laboratory)
    - ○ Ordering physician
    - ○ Covering physician
    - ○ Attending physician of record

21. Who determines if a possible blood transfusion reaction is reported to the Transfusion Service (Blood Bank / Laboratory)?
    - ○ Physician
    - ○ Nurse
    - ○ Stated in Policy

Technology and Safety Measures

22. Does your hospital use a unique patient wristband for blood transfusion (blood band) in addition to the standard patient identification wristband?
    - ○ Yes
    - ○ No

23. Do nurses use electronic identification (ID) systems (hand held scanners or computer wands) in your hospital?*
    - ○ Yes [LOGIC, skip to 24]
    - ○ No [LOGIC, skip to 23]

24. What non-electronic identification system is used for bedside pretransfusion verification? [LOGIC skip to #29]
    - ○ Standard patient ID wrist band
    - ○ Unique non-electronic blood band (Ident-A-Blood or Securline, etc.)
    - ○ Barrier system (BloodLoc or Typenex FinalCheck, etc.)

    (The blood bag is locked in a clear plastic bag and unlocked with a code from the patient's wristband)

25. The bedside electronic identification (ID) systems (scanners/wands) are used for which activities:
    Check all that apply.
    - ○ Patient identification (PPID or positive patient identification)
    - ○ Medications
    - ○ Specimen collection (for general labs)
    - ○ Blood sample collection (for blood compatibility testing)
    - ○ Blood product administration (bedside transfusion verification)

26. Is the Blood Bag scanned as part of electronic transfusion verification?
    - ○ Yes
    - ○ No

27. What type of bedside electronic identification (ID) system is used for pre-transfusion verification?
    - ○ Barcode ID [LOGIC to #27]
    - ○ Wireless RFID tag, Radio Frequency IDentification (SmartBand RFID, etc.) [Logic, Skip to #28]
    - ○ QR Code (Quick Response code) [Logic, Skip to #28]
    - ○ Wireless proximity tag [Logic, Skip to #28]

28. What type of Barcode wristband is used for pre-transfusion verification?
    - ○ Standard barcode wristband for patient identification
    - ○ Unique barcode blood band (e.g. I-Track Plus, Securline, Typenex, etc.)

29. How many licensed staff are required to complete **electronic** bedside pre-transfusion verification?
    - ○ One person
    - ○ Two persons

30. What methods are used to transport blood products to the clinical area?
    Check all that apply.
    - ○ Nursing personnel
    - ○ Other hospital personnel
    - ○ Pneumatic tube
    - ○ Robot (UG Automated Robotic Delivery by Aethon, etc.)

31. Who is most likely to pick up blood products from the Transfusion Service (Blood Bank/Laboratory)?
    - ○ Non-licensed staff
    - ○ Licensed staff

32. Which of the following are used to store or dispense blood products at the point-of-care in medical-surgical units. Check all that apply.
    - ○ Portable blood cooler with ice packs/timer (several hours of cooling)
    - ○ Thermal Wizard Red Shield blood cooler with an electronic temperature validator (up to 24 hours of continuous cooling)
    - ○ Satellite blood product refrigerators (located outside the Transfusion Service/Blood Bank)
    - ○ Blood Bank Vending Machine (BloodTrack HemoSafe system, etc.)
    - ○ Not applicable - Blood is not stored or dispensed in medical-surgical units.

Bedside Transfusion Practices in Medical-Surgical Patient Care Units

33. In medical-surgical units are blood transfusion vital signs delegated to non-licensed nursing staff? (CNA, PCA HT, or others)
    - ○ Yes
    - ○ No

34. In medical-surgical units does someone from the nursing staff stay at the patient's bedside during the first 15 minutes of a transfusion?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

35. Who is the most likely person to remain at the bedside during the first 15 minutes of the transfusion?
    - ○ RN
    - ○ LPN / LVN
    - ○ Non-licensed staff

36. In medical-surgical areas (non-ICU) how often is an automatic or electronic non-invasive BP (NIBP) device such as a Dinamap used during blood transfusions?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

37. Are transfusion vital signs from a NIBP device automatically integrated (downloaded) into the electronic medical record (EMR)?
    - ○ Yes
    - ○ No

38. How is the flow rate regulated for blood products in medical-surgical units? Check all that apply.
    - ○ Infusion pump
    - ○ A flow regulating device such as a Dial-a-Flow or Control-a-Flo, etc. is added to the filtered blood administration set.
    - ○ Roller clamp on the filtered blood administration set

39. How often is an Infusion Pump used for blood transfusions in medical-surgical units?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

40. How often is Pulse Ox (oxygen saturation) measured on patients receiving a blood transfusion in medical-surgical units?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

41. Are blood warmers occasionally used in medical-surgical units?
    - ○ Yes
    - ○ No

42. Are patients from medical-surgical units transported to diagnostic testing or procedure areas <u>with blood infusing</u>?
    - ○ Yes [Logic: Skip to #42]
    - ○ No [Logic: Skip to #44]

43. Who observes the patient receiving a blood transfusion during transportation to the test or procedure?
    - ○ RN
    - ○ LPN / LVN
    - ○ Non-licensed nursing staff
    - ○ Transport staff, non-clinical
    - ○ Physician

44. Who observes the patient receiving a blood transfusion DURING the test or procedure?
    - ○ Test/Procedure area RN
    - ○ Test/Procedure area technician
    - ○ Physician
    - ○ Medical-surgical unit RN who stays with the patient
    - ○ Medical-surgical unit LPN / LVN who stays with the patient

Nurses & Nursing Staff Preparation

45. During orientation of NEW employees, who receives education on blood transfusions? Check all that apply.
    - ○ RNs
    - ○ LPNs or LVNs
    - ○ Non-licensed nursing staff (PCA, PCT, CNA, etc.)
    - ○ Not applicable - Blood transfusion is NOT covered during orientation for new employees.

46. During orientation of NEW employees, what methods are used for education on blood transfusions? Check all that apply.
    - ○ Online module (eLearning)
    - ○ Video
    - ○ Classroom presentation
    - ○ Read transfusion policy
    - ○ Self-learning module (content in addition to policy)
    - ○ Competency validation skills station
    - ○ Simulation plus discussion
    - ○ Case studies

47. During orientation for new RNs, what information is included in the blood transfusion education?
    Check all that apply.
    - ○ Hospital procedures (ordering, obtaining blood, vital sign frequency, etc.)
    - ○ Transporting blood products
    - ○ Equipment used for blood transfusions (infusion pumps, or scanners, etc.)
    - ○ Types of blood products & blood filters
    - ○ Infusion rates and duration of infusion
    - ○ Symptoms of transfusion reactions
    - ○ Patient management of a transfusion reaction
    - ○ Types of transfusion reactions
    - ○ Blood conservation
    - ○ Blood wastage (blood unit/bag NOT returned to the blood bank within time or temperature limits)

48. Which blood products are included in the RN education
    Check all that apply.
    - ○ Whole blood
    - ○ Packed red blood cells (PRBC)
    - ○ Fresh frozen plasma (FFP)
    - ○ Platelets
    - ○ Cryoprecipitate
    - ○ Special products (leukoreduced, irradiated blood products, etc.)

49. In the RN education on blood transfusions, which transfusion reactions listed below are reviewed in your hospital's education program?
    Check all that apply.
    - ○ Allergic reaction
    - ○ Acute hemolytic transfusion reaction (AHTR)
    - ○ Delayed hemolytic transfusion reaction (DHTR)
    - ○ Hypotensive transfusion reaction
    - ○ Febrile non-hemolytic transfusion reaction (NFHTR)
    - ○ Transfusion associated circulatory overload (TACO)
    - ○ Transfusion associated dyspnea (TAD)
    - ○ Transfusion associated – graft vs. host disease (TA-GVHD)
    - ○ Transfusion-related acute lung injury (TRALI)
    - ○ Infection

50. For RNs what adverse reactions are identified in their transfusion education? Check only those that are directly mentioned in the education program.

- ○ Chills/rigors
- ○ Fever
- ○ Nausea/vomiting
- ○ Bradycardia
- ○ Blood pressure increase
- ○ Blood pressure decrease
- ○ Shock
- ○ Tachycardia
- ○ Edema
- ○ Flushing
- ○ Hives
- ○ Itching
- ○ Jaundice
- ○ Urticaria
- ○ Other rash
- ○ Diffuse hemorrhage
- ○ Hemoglobinemia
- ○ Positive antibody screen
- ○ Abdominal pain
- ○ Back pain
- ○ Chest pain
- ○ Flank pain
- ○ Headache
- ○ Infusion site pain
- ○ Other pain
- ○ Dark urine
- ○ Hematuria
- ○ Oliguria
- ○ Bilateral infiltrates on chest x-ray
- ○ Cough
- ○ Hypoxemia
- ○ Shortness of breath
- ○ Wheezing

51. During orientation for new LPNs or LVNs, what information is included in the blood transfusion education? Check all that apply.

- ○ Hospital procedures (ordering, obtaining blood, vital sign frequency, etc.)
- ○ Transporting blood products
- ○ Equipment used for blood transfusions (infusion pumps, or scanners, etc.)
- ○ Types of blood products & blood filters
- ○ Infusion rates and duration of infusion
- ○ Symptoms of transfusion reactions
- ○ Patient management of a transfusion reaction
- ○ Types of transfusion reactions
- ○ Blood conservation
- ○ Blood wastage (blood bag/unit NOT returned to the blood bank within time or temperature limits)

52. For LPNs or LVNs what adverse reactions are identified in their transfusion education? Check only those that are directly mentioned in the education program.

- ○ Chills/rigors
- ○ Fever
- ○ Nausea/vomiting
- ○ Bradycardia
- ○ Blood pressure increase
- ○ Blood pressure decrease
- ○ Shock
- ○ Tachycardia
- ○ Edema
- ○ Flushing
- ○ Hives
- ○ Itching
- ○ Jaundice
- ○ Urticaria
- ○ Other rash
- ○ Diffuse hemorrhage
- ○ Hemoglobinemia
- ○ Positive antibody screen
- ○ Abdominal pain
- ○ Back pain
- ○ Chest pain
- ○ Flank pain
- ○ Headache
- ○ Infusion site pain
- ○ Other pain
- ○ Dark urine
- ○ Hematuria
- ○ Oliguria
- ○ Bilateral infiltrates on chest x-ray
- ○ Cough
- ○ Hypoxemia
- ○ Shortness of breath
- ○ Wheezing

53. During orientation, what information is included in the Non-licensed staff blood transfusion education? Check all that apply.

- ○ Not applicable - Non-licensed staff do NOT receive blood transfusion education.
- ○ Hospital procedures (entering orders into the computer, obtaining blood, vital sign frequency, etc.)
- ○ Transporting blood products
- ○ Different blood products (packed red blood cells (PRBC), fresh frozen plasma (FFP), platelets, cryoprecipitate)
- ○ Symptoms of transfusion reactions
- ○ Responsibilities during a transfusion reaction

54. For Non-licensed staff, what adverse reactions are identified in their transfusion education? Check only those that are directly mentioned in the education program
    - ○ Not applicable - Non-licensed staff do NOT receive education on blood transfusions.
    - ○ Chills
    - ○ Fever
    - ○ Nausea/vomiting
    - ○ Bradycardia
    - ○ Blood pressure increase
    - ○ Blood pressure decrease
    - ○ Shock
    - ○ Tachycardia
    - ○ Edema
    - ○ Flushing
    - ○ Hives
    - ○ Itching
    - ○ Jaundice
    - ○ Urticaria
    - ○ Other rash
    - ○ Diffuse hemorrhage (bleeding)
    - ○ Abdominal pain
    - ○ Back pain
    - ○ Chest pain
    - ○ Flank pain
    - ○ Headache
    - ○ Infusion site pain
    - ○ Other pain
    - ○ Dark urine
    - ○ Bloody urine
    - ○ Cough
    - ○ Hypoxemia
    - ○ Shortness of breath
    - ○ Wheezing

55. RNs complete education about blood transfusions every _____ year(s).
    Enter "0" if recurring education on blood transfusions is NOT required for RNs.
    Text box (two-character limit) [____]

56. LPNs or LVNs complete education about blood transfusions every _____ year(s).
    Enter "0" if recurring on blood transfusions is NOT required for LPNs/LVNs.
    Text box (two-character limit) [____]

57. Non-licensed staff receives education about blood transfusions every _____ year(s).
    Enter "0" if non-licensed staff is NOT required to receive education on blood transfusions.
    Text box (two-character limit) [____]

58. During Recurring Education on blood transfusions, what methods are used?
    - ○ Online module (eLearning)
    - ○ Video
    - ○ Classroom presentation
    - ○ In-service
    - ○ Read transfusion policy
    - ○ Self-learning module – (content in addition to policy) written
    - ○ Competency validation skills station
    - ○ Simulation with discussion
    - ○ Case studies
    - ○ Blended learning (online eLearning PLUS discussion)

59. Which internal resources have a strong influence on nurse's blood transfusion practices: Check all that apply.
    - ○ Hospital policy
    - ○ Clinical nurse specialists or nurse practitioners
    - ○ Nurse education specialists
    - ○ Nurse managers
    - ○ Other staff nurses
    - ○ Physicians
    - ○ Staff from the Transfusion Service (Blood Bank)
    - ○ Transfusion safety medical officer
    - ○ Transfusion safety nurse

60. Which external resources do nurses use to obtain updates with current information on blood transfusions? Check all that apply.
    - ○ AABB
    - ○ Circular of Information
    - ○ Google or other general search engines
    - ○ Members of an Online professional listserv or group
    - ○ Journal articles
    - ○ Medscape (free weekly electronic newsletter, or nursing education CE, etc.)
    - ○ Subscribed online sources (example: Mosby Skills or Mosby Consults, tec.)
    - ○ Textbooks
    - ○ Webinars on blood transfusions
    - ○ Other internet sources

Patient & Family Instructions

61. Prior to the blood transfusion, how often are patients and families <u>verbally informed</u> by the nurse of symptoms to report during a blood transfusion?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

62. How often is a blood transfusion pamphlet or patient information sheet given to patients prior to transfusion?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never [Logic: Skip to #65]

63. Who developed the blood transfusion pamphlet or information sheet?
    - ○ In House: Employee of the hospital or healthcare system
    - ○ Outside Source: An example is Krames Patient Education, The Patient Education Institute, Micromedex CareNote® or others

64. Does the blood transfusion pamphlet or information sheet include Symptoms to Report to the nurse?
    - ○ Yes
    - ○ No

65. Is the blood transfusion pamphlet or information sheet available in more than one language?
    - ○ Yes
    - ○ No

66. How often are nurses obtaining signatures for informed consent that authorize the transfusion of blood products?
    - ○ All of the time
    - ○ Most of the time
    - ○ Occasionally
    - ○ Never

Nursing & the Transfusion Service (Blood Bank)

67. What documentation or paperwork is required to pick up blood from the Transfusion Service (Blood Bank)?
    - ○ Transfusion order
    - ○ A blood product transport request form (Example: Blood Pick-up Slip, Blood Card, or Blood Transport Request, etc.)
    - ○ No paperwork is required to pick up blood

68. Which items are "double checked" at the time of issue from the Transfusion Service (Blood Bank)?
    A "double check" system is where two persons verify a process.
    - ○ Blood product is labeled correctly before issue.
    - ○ Blood product is compared to the Order or transport request form before issue.
    - ○ No double check is required.

69. May one person pick up blood from the Transfusion Service (Blood Bank) for Different Patients at the same time?
    - ○ Yes
    - ○ No

70. Transfusion related sentinel events (transfusion fatality or wrong blood infused, etc.) are required to be reported to the FDA.
    Does your hospital Voluntarily participate in the Biovigilance Network, an AABB and CDC partnership, and report other transfusion-related adverse events?
    - ○ Yes
    - ○ No

71. Does your hospital employ a Transfusion Nurse Specialist or Blood Utilization Specialist?
A Transfusion Nurse Specialist is a nurse who is the liaison between Nursing and the Transfusion Service (Blood Bank), answers nurse's questions about blood transfusions, may develop blood transfusion education for nurses may collect quality data related to blood transfusions, and may be involved with blood product utilization, etc
    - ○ Yes
    - ○ No

72. Does your hospital have a nurse representative on the Transfusion Committee?
A Transfusion Committee is a medical staff committee that monitors and addresses transfusion practices.
    - ○ Yes
    - ○ No

APPENDIX G

Chi Square Tables of All Questions for Associations to Hospital Size

Table 40

Chi Square Comparisons for Hospital Size to Questions 6-17

No	Question	Hospital Size			
		n	*df*	χ^2	*p*
6.	Computer Provider Order Entry (CPOE) for transfusion orders	147	6	13.957	.030
7.	RNs complete clinical indications for transfusion order because indication not specified by physician	147	9	4.138	.902
8.	Non-licensed staff enter non-CPOE orders into laboratory information system (LIS)	147	9	9.344	.406
9.	Who obtains blood sample for type and screen				
	RN	147	3	1.755	.625
	LPN/LVN	147	3	5.736	.125
	Non-licensed nursing staff	147	3	12.271	.007
	Other (non-nursing staff phlebotomist)	147	3	4.622	.202
10.	Number of persons to verify a blood specimen for type and screen	146	3	2.066	.559
11.	Second blood sample required to confirm blood type	147	3	7.447	.059
12.	Parameters assessed with transfusion vital signs				
	Blood pressure	147	3	2.211	.530
	Pulse	146	3	2.211	.530
	Respiratory rate	147	3	1.331	.722
	Temperature (100% agree, not computed)	147			
	Pulse Ox (oxygen saturation)	147	3	5.308	.151
13.	Transfusion vital signs are obtained				
	Pre-transfusion	147	3	1.212	.750
	10-15 minutes after initiation of transfusion	147	3	2.330	.507
	Every 30 minutes during transfusion	147	3	6.444	.092
	Every 60 minutes during transfusion	147	3	4.768	.190
	End of transfusion	147	3	3.338	.342
	30 minutes post transfusion	147	3	16.643	.001
14.	Post-transfusion vital signs are monitored more frequently than the patient's standard vital signs	147	3	3.102	.376
15.	Method to determine infusion rate for first 15 minutes	146	6	5.936	.430
16.	Infusion Rate in policy for first 15 minutes	147	48	45.435	.579
17.	Method to determine infusion rate after first 15 minutes	146	6	14.952	.021

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 41

Chi Square Comparisons for Hospital Size to Questions 18-30

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
18.	Maximum hours of use for one filtered blood administration set	147	15	23.675	.071
19.	During handoff communication, transfusing blood is rechecked for identification match to the patient	147	3	2.432	.488
20.	Who is first notified by the nurse of a transfusion reaction	147	9	6.261	.714
21.	Who determines if transfusion reaction is reported to the Transfusion Service	146	5	6.069	.416
22.	Unique wristband for blood transfusion (blood band)	147	3	9.283	.026
23.	Nurses use electronic ID systems (scanners/wands)	147	3	1.796	.616
24.	Type of non-electronic ID system for pretransfusion verification	58	6	5.384	.496
25.	Activities when nurses use electronic ID systems				
	Patient ID	89	3	3.808	.283
	Medications	89	3	7.634	.054
	Specimen collection for general labs	89	3	5.347	.148
	Blood sample collection for compatibility testing	89	3	5.591	.133
	Blood product administration (bedside transfusion verification)	89	3	5.622	.132
26.	Blood bag is scanned as part of electronic transfusion verification	89	3	6.776	.079
27.	Type of electronic ID system used for pretransfusion verification	36	3	0.965	.810
28.	Type of barcode wristband used for pretransfusion verification	39	3	14.857	.002
29.	Number of licensed staff required for electronic pretransfusion verification	39	3	14.857	.002
30.	Methods used to transport blood products to clinical area				
	Nursing personnel	147	3	2.871	.421
	Other hospital personnel	147	3	13.736	.003
	Pneumatic tube	147	3	26.053	**.000009**$_b$
	Robot (TUG Automated Robotic Delivery)	146	3	4.686	.196

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 42

Chi Square Comparisons for Hospital Size to Questions 31-43

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
31.	Who most likely to pickup blood products from Transfusion service, blood bank, or laboratory	146	3	15.820	.001
32.	Equipment to store or dispense blood products at the point-of-care in the medical-surgical areas				
	Portable blood cooler with ice packs	147	3	7.918	.048
	Thermal Wizard Red Shield blood cooler	147	3	2.211	.530
	Satellite blood refrigerator	147	3	2.211	.530
	Blood bank vending machine (0% not computed)	147			
	Not applicable – blood not stored or dispensed in medical-surgical areas	147	3	12.165	.007
33.	Delegate transfusion vital signs to non-licensed nursing staff	147	3	3.958	.266
34.	Nursing staff stay with patient during first 15 minutes of transfusion	147	9	7.295	.606
35.	Who most likely to stay with patient during first 15 minutes of transfusion	146	6	6.383	.382
36.	Frequency of non-invasive BP device (NIBP) used during transfusions	147	9	5.431	.795
37.	NIBP vital signs automatically downloaded into electronic medical record	147	3	3.314	.346
38.	Method of regulating flow rate of blood transfusion				
	Infusion pump	147	3	1.929	.587
	Flow regulating device (Dial-a-Flow / Control-a-Flo)	147	3	3.408	.333
	Roller clamp on administration	147	3	2.389	.322
39.	Frequency of use of infusion pump for transfusion	145	9	10.389	.320
40.	Frequency of oxygen saturation measured on patients receiving blood transfusions in medical-surgical areas	147	9	6.220	.718
41.	Blood warmers occasionally used in medical-surgical areas	147	3	2.434	.487
42.	Patients with blood infusing transported to diagnostic testing or procedure areas	147	3	3.298	.348
43.	Who observes patient receiving blood transfusion during transportation to test or procedure area	102	12	14.817	.252

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 43

Chi Square Comparisons for Hospital Size to Questions 44-48

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
44.	Who observes patient receiving blood transfusion during the test or procedure	102	9	16.779	.052
45.	Who receives education on blood transfusion during new employee orientation				
	RN	146	3	.835	.841
	LPN/LVN	146	3	1.816	.612
	Non-licensed nursing staff	146	3	7.654	.054
	Not covered in orientation	146	3	.835	.841
46.	Methods for blood transfusion education during orientation				
	Online module (eLearning)	146	3	12.281	.006
	Video	146	3	1.340	.720
	Classroom presentation	146	3	13.167	.004
	Read transfusion policy	146	3	2.587	.460
	Self-learning module (content in addition to policy)	146	3	.093	.993
	Competency validation skills station	146	3	2.110	.550
	Simulation plus discussion	146	3	3.839	.279
47.	RN - Content of transfusion education during orientation				
	Hospital procedures for blood transfusion	146	3	1.642	.650
	Transporting blood products	146	3	1.010	.799
	Equipment for blood transfusion	146	3	1.266	.737
	Types of blood products and blood filters	146	3	1.638	.651
	Infusion rates and duration of infusion	146	3	1.614	.656
	Symptoms of transfusion reaction	146	3	.056	.997
	Patient management of a transfusion reaction	146	3	2.368	.500
	Types of transfusion reactions	146	3	2.477	.479
	Blood conservation	146	3	10.374	.016
	Blood wastage	146	3	.743	.863
48.	RN - Types of blood products in education				
	Whole blood	146	3	6.936	.074
	Packed red blood cells	146	3	4.647	.200
	Fresh frozen plasma	146	3	4.175	.243
	Platelets	146	3	4.175	.243
	Cryoprecipitate	146	3	10.411	.015
	Special products (leukoreduced, irradiated)	146	3	4.503	.212

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 44

Chi Square Comparisons for Hospital Size to Questions 49-50

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
49.	RN - Transfusion reactions in education				
	Allergic	146	3	2.573	.462
	Acute hemolytic transfusion reaction (AHTR)	146	3	4.197	.241
	Delayed hemolytic transfusion reaction (DHTR)	146	3	11.906	.008
	Hypotensive	146	3	4.856	.183
	Febrile non-hemolytic transfusion reaction	146	3	5.266	.154
	Transfusion associated circulatory overload (TACO)	146	3	3.045	.385
	Transfusion associated dyspnea (TAD)	146	3	7.071	.070
	Transfusion associated graft vs. host disease (TA-GVHD)	146	3	14.473	.002
	Transfusion-related acute lung injury (TRALI)	146	3	7.614	.055
	Infection	146	3	6.120	.106
50.	RN – Symptoms of transfusion reaction				
	Chills/rigors	146	3	1.221	.748
	Fever	146	3	3.067	.381
	Nausea/vomiting	146	3	8.178	.042
	Bradycardia	146	3	13.571	.004
	Blood pressure increase	146	3	7.046	.070
	Blood pressure decrease	146	3	5.959	.114
	Shock	146	3	21.119	.0000995[c]
	Tachycardia	146	3	5.116	.164
	Edema	146	3	25.727	**.0000109[b]**
	Flushing	146	3	8.291	.040
	Hives	146	3	1.755	.625
	Itching	146	3	3.710	.294
	Jaundice	146	3	4.899	.179
	Urticaria	146	3	2.203	.531
	Other rash	146	3	5.613	.132
	Diffuse hemorrhage	146	3	6.712	.082
	Chest pain	146	3	2.940	.401
	Hemoglobinemia	146	3	3.367	.338
	Positive antibody screen	146	3	4.316	.229
	Abdominal pain	146	3	11.263	.010
	Back pain	146	3	4.511	.211
	Flank pain	146	3	13.195	.004
	Headache	146	3	3.409	.333
	Infusion site pain	146	3	9.554	.023
	Other pain	146	3	6.504	.089

a. χ^2 with continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 45

Chi Square Comparisons for Hospital Size to Question 50-52

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
50.	RN – Symptoms of transfusion reaction (continued)				
	Dark urine	146	3	.790	.852
	Hematuria	146	3	2.207	.531
	Oliguria	146	3	1.223	.748
	Bilateral infiltrates on chest x-ray	146	3	1.247	.742
	Cough	146	3	6.976	.073
	Hypoxemia	146	3	8.040	.045
	Shortness of breath	146	3	6.657	.084
	Wheezing	146	3	5.857	.119
51.	LPN/LVN - Content of transfusion education during orientation				
	Hospital procedures for blood transfusion	146	3	2.695	.441
	Transporting blood products	146	3	1.625	.654
	Equipment for blood transfusion	146	3	.911	.823
	Types of blood products and blood filters	146	3	.774	.856
	Infusion rates and duration of infusion	146	3	1.105	.776
	Symptoms of transfusion reaction	146	3	2.702	.440
	Patient management of a transfusion reaction	146	3	.904	.824
	Types of transfusion reactions	146	3	1.586	.662
	Blood conservation	146	3	1.615	.656
	Blood wastage (blood bag not returned to blood bank within time or temperature limits)	146	3	1.813	.612
52.	LPN/LVN – Symptoms of transfusion reaction				
	Chills/rigors	146	3	4.140	.247
	Fever	146	3	2.775	.428
	Nausea/vomiting	146	3	3.814	.282
	Bradycardia	146	3	2.881	.410
	Blood pressure increase	146	3	2.641	.450
	Blood pressure decrease	146	3	2.345	.504
	Shock	146	3	10.148	.017
	Tachycardia	146	3	4.935	.177
	Edema	146	3	8.665	.034
	Flushing	146	3	10.917	.012
	Hives	146	3	2.906	.406
	Itching	146	3	1.438	.697
	Jaundice	146	3	2.626	.453
	Urticaria	146	3	5.156	.161
	Other rash	146	3	2.288	.515

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 46

Chi Square Comparisons for Hospital Size to Question 52-54

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
52.	LPN/LVN – Symptoms of transfusion reaction (continued)				
	Diffuse hemorrhage	146	3	1.988	.575
	Hemoglobinemia	146	3	1.340	.720
	Positive antibody screen	146	3	2.553	.466
	Abdominal pain	146	3	2.140	.544
	Back pain	146	3	7.135	.068
	Chest pain	146	3	4.714	.194
	Flank pain	146	3	2.864	.413
	Headache	146	3	.821	.844
	Infusion site pain	146	3	1.727	.631
	Other pain	146	3	3.423	.331
	Dark urine	146	3	1.635	.651
	Hematuria	146	3	2.443	.486
	Oliguria	146	3	4.830	.185
	Bilateral infiltrates on chest x-ray	146	3	2.658	.447
	Cough	146	3	3.804	.283
	Hypoxemia	146	3	4.281	.233
	Shortness of breath	146	3	4.829	.185
	Wheezing	146	3	2.518	.472
53.	Non-licensed staff - transfusion content in orientation				
	Not applicable – no transfusion education	146	3	8.772	.032
	Hospital procedures	146	3	3.064	.382
	Transporting blood products	146	3	12.546	.006
	Different blood product types	146	3	1.559	.669
	Symptoms of transfusion reaction	146	3	3.458	.326
	Responsibilities during a transfusion reaction	146	3	.358	.949
54.	Non-licensed staff – Symptoms of transfusion reaction				
	Not applicable – not taught to non-licensed staff	146	3	1.886	.596
	Chills/rigors	146	3	1.747	.627
	Fever	146	3	1.747	.627
	Nausea/vomiting	146	3	2.914	.405
	Bradycardia	146	3	4.763	.190
	Blood pressure increase	146	3	7.394	.060
	Blood pressure decrease	146	3	7.072	.070
	Shock	146	3	4.746	.191
	Tachycardia	146	3	6.229	.101

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 47

Chi Square Comparisons for Hospital Size to Questions 54-58

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
54.	Non-licensed staff – Symptoms of transfusion reaction (continued)				
	Edema	146	3	4.740	.192
	Flushing	146	3	1.190	.755
	Hives	146	3	1.904	.593
	Itching	146	3	2.736	.434
	Jaundice	146	3	1.950	.583
	Urticaria	146	3	5.050	.168
	Other rash	146	3	2.632	.452
	Diffuse hemorrhage	146	3	2.001	.572
	Abdominal pain	146	3	2.431	.488
	Back pain	146	3	2.087	.555
	Chest pain	146	3	3.590	.309
	Flank pain	146	3	1.141	.767
	Headache	146	3	1.512	.679
	Infusion site pain	146	3	1.318	.725
	Other pain	146	3	1.221	.748
	Dark urine	146	3	7.570	.056
	Bloody urine	146	3	5.374	.146
	Cough	146	3	9.212	.027
	Hypoxemia	146	3	1.780	.619
	Shortness of breath	146	3	2.752	.431
	Wheezing	146	3	1.915	.590
55.	RN Transfusion education frequency (years)	143	9	13.237	.52
56.	LPN/LVN Transfusion education frequency (years)	122	6	6.819	.338
57.	Non-licensed Transfusion education frequency (years)	137	3	.788	.852
58.	Methods of recurring transfusion education				
	Online module (eLearning)	146	3	5.652	.130
	Video	146	3	.056	.997
	Classroom presentation	146	3	2.052	.562
	Inservice	146	3	3.653	.301
	Read transfusion policy	146	3	4.504	.212
	Self-learning module (content in addition to policy)	146	3	5.036	.169
	Competency validation skills station	146	3	2.034	.565
	Simulation plus discussion	146	3	.369	.947
	Case studies	146	3	.713	.870
	Blended learning (online plus discussion)	146	3	5.898	.117

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 48

Chi Square Comparisons for Hospital Size to Questions 59-67

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
59.	Internal resources with strong influence on nurse's transfusion practices				
	Hospital transfusion policy	146	3	2.255	.521
	Clinical nurse specialists or nurse practitioners	146	3	17.916	.00046
	Nurse education specialists	146	3	13.252	.004
	Nurse managers	146	3	9.514	.023
	Other staff nurses	146	3	6.978	.073
	Physicians	146	3	2.980	.398
	Staff from transfusion service or blood bank	146	3	8.361	.039
	Transfusion safety medical officer	146	3	10.135	.017
	Transfusion safety nurse	146	3	13.045	.005
60.	External resources nurses used to obtain current information on blood transfusion				
	AABB	146	3	4.776	.189
	Circular of Information	146	3	1.025	.795
	Google or other general search engines	146	3	3.770	.287
	Member of online professional listserv or group	146	3	5.323	.150
	Journal articles	146	3	.142	.986
	Medscape (free weekly electronic newsletter or CE)	146	3	.404	.939
	Subscribed online sources (Mosby Skills, etc.)	146	3	9.967	.019
	Textbooks	146	3	1.807	.613
	Webinars on blood transfusion	146	3	7.191	.066
	Other internet sources	146	3	1.943	.584
61.	Frequency of patients and families verbally informed by nurse of symptoms to report	145	6	5.260	.511
62.	Frequency of blood transfusion pamphlet or information sheet given to the patient	146	9	6.027	.737
63.	Developer of pamphlet or information sheet	88	3	.430	.934
64.	Pamphlet includes symptoms to report to the nurse	88	3	.896	.926
65.	Pamphlet available in more than one language	88	3	2.154	.541
66.	Frequency of nurses obtaining signatures for informed consent for blood transfusions	138	9	25.304	.003
67.	Documentation or paperwork required to pickup blood from the Transfusion Service or blood bank	145	6	6.016	.421

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 49

Chi Square Comparisons for Hospital Size to Questions 68-72

No.	Question	Hospital Size			
		n	*df*	χ^2	*p*
68.	Double check at time of blood issue from the Transfusion service or blood bank				
	Blood product label	145	3	7.103	.069
	Blood compared to order or transport request form	145	3	3.598	.308
	No double check is required	145	3	3.127	.372
69.	One person may pickup blood on different patients at the same time	143	3	19.340	.00075
70.	Hospital voluntarily reports transfusion adverse events to the Biovigilance Network	140	3	2.522	.471
71.	Hospital employs a Transfusion Nurse Specialist or Blood Utilization Nurse	144	3	13.029	.005
72.	Nurse representative on the Transfusion Committee	144	3	7.199	.066

a. χ^2 with continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

APPENDIX H

Chi Square Tables of All Questions for Associations to Magnet Recognition

Table 50

Chi Square Comparisons for Magnet Recognition to Questions 6-17

No	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
6.	Computer Provider Order Entry (CPOE) for transfusion orders	148	2	7.715	.021
7.	RNs complete clinical indications for transfusion order because indication not specified by physician	145	3	.290	.962
8.	Non-licensed staff enter non-CPOE orders into laboratory information system (LIS)	148	3	10.287	.016
9.	Who obtains blood sample for type and screen				
	RN	148	1	.003[a]	.953
	LPN/LVN	148	1	.035	.851
	Non-licensed nursing staff	148	1	.011[a]	.917
	Other (non-nursing staff phlebotomist)	148	1	.000[a]	1.000
10.	Number of persons to verify a blood specimen for type and screen	147	1	.360[a]	.548
11.	Second blood sample required to confirm blood type	148	1	.919[a]	.338
12.	Parameters assessed with transfusion vital signs				
	Blood pressure	148	1	.000[a]	1.000
	Pulse	148	1	.000[a]	1.000
	Respiratory rate	148	1	.108[a]	.742
	Temperature (100% agree, not computed)	148			
	Pulse Ox (oxygen saturation)	148	1	.000[a]	1.000
13.	Transfusion vital signs are obtained				
	Pre-transfusion	148	1	.035[a]	.220
	10-15 minutes after initiation of transfusion	148	1	1.074[a]	.300
	Every 30 minutes during transfusion	148	1	3.768[a]	.052
	Every 60 minutes during transfusion	148	1	.000[a]	1.000
	End of transfusion	148	1	4.201[a]	.040
	30 minutes post transfusion	148	1	4.201[a]	.040
14.	Post-transfusion vital signs are monitored more frequently than the patient's standard vital signs	148	1	2.404[a]	.121
15.	Method to determine infusion rate for first 15 minutes	148	2	3.574	.167
16.	Infusion Rate in policy for first 15 minutes	148	16	14.009	.598
17.	Method to determine infusion rate after first 15 minutes	147	2	.588	.745

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 51

Chi Square Comparisons for Magnet Recognition to Questions 18-30

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
18.	Maximum hours of use for one filtered blood administration set	148	5	6.130	.294
19.	During handoff communication, transfusing blood is rechecked for identification match to the patient	148	1	.924[a]	.336
20.	Who is first notified by the nurse of a transfusion reaction	148	3	2.546	.467
21.	Who determines if transfusion reaction is reported to the Transfusion Service	147	2	.145	.930
22.	Unique wristband for blood transfusion (blood band)	148	1	4.042[a]	.044
23.	Nurses use electronic ID systems (scanners/wands)	148	1	1.647[a]	.199
24.	Type of non-electronic ID system for pretransfusion verification	58	2	.531	.765
25.	Activities when nurses use electronic ID systems				
	Patient ID	90	1	.067[a]	.796
	Medications	90	1	.105[a]	.746
	Specimen collection for general labs	90	1	2.842[a]	.092
	Blood sample collection for compatibility testing	90	1	5.098[a]	.024
	Blood product administration (bedside transfusion verification)	90	1	2.240[a]	.134
26.	Blood bag is scanned as part of electronic transfusion verification	90	1	5.721[a]	.017
27.	Type of electronic ID system used for pretransfusion verification	37	1	.000[a]	1.000
28.	Type of barcode wristband used for pretransfusion verification	40	1	.278[a]	.598
29.	Number of licensed staff required for electronic pretransfusion verification	40	1	.278[a]	.598
30.	Methods used to transport blood products to clinical area				
	Nursing personnel	148	1	1.170[a]	.279
	Other hospital personnel	148	1	6.664[a]	.010
	Pneumatic tube	148	1	9.742[a]	.002
	Robot (TUG Automated Robotic Delivery)	148	1	.168[a]	.082

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 52

Chi Square Comparisons for Magnet Recognition to Questions 31-43

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
31.	Who most likely to pickup blood products from Transfusion service, blood bank, or laboratory	147	1	7.875[a]	.005
32.	Equipment to store or dispense blood products at the point-of-care in the medical-surgical areas				
	Portable blood cooler with ice packs	148	1	.634[a]	.426
	Thermal Wizard Red Shield blood cooler	148	1	.168[a]	.682
	Satellite blood refrigerator	148	1	.000[a]	1.000
	Blood bank vending machine (0% not computed)	148			
	Not applicable – blood not stored or dispensed in medical-surgical areas	148	1	.970[a]	.326
33.	Delegate transfusion vital signs to non-licensed nursing staff	148	1	.486[a]	.486
34.	Nursing staff stay with patient during first 15 minutes of transfusion	148	3	.592	.898
35.	Who most likely to stay with patient during first 15 minutes of transfusion	147	2	1.873	.392
36.	Frequency of non-invasive BP device (NIBP) used during transfusions	148	3	13.042	.005
37.	NIBP vital signs automatically downloaded into electronic medical record	148	1	.763[a]	.382
38.	Method of regulating flow rate of blood transfusion				
	Infusion pump	148	1	.079[a]	.779
	Flow regulating device (Dial-a-Flow / Control-a-Flo)	148	1	.000[a]	1.000
	Roller clamp on administration	148	1	4.953	.026
39.	Frequency of use of infusion pump for transfusion	148	1	4.105	.250
40.	Frequency of oxygen saturation measured on patients receiving blood transfusions in medical-surgical areas	148	3	1.908	.592
41.	Blood warmers occasionally used in medical-surgical areas	148	1	.002[a]	.966
42.	Patients with blood infusing transported to diagnostic testing or procedure areas	148	1	8.355[a]	.004
43.	Who observes patient receiving blood transfusion during transportation to test or procedure area	102	4	5.219	.266

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 53

Chi Square Comparisons for Magnet Recognition to Questions 44-48

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
44.	Who observes patient receiving blood transfusion during the test or procedure	102	3	1.934	.586
45.	Who receives education on blood transfusion during new employee orientation				
	RN	147	1	.000[a]	1.000
	LPN/LVN	147	1	5.050[a]	.025
	Non-licensed nursing staff	147	1	.413[a]	.520
	Not covered in orientation	147	1	.000[a]	1.000
46.	Methods for blood transfusion education during orientation				
	Online module (eLearning)	147	1	7.734[a]	.005
	Video	147	1	.292[a]	.589
	Classroom presentation	147	1	.111[a]	.739
	Read transfusion policy	147	1	.116[a]	.733
	Self-learning module (content in addition to policy)	147	1	.000[a]	1.000
	Competency validation skills station	147	1	3.215[a]	.073
	Simulation plus discussion	147	1	.000[a]	1.000
47.	RN - Content of transfusion education during orientation				
	Hospital procedures for blood transfusion	147	1	.000[a]	1.000
	Transporting blood products	147	1	.147[a]	.701
	Equipment for blood transfusion	147	1	.304[a]	.581
	Types of blood products and blood filters	147	1	1.900	.168
	Infusion rates and duration of infusion	147	1	.005[a]	.942
	Symptoms of transfusion reaction	147	1	.093[a]	.761
	Patient management of a transfusion reaction	147	1	.417[a]	.519
	Types of transfusion reactions	147	1	.125[a]	.724
	Blood conservation	147	1	.567[a]	.451
	Blood wastage	147	1	.670[a]	.413
48.	RN - Types of blood products in education				
	Whole blood	147	1	.006[a]	.938
	Packed red blood cells	147	1	.178[a]	.673
	Fresh frozen plasma	147	1	1.613[a]	.204
	Platelets	147	1	1.613[a]	.204
	Cryoprecipitate	147	1	.947[a]	.331
	Special products (leukoreduced, irradiated)	147	1	.001[a]	.974

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 54

Chi Square Comparisons for Magnet Recognition to Questions 49-50

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
49.	RN - Transfusion reactions in education				
	Allergic	147	1	.916[a]	.339
	Acute hemolytic transfusion reaction (AHTR)	147	1	.047[a]	.829
	Delayed hemolytic transfusion reaction (DHTR)	147	1	.879[a]	.348
	Hypotensive	147	1	.050[a]	.823
	Febrile non-hemolytic transfusion reaction	147	1	.020[a]	.887
	Transfusion associated circulatory overload (TACO)	147	1	3.141[a]	.076
	Transfusion associated dyspnea (TAD)	147	1	2.826[a]	.093
	Transfusion associated graft vs. host disease (TA-GVHD)	147	1	6.685[a]	.010
	Transfusion-related acute lung injury (TRALI)	147	1	6.420[a]	.011
	Infection	147	1	.304[a]	.581
50.	RN – Symptoms of transfusion reaction				
	Chills/rigors	147	1	.000[a]	1.000
	Fever	147	1	.000[a]	1.000
	Nausea/vomiting	147	1	.003[a]	.957
	Bradycardia	147	1	.132[a]	.717
	Blood pressure increase	147	1	.040[a]	.842
	Blood pressure decrease	147	1	.000[a]	1.000
	Shock	147	1	1.098[a]	.295
	Tachycardia	147	1	.000[a]	1.000
	Edema	147	1	.947[a]	.331
	Flushing	147	1	.046[a]	.829
	Hives	147	1	.000[a]	1.000
	Itching	147	1	.003[a]	.957
	Jaundice	147	1	.000[a]	1.000
	Urticaria	147	1	1.426[a]	.232
	Other rash	147	1	.478[a]	.490
	Diffuse hemorrhage	147	1	2.171[a]	.141
	Chest pain	147	1	.472[a]	.492
	Hemoglobinemia	147	1	7.880[a]	.005
	Positive antibody screen	147	1	.822[a]	.365
	Abdominal pain	147	1	2.128[a]	.145
	Back pain	147	1	.656[a]	.418
	Flank pain	147	1	.025[a]	.876
	Headache	147	1	.182[a]	.670
	Infusion site pain	147	1	.819[a]	.365
	Other pain	147	1	.182[a]	.670

a. χ^2 with continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 55

Chi Square Comparisons for Magnet Recognition to Question 50-52

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
50.	RN – Symptoms of transfusion reaction (continued)				
	Dark urine	147	1	.408[a]	.523
	Hematuria	147	1	.000[a]	1.000
	Oliguria	147	1	.534[a]	.465
	Bilateral infiltrates on chest x-ray	147	1	2.124[a]	.145
	Cough	147	1	.013[a]	.910
	Hypoxemia	147	1	1.245[a]	.264
	Shortness of breath	147	1	.091[a]	.762
	Wheezing	147	1	5.441[a]	.011
51.	LPN/LVN - Content of transfusion education during orientation				
	Hospital procedures for blood transfusion	147	1	11.086[a]	.001
	Transporting blood products	147	1	4.850[a]	.028
	Equipment for blood transfusion	147	1	5.483[a]	.019
	Types of blood products and blood filters	147	1	3.514[a]	.061
	Infusion rates and duration of infusion	147	1	7.288[a]	.007
	Symptoms of transfusion reaction	147	1	8.744[a]	.003
	Patient management of a transfusion reaction	147	1	10.339[a]	.001
	Types of transfusion reactions	147	1	2.748[a]	.097
	Blood conservation	147	1	.400[a]	.527
	Blood wastage (blood bag not returned to blood bank within time or temperature limits)	147	1	1.421[a]	.233
52.	LPN/LVN – Symptoms of transfusion reaction				
	Chills/rigors	147	1	11.058[a]	.001
	Fever	147	1	11.890[a]	.001
	Nausea/vomiting	147	1	6.345[a]	.012
	Bradycardia	147	1	6.985[a]	.008
	Blood pressure increase	147	1	10.236[a]	.001
	Blood pressure decrease	147	1	12.230[a]	.000470[c]
	Shock	147	1	2.511[a]	.113
	Tachycardia	147	1	5.347[a]	.021
	Edema	147	1	1.124[a]	.289
	Flushing	147	1	6.006[a]	.008
	Hives	147	1	7.131[a]	.008
	Itching	147	1	10.435[a]	.001
	Jaundice	147	1	3.028[a]	.082
	Urticaria	147	1	10.425[a]	.001
	Other rash	147	1	4.641[a]	.031

a. χ^2 continuity correction
b. Significant at 0.0000954
d. Not significant at 0.0000954

Table 56

Chi Square Comparisons for Magnet Recognition to Question 52-54

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
52.	LPN/LVN – Symptoms of transfusion reaction (continued)				
	Diffuse hemorrhage	147	1	.189[a]	.664
	Hemoglobinemia	147	1	.000[a]	1.000
	Positive antibody screen	147	1	.014[a]	.906
	Abdominal pain	147	1	1.769[a]	.184
	Back pain	147	1	5.140[a]	.023
	Chest pain	147	1	6.345[a]	.012
	Flank pain	147	1	3.895[a]	.048
	Headache	147	1	5.281[a]	.022
	Infusion site pain	147	1	2.239[a]	.135
	Other pain	147	1	1.633[a]	.201
	Dark urine	147	1	.991[a]	.319
	Hematuria	147	1	2.854[a]	.091
	Oliguria	147	1	1.246[a]	.264
	Bilateral infiltrates on chest x-ray	147	1	.051[a]	.821
	Cough	147	1	3.365[a]	.007
	Hypoxemia	147	1	3.365[a]	.067
	Shortness of breath	147	1	9.608[a]	.002
	Wheezing	147	1	2.427[a]	.119
53.	Non-licensed staff - transfusion content in orientation				
	Not applicable – no transfusion education	147	1	.047[a]	.828
	Hospital procedures	147	1	1.690[a]	.194
	Transporting blood products	147	1	.060[a]	.806
	Different blood product types	147	1	.091[a]	.762
	Symptoms of transfusion reaction	147	1	.000[a]	1.000
	Responsibilities during a transfusion reaction	147	1	.559[a]	.455
54.	Non-licensed staff – Symptoms of transfusion reaction				
	Not applicable – not taught to non-licensed staff	147	1	.475[a]	.491
	Chills/rigors	147	1	.000[a]	1.000
	Fever	147	1	.000[a]	1.000
	Nausea/vomiting	147	1	.717[a]	.397
	Bradycardia	147	1	.870[a]	.351
	Blood pressure increase	147	1	.039[a]	.844
	Blood pressure decrease	147	1	.402[a]	.526
	Shock	147	1	.288[a]	.591
	Tachycardia	147	1	.384[a]	.536

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 57

Chi Square Comparisons for Magnet Recognition to Questions 54-58

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
54.	Non-licensed staff – Symptoms of transfusion reaction (continued)				
	Edema	147	1	.000[a]	1.000
	Flushing	147	1	.000[a]	1.000
	Hives	147	1	.125[a]	.724
	Itching	147	1	.092[a]	.761
	Jaundice	147	1	.036[a]	.849
	Urticaria	147	1	.052[a]	.819
	Other rash	147	1	2.443[a]	.118
	Diffuse hemorrhage	147	1	1.462[a]	.227
	Abdominal pain	147	1	1.185[a]	.276
	Back pain	147	1	.226[a]	.635
	Chest pain	147	1	.014[a]	.906
	Flank pain	147	1	.909[a]	.340
	Headache	147	1	1.185[a]	.276
	Infusion site pain	147	1	.000[a]	1.000
	Other pain	147	1	.093[a]	.761
	Dark urine	147	1	.309[a]	.578
	Bloody urine	147	1	.000[a]	1.000
	Cough	147	1	.000[a]	1.000
	Hypoxemia	147	1	.229[a]	.632
	Shortness of breath	147	1	.002[a]	.969
	Wheezing	147	1	.014[a]	.906
55.	RN Transfusion education frequency (years)	144	3	1.606	.658
56.	LPN/LVN Transfusion education frequency (years)	123	2	3.621	.164
57.	Non-licensed Transfusion education frequency (years)	138	1	.000[a]	1.000
58.	Methods of recurring transfusion education				
	Online module (eLearning)	147	1	13.654[a]	.000219[c]
	Video	147	1	.093[a]	.761
	Classroom presentation	147	1	.891[a]	.345
	Inservice	147	1	1.482[a]	.223
	Read transfusion policy	147	1	.254[a]	.614
	Self-learning module (content in addition to policy)	147	1	.016[a]	.898
	Competency validation skills station	147	1	.146[a]	.702
	Simulation plus discussion	147	1	.108[a]	.743
	Case studies	147	1	.687[a]	.407
	Blended learning (online plus discussion)	147	1	1.273[a]	.259

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 58

Chi Square Comparisons for Magnet Recognition to Questions 59-67

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
59.	Internal resources with strong influence on nurse's transfusion practices				
	Hospital transfusion policy	147	1	1.613[a]	.204
	Clinical nurse specialists or nurse practitioners	147	1	.126[a]	.723
	Nurse education specialists	147	1	.551[a]	.458
	Nurse managers	147	1	.132[a]	.717
	Other staff nurses	147	1	.000[a]	1.000
	Physicians			.162[a]	.687
	Staff from transfusion service or blood bank	147	1	2.427[a]	.119
	Transfusion safety medical officer	147	1	5.973[a]	.015
	Transfusion safety nurse	147	1	1.697[a]	.193
60.	External resources nurses used to obtain current information on blood transfusion				
	AABB	147	1	.000[a]	1.000
	Circular of Information	147	1	.064[a]	.800
	Google or other general search engines	147	1	.000[a]	1.000
	Member of online professional listserv or group	147	1	.017[a]	.896
	Journal articles	147	1	.001[a]	.838
	Medscape (free weekly electronic newsletter or CE)	147	1	.800[a]	.371
	Subscribed online sources (Mosby Skills, etc.)	147	1	.324[a]	.569
	Textbooks	147	1	.666[a]	.415
	Webinars on blood transfusion	147	1	.774[a]	.379
	Other internet sources	147	1	.047[a]	.829
61.	Frequency of patients and families verbally informed by nurse of symptoms to report	146	2	2.162	.339
62.	Frequency of blood transfusion pamphlet or information sheet given to the patient	147	3	2.127	.546
63.	Developer of pamphlet or information sheet	89	1	2.824[a]	.093
64.	Pamphlet includes symptoms to report to the nurse	89	1	.315[a]	.575
65.	Pamphlet available in more than one language	88	1	.000[a]	1.000
66.	Frequency of nurses obtaining signatures for informed consent for blood transfusions	139	3	6.638	.084
67.	Documentation or paperwork required to pickup blood from the Transfusion Service or blood bank	146	3	1.672	.433

a. χ^2 continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

Table 59

Chi Square Comparisons for Magnet Recognition to Questions 68-72

No.	Question	Magnet Hospital			
		n	*df*	χ^2	*p*
68.	Double check at time of blood issue from the Transfusion service or blood bank				
	Blood product label	146	1	$.275_a$	.600
	Blood compared to order or transport request form	146	1	1.929_a	.165
	No double check is required	146	1	$.002_a$	.968
69.	One person may pickup blood on different patients at the same time	144	1	13.314_a	$.0002634_c$
70.	Hospital voluntarily reports transfusion adverse events to the Biovigilance Network	141	1	$.904_a$	.342
71.	Hospital employs a Transfusion Nurse Specialist or Blood Utilization Nurse	145	1	4.893_a	.027
72.	Nurse representative on the Transfusion Committee	145	1	2.960_a	.085

a. χ^2 with continuity correction
b. Significant at 0.0000954
c. Not significant at 0.0000954

APPENDIX I

Distribution of States with Participating Hospitals

Distribution of States with Participating Hospitals

Region	State	Frequency	Percentage	Percentage by Region
Northeast	Connecticut	3	2.0%	14.3%
	Maine	2	1.4%	
	Massachusetts	1	0.7%	
	New Hampshire	2	1.4%	
	New Jersey	4	2.7%	
	New York	5	3.4%	
	Rhode Island	0	--	
	Pennsylvania	4	2.7%	
	Vermont	0	--	
Midwest	Illinois	9	6.1%	30.7%
	Indiana	5	3.4%	
	Iowa	5	3.4%	
	Kansas	2	1.4%	
	Michigan	2	1.4%	
	Minnesota	1	0.7%	
	Missouri	5	3.4%	
	Nebraska	4	2.7%	
	North Dakota	0	--	
	Ohio	9	6.1%	
	South Dakota	1	0.7%	
	Wisconsin	2	1.4%	

Region	State	Frequency	Percentage	Percentage by Region
South	Alabama	1	.7%	31.7%
	Arkansas	1	1.7%	
	Delaware	0	--	
	District of Columbia	0	--	
	Florida	11	7.4%	
	Georgia	1	0.7%	
	Kentucky	3	2.0%	
	Louisiana	1	0.7%	
	Maryland	4	2.7%	
	Mississippi	2	1.4%	
	North Carolina	7	4.7%	
	Oklahoma	2	1.4%	
	South Carolina	0	--	
	Tennessee	3	2.0%	
	Texas	26	17.6%	
	Virginia	0	--	
	West Virginia	1	0.7%	
West	Alaska	1	0.7%	11.0%
	Arizona	0	--	
	California	4	2.7%	
	Colorado	2	1.4%	
	Hawaii	0	--	
	Idaho	1	0.7%	
	Montana	1	0.7%	
	New Mexico	3	2.0%	
	Nevada	1	0.7%	
	Oregon	2	1.4%	
	Washington	2	1.4%	
	Wyoming	1	0.7%	
	Utah	0	--	

List of Regions of the United States (2013). In *Wikipedia. Regional divisions used by the United States Census Bureau*.. Retrieved from http://en.wikipedia.org/wiki/List_of_regions_of_the_United_States