UNIVERSITY OF CAPE COAST

KNOWLEDGE AND PRACTICE OF BLOOD TRANSFUSION AMONG NURSES IN GHANA: EXPERIENCES FROM THE CAPE COAST TEACHING HOSPITAL, CAPE COAST

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:……. Date:.....

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Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

Blood transfusion saves lives but can result in poor client outcome when it is associated with errors. This study aimed at examining the knowledge of blood transfusion and practice errors among nurses in the Cape Coast Teaching Hospital. The study utilized a descriptive cross-sectional design approach using 140 registered nurses who were selected purposively. A modified Routine Blood Transfusion Knowledge Questionnaire (RBTKQ) was used to collect information in two sections. First part on demographic data and second part on knowledge and practice errors which were structured along a three-point Likert scale. Data was analysed with SPSS version 20, the binary logistic regression analysis was employed and all inferences were drawn at 5% significance level. Results showed that nurses have higher knowledge in the four phases of blood transfusion practices as they scored overall averages of 2.79, 2.80, 2.64 and 2.83 out of 3.0 for Phases I, II, III and IV, respectively. Although, majority of the nurses (72.0%) acknowledged they have not received any official training on blood transfusion since commencement of clinical work. A z-value of 165.29 and $p<.05$ indicated that there was a significant difference in the knowledge level of the nurses on the four phases of the procedure. On commonest errors, 40 (28.6%) nurses reported that they sometimes forgot to check vital signs throughout the transfusion process. This study concludes that nurses have very good knowledge on blood transfusion process but some practice errors exist that put patients at risk. Periodic training and auditing of the transfusion process is therefore recommended.

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DEDICATION

To my grandfather Mr. Frank Prah who inspired me to this height and all the dedicated nurses in Ghana.

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LIST OF ACRONYMS

OPD	Out Patient Department
WHO	World Health Organization
RBTKQ	Routine Blood Transfusion Knowledge questionnaire
HIV	Human Immunosuppressed Virus
AIDS	Acquired Immuno – Deficiency Syndrome
HCWs	Healthcare Workers
GHS	Ghana Health Service
MOH	Ministry of Health
O&G	Obstetric and Gyaenecology
PICC.	Peripherally Inserted Central Catheter
RFID	Radio frequency identification
CDC	Centre for Disease Control and Prevention
U S	United States
S D	Standard Deviation
I V	Intravenous
BCMA	Barcode medication administration systems
FMEA	Failure Mode Effects Analysis
SHOT	Serious Hazards of Transfusion
PHS	Public Health Service
BWG	Biovigilance Working Group

CHAPTER ONE

INTRODUCTION

Background to the Study

Blood transfusion is the transfer of blood or a blood component from one person (a donor) to another (a recipient). Transfusions are given to improve the blood's ability to increase its oxygen carrying capacity, restore any blood deficit, improve immunity, and correct clotting problems. Depending on the reason for the transfusion, a physician may order whole blood or a blood component, such as red blood cells, platelets, blood clotting factors, fresh frozen plasma (the liquid part of blood), or white blood cells (Shander, & Popovsky, 2005). Demand for blood is driven by an array of factors that include obstetric hemorrhage, road traffic accidents, armed conflict, sickle cell disease and childhood anemia, malnutrition, HIV, malaria, and parasitic infections (Tapko, Mainuka & Diarra-Nama, 2006).

Every second, someone in the world needs blood. In every country, surgery, trauma, severe anaemia and complications of pregnancy are among the clinical conditions that demand blood transfusion (World Health Organization [WHO], 2006). The WHO report on blood transfusion safety found that the pattern of blood usage is very different in many countries with a much greater proportion of transfusions being given to women with obstetric emergencies and children suffering from severe anaemia, often resulting from malaria and malnutrition. It is estimated the use of red blood cell transfusion in developing countries as pregnancy-related 37%, children 14%, surgery 12%, trauma 18% and medical 19%. This is in sharp contrast to red blood cell transfusion in the developed countries where red blood cell is used for

purposes of complicated procedures such as open-heart surgery, organ transplantation and other medical conditions such as leukaemia and thassalaemia with pregnancy-related (6%) and child anaemia (3%) been the least for red blood cell transfusion (Cable, Fatemeh & Edwards, 2007). A closer look at these findings from the World Health Organization (WHO) report suggest that blood transfusion are given in developing countries to treat basic conditions to avert mortalities that would otherwise happen in the advance countries.

The above findings are agree with a research finding from another studies from WHO, The United Nations Children's Fund (UNICEF), The United Nations Population Fund (UNFPA) and The World Bank (2012), which stated that , each year, an estimated 287,000 women die worldwide from complications related to pregnancy and childbirth. More than half of these maternal deaths (56%) occur in Sub-Saharan Africa with haemorrhage (severe bleeding) as the leading cause. Therefore, among other strategies to prevent maternal deaths from haemorrhage, child anaemia and other blood transfusion driven conditions, the WHO, UNICEF, UNFPA and the World Bank states that it is important to make available rapid access to adequate blood and highly knowledgeable personnel to safely administer blood. Whatever the degree of development of the health care system, blood transfusion is the only choice for survival for many patients and this is where the essence of nurses' knowledge and practice of blood transfusion is imminent.

Blood transfusion is usually a life-saving component of health care systems. Nevertheless, it can also be a quick and easy method of exposing

patients to risks, particularly the transmission of infectious agents to recipients. Despite improvements in the safety of transfusion services worldwide the procedure still subject patients to many risks. Lee (2003), reported on a study of the differences between clinicians' and laypersons' perceptions of the risks involved in blood transfusion. He found that clinicians' concerns revolve around the appropriateness of transfusion as a treatment and its risks, administration, and costs; patients' concerns often centre on transmissible disease and comfort. Transfusion of blood saves life. An error in blood transfusion, at the same time, takes life. Clinical demand for blood is perennial and transfusion errors are must be accountable. This accountability of transfusion errors comes to light with the numerous reports on total blood transfusion errors. The discovery that HIV could be transmitted by blood transfusion in 1982 has given rise to strict regulations on blood donation and screening procedures. Apart from HIV, HBV and HCV risks have also been well addressed in blood transfusion process.

The blood transfusion process is manned by a multidisciplinary healthcare team which include nurses. 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. 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. Blood transfusion procedure lies largely in the domain of nursing practice. Bishop (2008) indicated that the transfusion process is composed of five interrelated

phase; four of which are relevant to routine nursing practice, such as, patient preparation before blood bag collection, blood pack collection, pre and post transfusion nursing activities and where the safety of blood transfusion is, amongst others, dependent on nurses' knowledge and skills.

A lack of awareness of good transfusion practice has been identified as a reason for poor compliance (Parris, 2007). Hijji (2010) highlighted problems associated with Nurses' blood transfusion practice and adherence to recommendations. According to Hijji, blood transfusion errors often include administration of blood to wrong recipient, phlebotomy errors & blood bank errors including testing of wrong specimen. According to Linden (2000), the most important of all those errors has been the failure to detect at the bedside before transfusion of the blood unit .This is where nursing action is independent of any member within the multidisciplinary team. Therefore an error committed during this stage is largely a nursing error though the decision to transfuse a patient was initiated and prescribed by the physician. Nurses are responsible for the final bedside check before transfusion and therefore have the opportunity to prevent a mis-transfusion (Mole, 2007). Deficiencies in the knowledge of blood transfusion can adversely affect patient safety (Gallagher-Swann, 2011). Blood transfusion is a highly effective and potentially life-saving treatment for many patients (Bradbury & Cruickshank, 2000) and an essential component of modern health care. Red cell transfusions are the backbone of blood transfusion therapy as they account for the majority of components issued to patients (Taylor et al., 2010). Surprisingly, transfusions of blood products, a practice which is intended to save life, have been found to be associated with several complications, many of which can be grouped as

immunological or infectious. There is also increasing focus on complications arising directly or indirectly from potential quality degradation during storage (Wang, 2009).

Improper identification of patient as the main cause of mistransfusion resulting in significant transfusion mortality may indicate similar lack of knowledge (Myhre & McRuer, 2000). Lack of knowledge of various aspects of blood transfusion by clinical staff, including nurses, continues to be a real threat to patient safety (Taylor et al., 2010). For example, errors in practice involving remote checks at nurses' stations (Whitehead et al., 2003) may indicate that nurses are unaware that such checks serve no purpose; they detract from performing proper bedside identification of patient, and contribute to mistransfusion (Whitehead *et* al.). Mistakes in blood transfusion and insufficient control of patients who receive blood during the transfusion are among causes of death for such patients (Clark et al., 2001). Since there is no substituting product for human blood, the need for blood transfusion is still continuing.

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, & 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 there are only limited reports of research involving nurses' knowledge on blood transfusions. It is quiet surprising to note that evidence used to guide blood transfusion practices in Africa has almost exclusively been generated by wealthy countries in Europe and North America. This trend

is often inappropriate for low-income countries such as Ghana yet research from within Africa about nurses' knowledge on blood transfusion and practice is seriously lacking. It is against this background that this study was conducted.

Statement of the Problem

Adequate knowledge and proper practice of blood transfusion are essential elements in modern clinical therapy. In a situation where practice is mostly associated with error then the knowledge underpinning the practice for the therapy has to be investigated. Rowe, (2000), revealed that most published guidelines highlight that most serious transfusion complications occur within the first fifteen minutes of transfusion. Therefore, a close monitoring has been recommended before and fifteen minutes after commencement of each unit of blood. The guidelines also recommend careful monitoring in the areas of sample collection, preadministration checking to avoid adverse reactions (Hainsworth, 2000).The above practice activities are all within the time frame of nursing care in the blood transfusion process.

The practice of blood transfusion has evolved as therapy for many patients and still continues to serve as the only hope for the survival of those who require blood to live. Despite its existence for many decades in Ghana's health care system, research in the area of nurses' knowledge that underpins their practice of blood transfusion is very scanty. The justification for this study is the paucity of nursing research in Ghana on blood transfusion knowledge and 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 Ghana 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.

Thomas and Hannon (2010) linked the national focus to improve transfusion safety in Ghana with the need to address the knowledge and performance gaps of the bedside transfusionist. However, a description of Ghana nurses' preparation and practices with blood transfusions is lacking. Research is needed to address this important clinical issue to validate or refute the findings of quality reports on nurses' transfusion practices which has generated much debate.

It has been shown that errors associated with blood transfusions in which nursing failure was often identified as the source of error was recognized by (Wilkinson & Wilkinson, 2001, Heddle et al., 2012). Additionally nurses' lack of familiarity with the patient and language barriers and lack of compliance with recommended practices promoted error (Dzik et al., 2003 & Hyson, 2009). Most of these findings were generated by individuals outside Ghana .However researching coming from within Ghana on errors nurses commit and the reasons for the occurrence of these are lacking. Therefore the purpose of this study was to examine the knowledge and practice errors among Ghanaian nurses on blood transfusion processes.

Objectives of the Study

The main objective of this study was to investigate knowledge of blood transfusion practices among clinical nurses. This was done through the following specific objectives

1. To determine nurses knowledge involving the four phases of blood transfusion.
2. To identify if differences exist in clinical nurses knowledge about the four phases of blood transfusion.
3. To identify common errors associated with blood transfusion practice

Research Questions

1. Do clinical nurses have thorough knowledge about the four phases of blood transfusion?
2. Is there a difference in the clinical nurses' knowledge about the four phases of blood transfusion?
3. What common errors in nursing practice exist in the transfusion of blood to patients?

Research Hypotheses

The following hypothesis was formulated and tested

H_0 : There is no significant difference in knowledge among nurses in the four phases of blood transfusion.

H_1 : There is significant difference in the knowledge about the four phases of blood transfusion.

Significance of Study

Clinical units are places where the use of blood and blood components is a common therapeutic procedure. It is therefore not uncommon to observe a significant number of transfusion errors in these wards. Nurses have a paramount responsibility in ensuring a safe blood transfusion. Therefore, it is important for nurses to have sufficient knowledge on best practices. The findings of this study could be used to teach nurses during in service training

and workshops to ensure best practice. Also the findings could be incorporated into nursing and midwifery curricula in Ghana.

Limitation of the Study

It is a cross-sectional study and may not capture true effect of knowledge – practice gaps on blood transfusion. It is also acknowledged that there was a limited time for the study. As a result one hospital (Cape Coast Teaching Hospital), the largest in the region was used for the study. Therefore generalizing the results to the population of nurses may not be warranted. However, efforts were made to use a standard sample size calculation ensuring that statistically acceptable significant numbers were selected for the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This chapter is a review of the literature related to nurses' knowledge and practices with blood transfusions. The literature search encompassed the last 10 years so that it would fill in the gap. The review was done in three perspectives, overview, theoretical framework and empirical perspective.

Blood as a Therapeutic Agent

Blood is a complex fluid in which variety of cells RBCs, WBCs and platelets are suspended in plasma. It is composed of a straw-coloured transparent fluid, plasma, in which different types of cells are suspended. Plasma constitutes about 55% and cells about 45% of blood volume. Blood circulate continuously through the heart and vascular system. Arterial blood is bright red owing to the mixture of oxygen with haemoglobin within the red blood cells whilst venous blood is dark red because of loss of oxygen from the reduced hemoglobin. Blood is three to four times more viscous (thick) than water. Blood is located inside blood vessels (arteries, veins and capillaries) and heart. Blood has a slightly salty taste and slightly alkaline reaction of pH 7.35 –7.45 (Blajshman, 2007). Blood varies in terms of volume with age and body composition. The less body fats, the more blood per kilogram of body weight is present. The average blood volume in a 75kg male is about 6.0L and may be less in women. Organs involved in formation of blood and its constituent cellular elements are the bone marrow, the spleen, liver, and lymph

nodes. Cells produced by these organs include erythrocytes, leukocytes, thrombocytes, plasma cells and reticuloendothelial cells.

There are many therapeutic functions of the blood to the human body which includes: supplying cells with oxygen from the lungs and absorbed nutrients from the gastro-intestinal (GI) tract, removing waste products from tissues to the kidney, skin, and lungs for excretion, transporting hormones from their origin in the endocrine gland to their target in other parts of the body and protecting the body from infectious microorganisms. The primary function of erythrocytes is to transport oxygen from the lungs to the tissues and also carbon dioxide from the tissues to the lungs (Goodnough & Monk, 2000). The leukocytes have an important function in defending the body against microbes and other foreign materials, promoting hemostasis (the arrest of bleeding), regulating body temperature by heat transfer. They contain a variety of substances that promote blood clotting which causes haemostasis (Faber, 2002)

Blood Groups

The discovered that human blood differs from one individual to another was by Mehta Deeh in 1900. This difference arises from the presence or absence of specific antigens (agglutinogens) on the surface of Red Blood Cells and on the presence or absence of specific antibodies (agglutinins) in plasma (Goodnough & Monk, 2000). This explains why blood cannot be taken at random from one person and transfused into another. The blood, when it is different from that of the recipient may cause a serious reaction. Many different blood group systems are now known but the ABO and Rhesus system are of the most clinical importance.

ABO Blood Group

Blood group is determined genetically, with the genes for A and B agglutinogins being co-dominant. An individual's blood is typed as A, B, or AB, if it has those agglutinogins present on the Red Blood Cells. If no agglutinogins are present, then the blood is termed type O. The blood plasma does not contain agglutinins that will agglutinate the Red Cells therefore the plasma of an individual with type AB will contain no antibody, whereas plasma of an individual with blood type O will contain both. An individual whose Red Blood Cells express either A or B agglutinogins will have plasma containing anti-B and anti-A antibodies respectively (Goodnough & Monk , 2000). These antibodies are termed naturally occurring as, unlike most other antibodies, there is no need for exposure to specific antigens for their formation. Blood is grouped by adding specially prepared serum containing either anti-A or anti-B serum to a sample of the blood to be typed and observing for clamping of the Red cells. The relative incidence of blood group antigens varies from race to race but worldwide, type O and A are more common than B and AB.

Rhesus (Rh) Blood Group

Several antigens (agglutinogins) are involved in this system, but the D factor is of greatest clinical significance. Approximately 85% of Caucasians poses the D factor and are classified as being Rh positive (Knowles & Poole, 2005). Those without the D factor are said to be Rh negative. The gene for the D agglutinogin is always dominant so an Rh (D)-positive individual may have inherited the gene from only one or both parents. Antibodies against the D factor do not occur naturally; they develop in the plasma of Rh (D)-negative

blood when the D factor is introduced on Red Blood Cells of Rh (D)-positive blood. Anti-D antibodies develop slowly and after initial exposure do not usually reach a sufficient concentration to cause a reaction before the Red Blood Cells are destroyed naturally. A second exposure to Rhesus D positive will however result in a reaction causing agglutination of the donor cells. When an Rh-positive foetus develops within an Rh-negative mother, some of the foetus' Red Blood Cells or D antigens released by worn out erythrocytes may pass through the placenta into the maternal circulation. This usually occurs at delivery. The mother then forms antibodies that diffuse into the foetal circulation in subsequent pregnancies causing agglutination of the foetal erythrocytes. This causes severe haemolytic disease of the new born. It is rare for this to occur in a first pregnancy (Faber, 2002).

Blood Transfusion

Blood transfusion is the transfer of blood or a blood component from one person a (donor) to another a (recipient). Transfusions are given to increase the blood's ability to increase its oxygen carrying capacity, restore any blood deficit, improve immunity, and correct clotting problems. Depending on the reason for the transfusion, a doctor may order whole blood or a blood component, such as red blood cells, platelets, blood clotting factors, fresh frozen plasma (the liquid part of blood), or white blood cells (Shanders, 2009). Giving a specific component is both safer and less wasteful. In the United States, about 15 million transfusions are given every year (American Hospital Association, 2012). Blood transfusions typically use two sources of blood: one's own (autologous transfusion), or someone else's (allogeneic transfusion). The latter is much more common than the former. Using another

person's blood must first start with donation of blood. Blood is most commonly donated as whole blood intravenously and collecting it with an anticoagulant. In developed countries, donations are usually anonymous to the recipient, but products in a blood bank are always individually traceable through the whole cycle of donation, testing, separation into components, storage, and administration to the recipient. This enables management and investigation of any suspected transfusion related disease transmission or transfusion reaction. In developing countries the donor is sometimes specifically recruited by or for the recipient, typically a family member, and the donation occurs immediately before the transfusion

Indications for Blood Transfusion

According to Blajshman, (2007) blood transfusion are given for many reasons some of which include correction of anaemia, in bone marrow failure, chronic diseases and haemoglobinopathies,correction of deficiencies in other blood and plasma component, such as platelets or clotting factors and replacement of blood lost during major surgical operation, trauma, haemorrhage. Red blood cells transfusions are also given to cancer patients requiring therapy, women in childbirth and newborn babies in certain cases patients of hereditary disorders like Haemophilia and Thalassaemia and in cases of severe burn victims.

History of Blood Transfusion

The essential requirements for transfusions to begin in Africa were doctors trained in the techniques, donors, and patients in need of and willing to receive transfusions (Allain, Owusu-Ofori & Bates, 2004). The first reports in Africa were in the early 1920s, and organized transfusion practices had been

developed before the Second World War. The records between the two world wars show not only that all conditions existed in sub-Saharan Africa that were necessary for blood transfusions; they also suggest that the numbers were limited primarily by the availability of Western medical doctors and facilities to do transfusions (Bates, Chapotera, McKew & Broek, 2008). There is also an indication of how innovation took place, usually through connections to people and resources outside the usual colonial medical structures, for example, the Red Cross, missionaries, universities, and mining companies (Allain, Owusu-Ofori & Bates, 2004).

Transfusion became a regular part of modern medical treatment in sub-Saharan Africa from 1945 to independence. The means by which this occurred differed significantly according to the colonial ruler. For example, in francophone Africa the government attempted to implement a policy of centralized blood collection in Dakar, Senegal, to supply blood to all colonies in French West Africa (Bates, Chapotera, McKew & Broek, 2008). In the British and Belgian colonies local initiatives and the Red Cross were much more important in creating transfusion services. In Uganda, this practice led to the Red Cross expanding the number of collection centers from the capital, Kampala, to other regions of the protectorate. The common underlying reason for growth everywhere was the Africans' acceptance of donating and receiving blood. Equally important were the increased expenditures in colonies on health, particularly new hospital construction, because transfusions were done in the hospital setting.

In addition, new and simpler techniques developed during the Second World War made transfusion easier to practice in sub-Saharan Africa.

Following independence, in the 1960s, transfusion continued to grow in Africa and the organization of services entered a new phase. Most newly independent countries accelerated expansion by building provincial and district hospitals to serve regional and local needs (Brooks, 2005). These hospitals usually had the ability to do transfusions, but with only a few exceptions governments left it to the local hospitals to arrange for their own blood collection, sometimes with the assistance of the Red Cross and unpaid donors, sometimes with a paid service, and sometimes both. Thus, there was a general swing away from centralization and its high costs, toward a mixed organization with at best limited regional services, but also hospital-based means to supplement or complement the collection, testing, and distribution of blood for transfusion.

Hospitals thus developed a number of options for blood collection, all of which were driven by an increase in the use of transfusion for medical care and the corresponding need for more donors (Melnyk, & Fineout-Overholt, 2011). The final phase in the development of African transfusion services began after the economic crisis of the mid-1970s, when African countries were unable to provide resources to continue, let alone keep up with, new techniques in transfusion medicine. This constraint limited their ability to draw and store blood or extend transfusion to more remote regions. Problems were exacerbated by growing concerns with testing and safety, such as the need to screen for hepatitis B, a new disease that was discovered well before the appearance of HIV. One response was to seek funding from developed countries, especially in Europe, North America, and in Japan. When successful, the result was a recentralization of transfusion services because donor countries found that it was more efficient and safe and gave them better

ability to monitor how funds were used. For example, foreign assistance in Burundi and Rwanda followed this pattern, as did Ethiopia, but not all countries were able to secure outside funding (Allain et al., 2004). Other pressure for centralization came from the growth of programs at the World Health Organization and the International Red Cross, both of which helped secure funding and coordinated offers of technical assistance for setting standards of blood safety beginning in the mid-1970s (Melnyk, & Fineout-Overholt). They also co-sponsored the first African blood transfusion workshops, beginning in Burundi in 1976 and the Ivory Coast in 1977. Thus, when the AIDS crisis hit Africa, less than a decade later, mechanisms to support and coordinate efforts to monitor and insure a safe blood supply were already in place (Kemp, 2009).

Three crucial features of blood transfusion in Africa are particularly noteworthy compared to elsewhere: what transfusions were used for, who donated blood, and safety. One surprising finding is that reluctance of patients to receive the blood of others offered relatively little impediment to the adoption of transfusion in Africa (Tapko, Mainuka & Diarra-Nama, 2006). To be sure, as elsewhere, there were fears and myths that arose and for the most part were allayed by practitioners. Moreover, the needs were so extensive, and the successful results of transfusion were so dramatic, that if anything, the overuse of transfusion became a bigger problem than resistance on the part of patients. Hospital records are scarce in the early period, but after the 1980s statistics show that transfusions were done increasingly for maternity and pediatric (anemia) use. Other evidence of the uses of transfusion includes posters from the Red Cross archives, which, in an effort to encourage Africans

to donate blood, prominently featured how the blood would be used (Tapko, Mainuka & Diarra-Nama, 2006). Another surprising conclusion is that sufficient donors were generally found in Africa so that the blood supply was able to meet the growing use of transfusion. The best explanation for this success in meeting the need for blood donation was the flexibility of these practices. Most notably, hospitals were innovative in how they adapted to their circumstances in order to secure blood donors.

This pragmatism ran counter to some expectations of resistance and irrational opposition by Africans. One way to interpret this was that the "medicine" given to Africans in transfusion, blood, was possessed in the same amount and with the same control by Africans as anywhere else in the world (Thomas & Hannon, 2010). There were few or no drug companies or expensive chemical manufacturing or rare materials that had to be purchased. As far as donors were concerned, therefore, the history of blood transfusion offers a good example of Africans' ability to organize and adapt their health care well when the materials were available to them. With some significant exceptions, the most important institutions in finding ways to obtain blood for transfusions were hospitals (Allain et al., 2004).

Theoretical Framework

The theoretical framework for this research was Everett Rogers' 1962 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). 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 10 which is alternately described as *simplicity* to understand and to use (Frazer and Robinson, 2009); *testability* or the ability to 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)

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. 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.

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 they 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.

Empirical Perspective

This section gives a critique of the works of other authors in relation to the current study. This analysis was done and grouped under various headings to suit the research questions and objectives of the study.

Nursing Practice and Transfusion Safety

The transfusion practices of nurses and patient safety are integrally linked. 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 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) reviewed the medical and nursing literature for research and quality reports that investigated error and blood transfusion published from 1989 to 1996. 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.

A qualitative study by Adams and Tolich (2011), on blood transfusion: Patients experiences using medically stable adults who had received a blood transfusion at an Ohio hospital over a five week period in 2009 were identified; a convenience sample of 21 of those patients participated in semi-structured interviews lasting 15 to 30 minutes. The researchers recorded and transcribed the interviews and performed a thematic analysis. The study sought to identify how well patients understood the role of blood transfusion in their treatment and whether it caused them discomfort. Four themes emerged: paternalism and decision making, patients' knowledge, blood safety and administration, and the nurse's role. Participants said that because a physician decided the transfusion would take place, they didn't understand that there were other options for treating their anaemia; pretransfusion written

materials weren't adequate to explain risks and benefits of the procedure; they had concerns about the safety of the blood supply; and they valued nurses' opinions. They concluded that clinicians may be missing opportunities to improve patients' knowledge and comfort with blood transfusion and that they can better meet patients' needs before, during, and after the procedure.

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. 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. Their study revealed five main themes: *pretransfusion checking, policy, training, opportunity for error,* and *monitoring the transfusion process*. These themes are consistent with earlier research findings on the nursing blood transfusion practices and safety. Transfusion medicine in hospitals is concerned with ensuring that at the time when transfusion is clinically indicated the patient receives the correct blood safely (Knowles and Poole, 2005)

Fitzgerald, Hodgkinson and Thorp (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. Transfusion therapy is a relatively safe and often life saving treatment where the benefits for the patients should outweigh the risks associated with the procedure (Wilkinson & Wilkinson, 2001). All nurses have the outmost responsibility to provide the highest standard of care and all clients have the rights to expect quality services (Nursing and Midwifery Council [NMC], 2004). It therefore does not fall outside nurses domain of practice to ensure that, blood transfusion, a procedure designed to save lives but associated with many risks is dispensed without danger to patients.

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. Hyson concluded that blood administration as a clinical procedure was highly respected by the nurses and was a strictly regulated.

Although blood transfusion 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 (Houck & Whiteford, 2007). Many reports of quality audits are classic articles repeatedly referenced in other transfusion literature. The methodology, 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.

Rendering blood transfusion safe also means observing the possibility of adverse reaction associated with the procedure. Narvios, Lichtiger and Newman (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). 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.

Novis, Miller, Howanitz, Renner, and Walsh (2003) reported on observational audits of transfusion practices conducted in 1994 and 2000. 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.

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 of their study was to provide data to address the perspective of transfusion services in Ghana 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 under recognition and underreporting of transfusion reactions. Safety concerns related to patient monitoring were raised.

A qualitative research by Adams and Tolich (2011) on patient's experiences on transfusionist in five countries highlight that blood transfusion is a current and relevant issue for nurses. The administration of blood products 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, the practice of 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

Hyson (2009) states that nurses have a strong sense of responsibility and accountability for transfusion safety as reported in the Canadian ethnographic study by and the. 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, Miller, Howanitz, Renner & Walsh, 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* was prepared jointly by the American Red Cross (ARC), America's Blood Centers (ABC), and the Armed Services Blood Program (ASBP) on the Use of Human Blood and Blood Components (AAABB),states that "periodic observation and recording of vital signs should occur during and after the transfusion to identify suspected adverse reactions" (AABB, 2009).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.

Blood Transfusion Errors

The 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 transfusionist (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 registered nurse (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". Although the article did not emphasized much on quality and transferability of error, a group of expert clinicians, educators, and researchers interpreted the qualitative data and identified themes which established the validity 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 taxonomy of distractions plus a "blocking" category absent from their study". 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, 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”.

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”. 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 related 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,).

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 to 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 transfusionist 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

Safety of blood transfusion relies on a number of factors, and one of the most important areas is the knowledge and skills of staff working in blood establishments. Throughout the world, the qualifications and experience necessary for entry into blood transfusion practices have generally risen to a much higher level than in the earlier period (U.S. Department of Health & Human Services, 2011). Transfusion medicine focuses on all the available medical, scientific and technical information pertinent for the assistance of patients receiving blood or blood products, manufactured by molecular biology and/or biotechnology techniques. The quality of the final product administered safely from a blood establishment/service therefore, depends on the quality of individual employee's performance in transfusion processes. Education and training is fundamental to every aspect of blood safety.

The aim of training and development is ultimately to improve the human capital within an organization. To facilitate the blood establishment to achieve its objectives, all the technical personnel including doctors, nurses,

medical laboratory technologists and scientists/researchers, have to be formally educated and trained (U.S. Department of Health & Human Services). Developing human capacity in transfusion medicine remains an essential focus of managing blood programs. The managers of the blood transfusions services need to provide an environment that is conducive to developing themselves and those under their responsibility.

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 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 questions; 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. Higher uncertain 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 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 train*ing* theme revealed that 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 phenomenal finding (Heddle, et al., 2012; and Hogg, Pirie, & Ker, 2006). In as much as training and continuous education of nurses are important with regards to safe transfusion of human blood for therapeutic purposes, withdrawing nurses from the bedside for this purpose is a challenge due to limited number of nursing workforce.

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 conducted during an eighteen months of an educational intervention. Significant improvements 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.

Blood Transfusion Risks

Each unit of whole blood can be preserved by refrigeration for forty two days and it can also be separated into several components. All these blood products are to be preserved at a specific temperature. The components include Red Blood Cells (RBCs) which may be stored under refrigeration for a maximum of forty two (42) days or may be frozen for up to ten (10) years. Red blood cells (RBCs) carry oxygen and are used to treat anemia. Platelets are important in the control of bleeding and generally used in patients with leukemia and other forms of cancer. They are stored at room temperature and may be kept for a maximum of seven days. Due to this, platelets have a higher probability of getting contaminated as compare to the other components of the blood. Plasma which is used to control bleeding due to low levels of some

clotting factors is normally kept in a frozen state for usually up to a year. (Radhakrishnan, 2003).Several studies have been undertaken to assess blood transfusion related risks.

A study carried out in the city of New Delhi, India by Aqqarwal, Prakash, Yadav and Chattopadhya, (1997) on the prevalence of transfusion associated infections in multitransfused children in relation to mandatory screening Of HIV in donated blood. This study indicated unchanged prevalence of Hepatitis B virus (HBV), Hepatitis C virus (HCV) and Hepatitis D virus (HDV) infections among the group of multitransfused children who were transfused after the implementation of mandatory screening of Human-immunodeficiency Virus (HIV) infections in blood banks. Study of epidemiological risk factors among blood donors showed a change in behavior towards safer sex practice with only 13.0% of donors in the post-implementation period having history of sex with one or more female commercial sex workers during their donation periods compared to 41.5% of donors in the pre-implementation period having similar history. However no change could be recorded in the proportion of donors donating at frequency higher than the permissible guidelines among the two groups. Aqqarwal (1997) points out nosocomial transmission as well as limitations in the existing guidelines for screening of infectious agents in blood banks as possible incriminating factors towards acquisition of hepatitis virus infections in blood donors as well as in multi-transfused children.

In 2012, Mathai, Sulochana, Satyadhama, Nair, and Sivakumar in Kerala, on the prevalence of transfusion transmissible infections and the possible risk factors among blood donors revealed that health care workers

constituted only a small fraction of the study due to the fact that prevalence of infections was low among them. History of jaundice or hospitalization was not associated with higher incidence of seropositivity. Seropositivity for HIV is relatively low compared to similar studies conducted in other regions of the country. This finding is attributed to the pre donation counseling in donor selection. An important outcome of the study is that Class III donors form a high-risk group for transfusion transmissible infections.

Another study was carried out in Ghana by Nkrumah, Owusu and Averu, (2011) on hepatitis B and C viral infections among blood donors. This study was conducted to investigate the prevalence of hepatitis B and hepatitis C infections and co-infections (CI) among blood donors at the Agogo Presbyterian Hospital in the Ashanti Akim district of Ghana. A total of 2773 prospective blood donors were screened from January 2006 to December 2008. Study participants were grouped into five age categories. Out of these, 2556 representing 92.2% were males and 217 representing 7.8% were females. Analysis of the prevalence of HBV and HCV among males and females revealed a statistically significant decrease in the occurrence of the infections among males and females. Of the total number, 10.53% (292/2773), 5.63% (156/2773) and 2.09% (58/2773) were HBV, HCV and both HBV and HCV positive, respectively. Furthermore, the prevalence of co-infection of HBV and HCV decreased for the years under review with the highest rate peaking at 2.6% in 2007. The overall prevalence rate for HBV was highest in 2006 peaking at13.8% but decreased in 2008 to 6.9%. The overall prevalence of HCV was highest in 2007 peaking at11.1% but decreased to 7.0% in 2008.

The prevalence rate of HBV was relatively higher in females but vice versa for HCV.

From the above studies it is evident that blood transfusion like other invasive clinical procedures is not without risks. Blood transfusion is generally a safe procedure that saves lives and improves the quality of life for patients with a large range of clinical conditions. However, there are a number of risks associated with transfusion, as with any other clinical intervention (Royal College of Nursing, 2007). There is also increasing focus (and controversy) on complications arising directly or indirectly from potential quality degradation during storage (Wang, 2009). Several attempts that have been carried to render blood safe for transfusion and some of the success include the development of a nucleic acid test for the HIV-1 RNA which has dramatically lowered the rate of donor blood seropositivity to about 1 in 3 million (Shander et al, 2009) and the transmission of hepatitis C via transfusion currently stands at about a rate of 1 in 2 million units (Blajshman, 2007). Despite the several attempts to render blood safe for transfusion, cases of infection and immunological reactions have been recorded in this modern era (Wang, 2009).

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 training 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. 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 (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 metropolitan 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 under recognition 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. Blood Track Hemo Safe 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 cross-match. During a period of four months, 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 Secureline 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 (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 Typene 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'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). 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 semi structured 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. 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 ($p < 0.0001$) were observed in specimen collection and in administration of blood with the barcode processes. Zero mistransfusion, 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, 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 (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. 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.

Gaps in the literature exist related to all forms of nursing research on blood transfusions, particularly on research of transfusion practices of nurses in Ghana. Identifying the proportion of transfusion innovations adopted into nursing practice is important in describing the state of the science of Ghana nurses' blood transfusion practices.

CHAPTER THREE

METHODOLOGY

Introduction

This chapter gives an overview of the research methods, the research setting, the study design, sampling technique, data collection approach and the instrument used for data collection, preview of data analysis and the ethical considerations that guided the study.

Study Design

This study utilized a descriptive cross-sectional design. According to Burns and Grove (2011) a descriptive study is designed to gain more information about the characteristics within a particular field of study. A descriptive design is used to describe the characteristics, prevalence, intensity or full nature of a phenomenon. It is a type of design that produces a 'snapshot' of a population at one or more points in time and is concerned with the present status of a phenomenon. Nurses who fell in the inclusion criteria were selected after obtaining inform consent from them.

The survey was used because it is comparatively quick and cheap to conduct and administer. It also enables researchers to identify the proportions of people in particular groups and controls the effects of subjects participating twice (Krejcie & Morgan, 1970). The study employed quantitative methods. The ever increasing need for a representative statistical sample in empirical research has created the demand for an effective method of determining sample size. To address the existing gap, Krejcie & Morgan (1970) came up with a table for determining sample size for a given population for easy reference. Although this design has some loopholes such as difficulty in

getting respondents to answer questions thoughtfully and honestly, it is considered the best for the study since it deals with interpreting the relationship among variables and describing their relationships (Gay, 1992).

Study Site

The research was conducted at the Cape Coast Teaching Hospital formerly Central Regional Hospital (CRH). The hospital was established in the year 1998 and officially opened in 2000 as a model hospital in the country. The hospital is located at the far east of Abura, a densely populated suburb of Cape Coast in the Central Region, Ghana. It is the biggest hospital in the region. It provides health care services to greater number of citizens and it serves as the last point in terms of patient referral in the region. It recently achieved a teaching hospital status. The hospital operates in three main divisions: the out-patient department, in-patient department and the accident and emergency unit with many specialty units. It has a bed capacity of two hundred and twenty six (226) and it is currently ranked among the best hospitals in the nation. The site was chosen because of high patient turnout and as the last referral point for the Central Region.

Area and Demography

The Central Region is one of Ghana's ten administrative regions. The region is bordered by the Ashanti region and Eastern region to the north and east-north respectively, Western region to the west, Greater Accra to the east and to the south by the Atlantic Ocean. It is located between latitudes 5° 1'N and 6° 18'N and longitudes 0°22'W and 2°10'W (Ghana Government Portal, 2012).

The Central Region has a land area of 9,826 square kilometers which forms about 6.6% of the total land size of Ghana. It has an estimated population of 2,201,863 (2010 projection) and annual population growth of 2.1% with 13 administrative districts. It is the second most densely populated region of the country with about 176 persons per –square kilometers with 63% of the inhabitants been rural settlers. The region has a total of 193 health facilities, comprising 77 public, 100 private and 16 missions. These facilities are mostly located in the district capitals and other big towns.' Beyond these, there are 15 functional community based-health planning and services (CHIPS) compound in six selected districts. It is a coastal savannah with grassland and few trees interspersed with semi deciduous forests which occupy the inland areas. The land rises above approximately between 250 meters and 300 meters.

The major economic activity is agriculture, largely fishing. There are other small scale manufacturing activities such as food processing, ceramic wares, as well as salt and soap making. The region is predominately occupied by Akan-speaking (82.0%), followed by Guan (6.1%) Ewe (4.8%).The Fantes occupy the coastal belt and they are the largest Akan group (56.6%) followed by other small ethnic groups (Ghana Government Portal, 2012).

Cape Coast Metropolis

The Cape Coast Metropolitan occupies a land size of 122 square kilometers and it is the smallest metropolis in Ghana. It is bounded on the south by the Gulf of Guinea, west by the Komenda, Edina, Eguafo,Abrem Municipal, east by the Abura,Asebu,KwamankeseDistrict and north by the

Twifu, Hemang, Lower Denkyira District. It is the first capital of Ghana the then Gold Coast.

Study Population and Sampling procedure

Polit and Beck (2004) describe the study population as the entire aggregation of cases in which a researcher is interested in. The study target population comprised all available registered nurses (diploma nurses, advanced diploma nurses and nurses with first and second degrees). However, the accessible population constituted registered clinical (bedside) nurses involved in direct in- patient care with more than 3 months of post internship training experience totaling 236.

The sampling procedure used for the study was purposive. As such the sample size used by the researcher was informed by the Krejcie and Morgan (1970) table for determining sample size. They maintain that a population of 236 will correspond representatively to a sample size of 145 (See appendix for sample size calculation)

Inclusion Criteria

Registered clinical (bedside) nurses involved in direct in- patient care with more than 3 months of post internship training.

Exclusion Criteria

Nurses who are not at the bedside or who are not in direct clinical care with patients such as nurse administrators and public health nurses.

Research Instrument

The Instrument for data collection was a modified version adapted from Hijji et al. (2012) It is a Routine Blood Transfusion Knowledge Questionnaire (RBTKQ) which comprises four (4) sections and twenty five

(25) items (see Appendix B). The first section captured the demographic data. This information was important for defining the sample characteristics. Minor restructuring of the instrument was done before data collection to align the instrument with the study objectives.

The use of the questionnaire was preferred because it ensures a wider coverage and enables researchers have personal contact with respondents. This minimizes the problem of no-contacts which other methods faced. The questionnaire was also used in the study because, in comparison to other methods, it is characterized by its impersonality. In other words, the items were the same for all respondents, anonymity is respected, and there are no geographical limitations to its implementation. Although questionnaires have potential low response rate, it is relatively economical in both cost and time, and it allows time to carefully check the content of the items that are likely to yield more accurate information (Williman, 2005). According to Patton (2002), researchers can get the right responses from respondents when they use questionnaires.

The items in second part, were structured along the lines of the Likert-type scale. This is because it enables the respondents to indicate the degree of their beliefs in a given statement. It is also easy to construct, administer, and score (Kimmon, 1990). The statement on the Likert-type scale was structured on a three-point scale which required the respondents to indicate the extent to which they agree or disagree ranging from True Always, True Sometimes and Not At All. In order to ascertain and measure their believe the following mean ratings were done as: Mean below 1.5 – Poor knowledge; Mean above 1.5 – 2.0 – Good Knowledge; 2.0 – 2.5 – Very Good Knowledge; 2.5 – 3.0 –

Excellent Knowledge. The administration of the research instrument was done by giving respondent the questionnaire, observing them answer and was taken from them on the same day following completion.

Pilot-testing of instrument

Scholars in research methodology advise that in order to test the validity and reliability of research instruments, the instruments need to be tested with a small sample similar to the potential respondents (Frankel & Wallen, 2006). The questionnaire was pilot-tested at the Cape Coast Municipal Hospital. The questionnaires were given to 20 nurses who were selected purposively. Cronbach alpha of 0.81 was obtained.

Validity and reliability of the instruments:

Reliability according to Uys and Basson (1991) mean the degree of consistency or accuracy with which an instrument measures the attribute it is designed to measure. Because all measurement techniques contain some error, reliability exists in degrees and is usually expressed as a form of correlation coefficient. Folkman and Lazarus (1988) reported internal consistency coefficient of 0.61 to 0.79 on the ways of Checklist.

The face and content validity of the instruments were addressed by submitting the content of the questionnaire to the researcher's supervisors whose comments and recommendations were used to revise the initial items.

Table 1: Cronbach's Reliability Coefficient for Phase I (Patient Preparation)

Items	No. of items	Cronbach's Alpha
The most important phase of the transfusion process is identifying client identity and confirming blood compatibility Two registered nurses are needed to check physician's order, client's identity ID band, number and compared to blood bag details. Client is assessed to determined previous reactions to blood transfusions Ensure that informed consent has been obtained Check vital signs before transfusion Obtain intravenous access line Obtain blood sample for grouping and cross-matching.	7	.922

From Table 1, the reliability coefficient on 7 Phase 1 items was 0.922. This value was greater than the cut-off point of 0.700 indicating that this scale had an 'adequate' internal consistency according to Cohen et al. (2005).

Table 2: Cronbach's Reliability Coefficient for Phase II (Blood Pack Collection)

Items	No. of items	Cronbach's Alpha
The blood bag tag, label and requisition form are assessed to ensure that ABO and Rh types are compatible. Assess blood bag for expiration date	5	.799

Inspect blood bag for leaks, abnormal colour, clots, excessive air and bubbles. Blood should be transported from the blood bank to only one client at a time. Transport blood in a validated blood box		

The Cronbach's Alpha reliability coefficient on 5 items on Phase II of the blood transfusion process was .799. This was examined against the acceptable range of .700 or above thus indicating that this scale had an 'adequate' internal consistency according to Leech, Barrett and Morgan (2005)

Table 3: Cronbach's Reliability Coefficient for Phase III (Administering the Transfusion)

Items	No. of items	Cronbach's Alpha
Identify the right patient Maintain standard(universal) precautions Return blood not administered longer than thirty(30) minutes to blood bank Check vital signs and lung sounds first fifteen minutes and every hour until completion. Pre-medicate according to institution's policy. Infuse blood via administration sets designed specifically for blood Blood products are made to warm up in microwaves or hot water Determine rate of infusion by physician order or by	12	.918

facility protocol Start transfusion slowly and monitor for signs and symptoms of transfusion reactions especially in the first 15 minutes. Encourage client to report any unusual feeling or manifestation. Document client's tolerance to the transfusion process. Monitor appropriate laboratory values and document procedure.	

As shown in Table 2, the reliability coefficient on the 12 items Phase III was 0.918. This value was greater than the cut-off point of 0.700; indicating that this scale had an 'adequate' internal consistency according to Cohen et al. (2005).

Table 4: Cronbach's Reliability Coefficient for Phase IV (Post-Transfusion Activities and Issues)

Items	No. of items	Cronbach's Alpha
Documentation of relevant information including vital signs Observation for transfusion reaction For the first 10-15 minutes it is essential to physically observe the patient for possible transfusion reaction. Carry out emergency treatment in case of transfusion reaction as ordered Blood products administered within four (4) hours after collection reduces complication.	5	0.898

Also from Table 4, the coefficient for the 5 items on the Phase III was .898. This implies that the items here had 'adequate' internal consistencies.

Table 5: Cronbach's Reliability Coefficient for Blood Transfusion Complications

Items	No. of items	Cronbach's Alpha
Patient identification error is the most commonest cause of fatal transfusion reaction Signs of immediate transfusion reactions include chills and diaphoresis, muscle aches, back pain or chest pain, rashes, itching, rapid pulse, apprehension, nausea, vomiting or diarrhoea. Starting the transfusion within 20 minutes after collection from blood bank minimises complications The first two measures following blood transfusion reaction is to stop the transfusion and keep iv line open with 0.9% normal saline. Delayed transfusion reaction occurs days to years of transfusion.	5	0.956

The reliability coefficient on 5 items constituting complications in blood transfusion was 0.956. This value was greater than the cut-off point of 0.700; indicating that this scale had an 'adequate' internal consistency according to Cohen et al. (2005).

Table 6: Cronbach's Reliability Coefficient for Blood Transfusion Protocols

Items	No. of items	Cronbach's Alpha
There is a unit protocol guide for administering blood transfusion. Protocol is clear, concise and simple to follow Protocol is revised every year	3	0.937

Also, from Table 6, the reliability coefficient on 3 items on the blood transfusion protocols was 0.937. This value was greater than the cut-off point of 0.700; indicating that this scale had an 'adequate' internal consistency according to Cohen et al. (2005).

Table 7: Overall Cronbach's Reliability Coefficient for Questionnaire

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.909	.914	37

On the whole, the Cronbach's Alpha reliability coefficients for Tables 1-6 were greater than 0.700. Also, the overall reliability coefficient for the pre-test result was 0.909, which according to Leech, Barrett and Morgan (2005) is an indicative of the fact that the instrument to be used for the main data collection was good because it had an "adequate" internal consistency.

Data Collection Method

A letter of introduction (Appendix A) was collected from School of Nursing to confirm the identity of the researcher. Further discussions were made with regards to what the study is about and the number of respondents needed for the study selected using purposive sampling.

The hospital management was contacted and an arrangement was made to administer the questionnaire and observe the respondents. Two research assistants were trained to help in the administration of the questionnaire. The questionnaires were distributed to the targeted samples within a period of three weeks. In order to ensure successful collection and sorting of the questionnaires, each questionnaire was given a serial number according to the separate wards.

Ethical Consideration

Following ethical clearance from the University of Cape Coast (UCCIRB10/5/2014) after Cape Coast Teaching Hospital for permission to undertake the study through the Ghana Health Service Ethical Committee on Research Involving Human Subjects. Thus, ethical approval was sought from the Ethics committee of the Hospital via the Ghana Health Service before study began. An ethical approval is required for the study because it involves audit of patient record. The researcher ensured that all regulations of keeping anonymity, confidentiality and third party data handling were adhered to. The nurses were assured that results from the study would be reported as aggregates with no indication of any response traceable to a particular individual. See appendix B for the certificate.

Data Analysis

The data was checked for mistakes committed by respondents. The questionnaires were given special serial numbers, coded and entered into the computer for analysis. A 10% random sample of questionnaire was checked against the data entered. Statistical analysis of the quantitative data was conducted using Statistical Package for the Social Sciences (SPSS) version 20.

Descriptive statistics was used to illustrate the demographic information of the respondents. Frequencies and percentages for socio demographics and areas of further training of nurses on blood transfusion, mean scores and standard deviation were used to analyse the research questions like: What is the knowledge of the four phases of blood transfusion among clinical nurses? The hypothesis was tested with one way analysis of variance (ANOVA) and z-test.

Delimitation of the Study

The inclusion criteria for the selection of nursing staff in the study sample was licensed nurses who are currently registered and providing direct care at the clinical units. Nursing staff from the hospital administration, public health nurses and others who do not provide in- patient care was not included in the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents the results of the study. The study aimed at investigating the knowledge and practices of blood transfusion among nurses in the Central Region of Ghana. It specifically sought to answer the following research questions:

1. What is the knowledge of the four phases of blood transfusion among clinical nurses?
2. Is there a difference in the knowledge levels in the four phases of blood transfusion?
3. What common errors in practice exist in the transfusion of blood among nurses?

All the 145 nurses targeted for the study completed and returned their copies of the questionnaire resulting in the study attaining a 100% retrieval rate, five of them were found to be partially filled. Therefore, they were discarded from the analysis. This means that the ensuing analyses were based on responses from 140 instead of the 145 nurses. Frequencies, percentages, means and standard deviations were used. Also, the binary logistic regression analysis was employed and all inferences were drawn at 5% significance level. Tables and graphs were briefly introduced and discussed to address the research questions stated above.

Table 8 presents the demographic characteristics of the nurses who responded to the questionnaire. Frequencies and percentages were computed.

Table 8: Socio-Demographic Characteristics of Respondents (N=140)

Variables	Frequency	Percentage
Sex		
Males	33	23.6
Females	107	76.4
Age (in years)		
21-25	23	16.3
26-30	50	35.8
31-35	37	26.5
Above 35	30	21.4
Religion		
Christianity	131	93.9
Islam	9	6.1
Traditional	0	0.0
Others	0	0.0
Marital Status		
Married	57	40.8
Single	71	51.0
Others	12	8.2
Educational Level		
Diploma	87	62.2
First Degree	47	33.8
Master's Degree	3	2.0
Doctorate	0	0.0
Others	3	2.0
Status of Hospital		
Teaching Hospital	86	61.2
Regional Hospital	50	35.7
District Hospital	4	3.1
Unit of Work		
Male Surgical	30	21.5
ICU	8	5.7
NICU	13	9.3
Recovery Dialysis	3	2.1
Female Medical Ward	24	17.1
Male medical ward	3	2.1
Paediatrics	14	10.0
S/Suite	7	5.0
Delivery Suits	14	10.0
O & G	13	9.3
Accident and Emergency	11	7.9

Number of Blood Transfusion in a Week		
None	0	0.0
1-3	71	50.7
4-6	57	40.7
7-10	12	8.6
Duration of Experience in Blood Transfusion (in years)		
1-5	93	66.4
6-10	32	22.9
11 and more	15	10.7
Training in Blood Transfusion		
Yes	39	27.9
No	101	72.1

It can be seen from Table 8 that a large majority of the respondents 107 (76.4%) was females, whiles the remaining 33 (23.6%) were males. Also, 110 (78.6%) of them were aged 21-35 years. In terms of their religion, as many as 131 (93.9%) of the respondents were Christians, and 9 (6.1%) were Muslims. There were, however, no traditionalists. More than half of the nurses (51.0%) were single, whiles 57 (40.8%) were married. Again, 87 (62.2%) had diploma, first degree (33.0%), and 3 (2.0%) were master's degree holders.

Eighty-six representing 61.2% of the respondents worked at Teaching Hospital, whiles 50 (35.7%) and 4 (3.1%) of worked at the Regional and the District hospitals, respectively. The respondents had worked in the various units across the hospitals. These included the male surgical, female medical ward, pacdics, delivery suits and obstetrics and gynaecology units. Half of the nurses indicated that they had between 1 and 3 blood transfusions per week, whiles 57 (40.7%) said 4-6 per week and 12 (8.6%) said 7-10 per week. On the number of years of working experience in blood transfusion, it was revealed that majority of them (66.4%) had had between 1-5 years'

experience. Also, 47 (33.6%) reported that they had at least 6 years working experience in blood transfusion. However, a substantial majority (72.1%) of the nurses claimed not to have had any training session in issues concerning blood transfusion.

Further to the above, the study sought their views on the type of training they needed to make them more efficient in the discharge of their duties. Table 9 contains their responses.

Table 9: Areas of Further Training/Education on Blood Transfusions among Nurses (N=140)

Training Areas	Frequency	Percentage
Adverse reactions	121	86.4
Administration	56	40.0
Sampling	43	30.7
Collection of blood bags	35	25.0
All of the above	26	18.6

Multiple choice so the total percentage greater than 100%.

A glance at Table 9 revealed that the nurses required further training in key areas like adverse reactions and administration. This because out of the 140 respondents, as many as 121 (86.4%) of them indicated that they needed training in adverse reactions. Also, 56 (40.0%) of them said that they required further training in administration of blood transfusions. Similarly, 43 (30.7%) of them said they required training in sampling, whiles 35 (25.0%) said collection of blood bags. However, 26 (18.6%) of the 140 nurses demanded training in all areas of blood transfusion including adverse reaction, administration of blood transfusion, sampling, and collection of blood bags. It

can, therefore, be deduced that the nurses required professional training in the field of blood transfusion.

Research Question 1: What is the knowledge of the four phases of blood transfusion among clinical nurses?

The aim of this research question was to assess the level of knowledge among nurses in Cape Coast on the four phases of blood transfusion, which according to Bishop (2008) are relevant to routine nursing practice. It, however, also assessed their knowledge with regard to blood transfusion complications and protocols. Descriptive statistics including the means and standard deviations were computed for each item on phases 1, 2, 3, and 4, used. Table 10 presents the analysis of nurses' knowledge on patient preparation activities (Phase 1).

Table 10: Nurses' Knowledge on Patient Preparation Activities (N=140)

Activities	Means	SD
Obtain blood sample for grouping and cross-matching.	3.00	0.000
The most important phase of the transfusion process is identifying client identity and confirming blood compatibility.	2.98	0.142
Obtain intravenous access line.	2.97	0.173
Check vital signs before transfusion.	2.86	0.352
Ensure that informed consent has been obtained.	2.61	0.620
Two registered nurses are needed to check physician's order, client's identity ID band, number and compared to blood bag details.	2.56	0.593
Client is assessed to determined previous reactions to blood transfusions.	2.55	0.594

***Mean=** *True always (3); True sometimes (2); and Not at all true (1)*

Table 10 shows that the respondents were generally emphatic in their response that during the patient preparation stage, they had to obtain blood sample for grouping and cross-matching. This is because they rated this statement with a mean value of 3.00 out of 3.00 with zero variability. The nurses also agreed that they had to always identifying client identity and confirming blood compatibility before blood transfusion took place. Similarly, on whether or not they should always obtain intravenous access line, overwhelming majority were in agreement as revealed in the mean rating of 2.97 (SD=0.173).

Other equally important phase one activities include the checking of vital signs before transfusion (Mean=2.86, SD=0.352), ensuring that informed consent has been obtained (mean=2.61, SD=0.620), two registered nurses are needed to check physician's order, client's identity ID band, number and compared to blood bag details, and client was assessed to determined previous reactions to blood transfusions. In sum, it can be concluded that the respondents had excellent knowledge this phase of blood transfusion as they scored an overall mean value of 2.79 out of 3.00; meaning that they believed these activities should always be done before blood transfusion began.

The responses of the respondents on the Blood Pack Collection phase (i.e., Phase 2) of the blood transfusion are summarised in Table 11. Means and standard deviations were used.

Table 11: Respondents' Knowledge on Blood Pack Collection (N=140)

Activities	Means	SD
The blood bag tag, label and requisition form are assessed to ensure that ABO and Rh types are compatible.	2.98	0.142
Assess blood bag for expiration date	2.95	0.221
Inspect blood bag for leaks, abnormal colour, clots, excessive air and bubbles.	2.92	0.345
Transport blood in a validated blood box	2.78	0.466
Blood should be transported from the blood bank to only one client at a time.	2.35	0.644

***Mean=** *True always (3); True sometimes (2); and Not at all true (1)*

From Table 11, it can be seen that the respondents claimed to have always assessed tags on blood bags, labels and requisition forms to ensure that ABO and Rh types were compatible. They mean rated this practice with a mean value of 2.98. This means that they always did this. Similarly, the nurses generally agreed that always checked expiration dates on blog bags (Mean 2.95, SD=0.221), inspected blood bag for leaks, abnormal colour, clots, excessive air and bubbles (Mean=2.92, SD=0.345). Also, they indicated that they always transported blood in a validated blood box (Mean=2.78, SD=0.446), and transported blood from the blood bank to only one client at a time (Mean=2.35, SD=0.644).

It can be deduced that that the nurses had excellent understanding of the second phase of the blood transfusion process. This is because they had, on the average, 2.80 out of the total mean score 3.00.

The third phase of blood transfusion process (i.e., Administering) involved among others the identification of patients, maintaining the standard precautions, and checking of vital signs. Using the mean and standard deviations, the summary of their responses are presented in Table 12.

Table 12: Nurses' Knowledge Level on the Administration of Transfusion (N=140)

Activities	Means	SD
Identify the right patient	3.00	0.000
Encourage client to report any unusual feeling or manifestation.	2.95	0.221
Start transfusion slowly and monitor for signs and symptoms of transfusion reactions especially in the first 15 minutes.	2.93	0.259
Maintain standard(universal) precautions	2.89	0.309
Infuse blood via administration sets designed specifically for blood	2.86	0.344
Document client's tolerance to the transfusion process.	2.85	0.415
Monitor appropriate laboratory values and document procedure.	2.77	0.426
Pre-medicate according to institution's policy.	2.76	0.428
Determine rate of infusion by physician order or by facility protocol	2.64	0.562
Return blood not administered longer than thirty (30) minutes to blood bank	2.46	0.501
Check vital signs and lung sounds first fifteen minutes and every hour until completion.	2.29	0.689
Blood products are made to warm up in microwaves or hot water	1.32	0.602

***Mean=** True always (3); True sometimes (2); and Not at all true (1)*

With a mean rating of 3.00, the nurses reported that they always identified the right patient for blood transfusion as shown in Table 12. On how frequently they encouraged clients to report any unusual feeling or manifestation, majority with an average rating of 2.98 and variability of 0.221

indicated that they always did. Similarly, they generally agreed to always started transfusion slowly and monitored for signs and symptoms of transfusion reactions especially in the first 15 minutes (Mean=2.93, SD=0.259). The nurses also claimed that they always maintained standard or universal precautions when transfusion blood to patients. They rated the ensuing practice with a mean value of 2.89 and a standard deviation of 0.3309.

There was also a general consensus among the respondents that they always infused blood via administration sets designed specifically for blood as they rated the statement with a mean rating of 2.86 and variability of 0.344. With regard to their knowledge on the documentation of client's tolerance to the transfusion process, the nurses said that they always documented patient's tolerance to the process. Similarly, they reported of always monitoring the appropriateness of laboratory values and documentation procedure.

It was also evident from Table 12 that the respondents always determined the rate of infusion by physician order or by facility protocol, and returned blood not administered longer than thirty (30) minutes to blood bank. However, the means ratings for the checking vital signs and lung sounds first fifteen minutes and every hour until completion (Mean=2.29, SD=0.689), and the warming up of blood products in microwaves or hot water (Mean=2.29, SD=0.689) respectively showed that they sometimes and not at all did them. In conclusion, the grand mean rating of 2.64 out of 3.00 is an indication that the nurses generally had a very good knowledge on the third phase of Bishops (2008) blood transfusion process.

Similarly, the nurses' responses on the fourth phase activities are presented in Table 13. Again, the mean and standard deviations were used.

Table 13: Respondents' Knowledge on Post-Transfusion Nursing Activities and Issues (N=140)

Activities	Means	SD
Observation for transfusion reaction.	2.97	0.175
Documentation of relevant information including vital signs.	2.94	0.245
Carry out emergency treatment in case of transfusion reaction as ordered.	2.92	0.265
For the first 10-15 minutes it is essential to physically observe the patient for possible transfusion reaction.	2.87	0.341
Blood products administered within four (4) hours after collection reduces complication.	2.46	0.732

***Mean=** *True always (3); True sometimes (2); and Not at all true (1)*

Table 13 reveals that after blood transfusion, nurses always observed the after-process for reactions. Here, the respondents rated this activity relatively high with a mean value of 2.97 and a standard deviation of 0.175. They also reported of always documenting relevant information including vital signs after bold transfusions. The nurses also higher rated the activity of carrying out emergency treatment in case of transfusion reaction as ordered with a mean value of 2.92 with variability of 0.265 out of 3.00. Other main activities that undertook after blood transfusion were the observation of patients for the first 10-15 minutes for possible transfusion reaction, and also administered within four (4) hours after collection in order to reduce complication.

The overall mean rating of the respondents on their knowledge about the post-transfusion activities was 2.83 out of 3.00. This means that the nurses

always performed the above activities after blood transfusion. It can, therefore, be concluded that they really had an excellent knowledge of this phase of blood transfusion.

The study also sought to measure the nurses' understanding of the possible complications patients could experience after blood transfusion. Table 14 contains their responses analysed using means and standard deviations. The lowest and highest mean ratings were 2.07 and 2.91, respectively.

Table 14: Nurses' Knowledge on Complications Related to Blood Transfusion (N=140)

Complications	*Means	SD
Signs of immediate transfusion reactions include chills and diaphoresis, muscle aches, back pain or chest pain, rashes, itching, rapid pulse, apprehension, nausea, vomiting or diarrhoea.	2.91	0.290
The first two measures following blood transfusion reaction is to stop the transfusion and keep iv line open with 0.9% normal saline.	2.89	0.432
Patient identification error is the most commonest cause of fatal transfusion reaction	2.65	0.617
Starting the transfusion within 20 minutes after collection from blood bank minimises complications	2.35	0.680
Delayed transfusion reaction occurs days to years of transfusion.	2.07	0.789

***Mean**= True always (3); True sometimes (2); and Not at all true (1)*

It can be seen from Table 14 that the main complications that clients usually experienced after blood transfusion was chills and diaphoresis, muscle aches, back pain or chest pain, rashes, itching, rapid pulse, apprehension,

nausea, vomiting or diarrhoea. They also revealed that another complication was fatal transfusion reaction.

On their understanding of blood transfusion protocols, Table 15 presents their responses. Using the mean and standard deviation, it can be seen that the lowest and highest mean ratings were 1.46 and 2.22, respectively.

Table 15: Nurses' Knowledge on availability of Blood Transfusion Protocols

Protocols	Means	SD
There is a unit protocol guide for administering blood transfusion.	2.22	0.868
Protocol is clear, concise and simple to follow	2.18	0.855
Protocol is revised every year	1.46	0.669

***Mean**= True always (3); True sometimes (2); and Not at all true (1)*

Table 15 reveals that the respondents were not too sure of having a unit protocol guide for administering blood transfusion (Mean=2.22, SD=0.868). Also, the nurses were not convinced that the available protocol was clear, concise and simple to follow as they rated it with a mean value of 2.18 and variability of 0.855. As to whether the protocol was revised yearly, the respondents generally disagreed with mean rating of 1.5 indicating poor knowledge. It can, therefore, be deduced that the nurses were not happy with the current protocols on blood transfusion at the hospital.

In conclusion to the research question on the knowledge level of nurses on the phases of blood transfusion, it can be concluded that they had excellent knowledge on all the phases. This can be seen in their average scores on each of the phases. They had overall averages of 2.79, 2.80, 2.64 and 2.83 for Phases I, II, III and IV, respectively.

Research Question 2: Is there a difference in knowledge levels in the four phases of blood transfusion?

The aim of this research question was to see if there were differences in the knowledge level of the nurses with respect to the various phases of blood transfusion. First, the comparison was done according to their socio-demographic characteristics using the means as shown in Table 16, whiles subsequently, the Z test and ANOVA were employed to test hypothesis of no statistical differences. .

Table 16: Socio-Demographic Differentials in the Knowledge of Level of Nurses on the Four Phases of Blood Transfusion

Variables	N	Phase I (Mean)	Phase II (Mean)	Phase III (Mean)	Phase IV (Mean)
Sex					
Males	33	2.79	2.68	2.68	2.68
Females	107	2.78	2.84	2.61	2.78
Grand Mean		***2.78***	***2.80***	***2.63***	***2.76***
Age (in years)					
21-25	23	2.71	2.71	2.56	2.66
26-30	50	2.83	2.75	2.62	2.78
31-35	37	2.80	2.88	2.68	2.86
Above 35	30	2.77	2.76	2.618	2.58
Grand Mean		***2.79***	***2.78***	***2.63***	***2.74***
Religion					
Christianity	131	2.78	2.77	2.62	2.72
Islam	9	2.93	2.90	2.66	3.00
Traditional	0	-	-	-	-
Others	0	-	-	-	-
Grand Mean		***2.79***	***2.78***	***2.62***	***2.74***
Marital Status					
Married	57	2.77	2.83	2.63	2.71
Single	71	2.82	2.82	2.62	2.84
Others	12	-	-	-	-
Grand Mean		***2.79***	***2.83***	***2.62***	***2.78***
Educational Level					
Diploma	87	2.81	2.76	2.60	2.74
First Degree	47	2.74	2.83	2.67	2.75
Master's Degree	3	2.57	2.60	2.17	2.40
Doctorate	0	-	-	-	-
Others	3	3.00	2.80	2.75	3.00

Grand Mean		***2.79***	***2.78***	***2.6211***	***2.74***
Status of Hospital					
Teaching Hospital	86	2.75	2.75	2.61	2.71
Regional Hospital	50	2.85	2.86	2.63	2.82
District Hospital	4	2.86	2.47	2.83	2.67
Grand Mean		***2.79***	***2.78***	***2.62***	***2.74***
Unit of Work					
Male Surgical	30	2.69	2.80	2.56	2.78
ICU	8	2.90	2.97	2.78	2.90
NICU	13	2.90	2.91	2.73	2.87
Recovery Dialysis	3	3.00	3.00	2.75	2.80
Female Medical Ward	24	2.86	2.73	2.62	2.75
Male Medical Ward	3	2.71	2.80	2.83	2.80
Paedics	14	2.78	2.56	2.46	2.64
S/Suite	7	2.65	2.64	2.45	2.08
Delivery Suits	14	2.76	2.90	2.53	2.92
O & G	13	2.78	2.93	2.68	2.93
Accid. & Emergency	11	2.79	2.67	2.73	2.47
Grand Mean		***2.79***	***2.79***	***2.62***	***2.74***
Number of Blood Transfusion per Week					
None	0	-	-	-	-
1-3	71	2.74	2.76	2.62	2.65
4-6	57	2.84	2.78	2.60	2.83
7-10	12	2.77	2.96	2.68	2.88
Grand Mean		***2.78***	***2.78***	***2.61***	***2.74***
Duration of Experience in Blood Transfusion (in years)					
1-5	93	2.77	2.79	2.62	2.78
6-10	32	2.75	2.74	2.59	2.64
11 and more	15	2.78	2.85	2.83	2.85
Grand Mean		***2.77***	***2.78***	***2.6248***	***2.75***
Training in Blood Transfusion					
Yes	39	2.85	2.86	2.71	2.90
No	101	2.80	2.76	2.60	2.73
Grand Mean		***2.81***	***2.78***	***2.63***	***2.76***

A glance at Table 16 reveals that based on their sex, the nurses had higher knowledge on Phase II of blood transfusion, followed by Phase I, Phase IV and lastly Phase III as they scored average values of 2.80, 2.78, 2.76 and 2.63 out of a total of 3.00, respectively. The female nurses did better compared to the male counterparts on the Phase II, but did better with respect to the first phase. On the basis of their age, the respondents had higher scores on Phase I,

followed by Phase II compared with the other two phases. Those aged 31-35 years consistently obtained high scores in all the various phases. Similarly, the mean values showed that Muslim nurses had relatively higher knowledge in all the phases except on Phase III than their Christian colleagues.

The results also indicate that married nurses had higher knowledge about the second and third phases of blood transfusion than those who were single, whiles the unmarried ones performed better in Phases I and IV. Also, based on their educational level, diploma nurses had a better appreciation on Phase I compared to bachelors and master's holding nurses.

In terms of Phase II, first degree holders performed better, followed by diplomats and lastly master's degree holders. On their level of knowledge in Phase III, first degree holders again did better followed by those with diplomas. Similarly, bachelor degree holders obtained higher scores on Phase IV than other categories of nurses. It can be seen that first degree holders were comparatively knowledgeable on the phases, followed by diploma holders and lastly by master's degree holders.

Furthermore, those nurses who worked in the District Hospital were more knowledgeable on Phases I and III than those at the Teaching and Regional hospitals. However, respondents from the Regional Hospitals had comparatively better appreciations of the Phases II and IV than those in the Teaching and District hospitals.

In terms of their respective units of work, respondents from the Recovery Dialysis Unit performed better on the Phases I and II compared to those working in other units. Similarly, on the their knowledge levels on Phases III and IV, those from the Male Medical Ward and Obstetrics and

Gynaecology Unit did better than their colleagues from other units of the hospitals.

Nurses who had between 4-6 transfusions per week, were more knowledgeable on Phase I compared to those had 1-3 and 7-10 transfusions per week. However, those who had more transfusions in a week did better on Phases II, III and IV compared to those had fewer transfusions a week. It can be deduced that the more a nurse has several blood transfusions per week, the higher the likelihood of him/her having a better understanding of the activities on the various phases of blood transfusion. In confirmation of the above conclusion, it can be seen that the longer a nurse's experience in blood transfusion, the higher his or her knowledge level on all the various phases of blood transfusion. Also, those who had ever undergone training in blood transfusion appreciated better the activities pertaining to the various phases of blood transfusion than those who had had no such training sessions. It, therefore, means that experience in blood transfusion activities is crucial to nurses since it adds to their knowledge levels on the phases involved in the blood transfusion process.

Table 17 presents the results from the Z test conducted on their knowledge level on each of the phases at a 5% significance level.

Table 17: Comparison of Knowledge Level of Nurses in the Four Phases of Blood Transfusion using the *z-test*

Phases	N	Mean	SD	SE Mean	Z	*p*	95% CI Lower	95% CI Upper
Phase I	140	2.79	0.1989	0.0169	165.29	.000	2.7570	2.8232
Phase II	140	2.80	0.2505	0.0382	72.85	.000	2.7068	2.8565
Phase III	140	2.64	0.2114	0.0214	122.73	.000	2.5789	2.6626
Phase IV	140	2.83	0.3780	0.0453	60.50	.000	2.7520	2.8496

It can be seen in Table 16 that with respect to Phase I, the respondents had an average value of 2.79 with a standard error of the mean as 0.0169 out of a total of 3.00. This produced a 95% confidence interval of 2.7570 to 2.8232. A z-value of 165.29 and $p<.05$ indicated that there was a significant difference in the knowledge level of the nurses on Phase I. This implies that some nurses had better understanding of activities pertaining to Phase I of the blood transfusion process than the others.

With respect to the nurses' knowledge on Phases II, a mean value of 2.80 and a standard deviation of 0.2505 were realised. A 95% confidence interval for the mean was 2.7068 to 2.8565. The significant test produced a *z*-value of 72.85 with an associated *p*-value of .000. The implication of this result is that some nurses had a higher knowledge on Phase II of blood transfusion process than others.

Similarly, there were statistically significant differences in the knowledge levels of the nurses with respect to Phase III since some respondents had higher appreciations than the others. The *z*-value of 122.73 and $p=.000$ were obtained with a confidence interval of 2.5789 to 2.6626.

Lastly, the results in Table 16 further showed that a mean value of 2.83 was realised for all the 140 nurses who participated in the study with regard to their knowledge levels on Phase IV of the blood transfusion process. The *z*-test performed revealed a *z*-value of 60.50 with a *p*-value of .000; indicating that there was a significant difference in their knowledge on this phase.

In sum, it can also be seen that the respondents had higher knowledge on Phase IV, followed by Phase II and Phase I than they did on Phase III. This is because they, on the average, had 2.83, 2.80, 2.79 and 2.64, respectively on Phases IV, II, I and III.

Now, the one-way analysis of variance (ANOVA) was further applied to determine if there was a statistically significant difference in their knowledge levels on the four phases. Table 18 presents the details of the analysis.

Table 18: Differences in Knowledge Level of Nurses on the Four Phases

Source	**df**	**SS**	**MS**	**F**	***P***
Factor	3	1.7920	0.5979	8.28	.000
Error	388	28.0013	0.0722		
Total	**391**	**29.7933**			

S = 0.2689, R-Sq = 6.01%, R-Sq(adj) = 5.29%

A glance at Table 17 reveals that there was a significant difference in the nurses' level of knowledge in the four phases of blood transfusion process. This is because of the F-value of 8.28 and *p*-value of .000 obtained. This means that the nurses generally had higher knowledge level on some phases of the transfusion process, whiles they had low knowledge level on others. As show in Table 16, they had higher knowledge on Phase IV than on Phase II,

followed by Phase I and lastly on Phase III. This means that some nurses were handicapped in administering of blood transfusion itself than they did on preparing patients (Phase I), blood pack collection (Phase II), and post-transfusion activities and issues (Phase IV).

Research Question 3: What common errors in practice exist in the transfusion of blood among nurses?

This research question sought to identify the common errors that nurses commit during the various phases of blood transfusion process. Specifically, it solicited for information on the common errors committed before, during and after blood transfusion process. Table 19 is a summary of their responses on the common errors.

Table 19: Common Errors in Blood Transfusion Practices among Nurses

Errors	Frequency	Percentages
Non-checking of vital signs before, during and after transfusion	40	28.6
Blood incompatibility	33	23.6
Wrong identification of patients	30	21.4
Non-monitoring of patients' given transfusion	15	10.7
Non-reporting of complications and adverse reactions	11	7.9
Incorrect adjusted flow rate	7	5.0
Others	4	2.8
Total	**140**	**100.0**

From Table 19, it can be seen that the commonest errors committed by the nurses in the blood transfusion process included the non-checking of vital signs before, during and after transfusion, blood incompatibility, and wrong

identification of patients. Specifically, 40 (28.6%) nurses reported that they sometimes forgot to check vital signs throughout the transfusion process.

Thirty-three representing 23.6% the nurses said that they usually encountered the problem of blood incompatibility. Similarly, wrong identification of patients was also common among the respondents. Other common errors made included the non-monitoring of patients' given blood transfusion, non-reporting of complications and adverse reactions, and high rate of blood transfusion.

Discussion of Findings

The main variables considered in this study include the knowledge level of nurses on the four phases of blood transfusion, complications and blood transfusion protocols. It also illustrated the knowledge gap of nurses concerning the blood transfusion process, and the common errors they committed during the process.

Knowledge Level of Nurses on the Phases of Blood Transfusion

It was revealed that the nurses had excellent knowledge on the four blood transfusion phases. However, they did better understanding of what pertained to Phase I than Phase II, III and had overall averages of 2.79, 2.80, 2.64 and 2.83 for Phases I, II, III and IV, respectively. According to Taylor et al. (2010), lack of knowledge of various aspects of blood transfusion by clinical staff, including nurses, continues to be a real threat to patient safety. This study's finding disagrees with the findings of Bayraktar and Erdil (2000) who found that nurses had insufficient knowledge about blood transfusion resulting in inadequate practice. However, that of Hijji et al. (2012) was similar to the finding here. They reported that nurses in the United Arab

Emirates (UAE) achieved a knowledge score that ranged from 27 to 56 (39-80%) out of a possible score of 70 (100%), with a mean score of 40.8 (58%).

Several researchers have also confirmed the relatively high knowledge level of blood transfusion among nurses. For example, Reza et al. (2009) assessed healthcare workers', including nurses, knowledge on proper methods of blood and components transfusion. They found that only 26.2% had weak level of knowledge, 22.2% had moderate knowledge, whiles 51.6% good knowledge. Contrary, Aslani et al. (2010) reported that most nurses (n=95, 81.2%) were unaware of the appropriate transfusion time after receiving the blood from blood bank. In this study, the reserve was the case.

Panagiotopoulou and Kerr (2002) concluded in their study that for nurses to provide high quality care and function effectively, they must have adequate knowledge that they actually use in practice with Dzik (2003) suggesting that besides administration of blood is an area which mostly needs improvement. According to the NMC (2008), information about nurses' blood transfusion knowledge, errors and gaps accounting for mistakes and their possible effects on patients in Ghana are lacking. Quality of care has been identified by the Nurses and Midwives Council of Ghana in the national health strategy as a high priority area, and this is where this area fits within Ghana's classifications of research priorities.

In some jurisdictions, there are always needs assessment for nurses in areas of blood transfusion. For example, Novis et al. (2003) reported that 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%). The replication of similar studies is important in the case of Ghana as well.

Differences in Knowledge of Nurses

There was a statistically significance difference in the knowledge level of nurses with respect to the four phases. Longer duration of experience in blood transfusion, number of transfusions per week and training are effective means to improve upon nurses' knowledge levels.

The above findings are consistent with that of Thomas and Hannon (2010) who revealed that the experience and training of the oncology nurses in recognising and responding to the signs and symptoms of transfusion reactions was important. The nurses at the point-of-care incorporated minor blood transfusion management into their practice. Also, Hijji et al. (2012) in their study found that 210 (85%) nurses reported that they had never received any in-service training in this field, with only 35 (14%) reported a perceived need for such training.

Common Errors Committed by Nurses in Blood Transfusion Process

The study found the non-checking of vital signs before, during and after transfusion, blood incompatibility, wrong identification of patients, non-monitoring of patients' given transfusion, non-reporting of complications and adverse reactions, and the incorrect adjusted rate flow as the most common errors made by nurses.

These findings are consistent with a finding by Dzik (2007). He posited that 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). He revealed that patient identification (ID) along with pre-transfusion specimen labeling, the decision to transfuse, and bedside pre-transfusion verification intended to match the right blood to the right patient were the common zones of error among nurses.

Linden et al. (2000) also identified that in New York State, 13% of the mistransfusions, and 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. Chan et al. (2004) whose study was done in China said that zero mistransfusions, transfusion of the wrong blood, occurred in thousands of transfusions when electronic barcode pretransfusion verification was used.

These errors have called for technological improvement and the use of more efficient equipment in blood transfusion. For instance, Dick (2007) suggested the 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. He indicated that 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 (Brooks, 2005).

Summary of Key Findings

The main findings from the study are as follows:

1. Generally, the nurses had a very good knowledge of all the four main patient-related phases of blood transfusion. This is because of the relatively higher average knowledge scores they obtained on the various phases. Specifically, they scored 2.79, 2.80, 2.64 and 2.83, respectively on phases I, II, III, and IV of the blood transfusion process.
2. There was a significant difference in the knowledge levels of the nurse in the four phases. They scored higher knowledge scores on phase IV compared to phases II, I and III in that order of importance.
3. The non-checking of vital signs before, during and after transfusion, blood incompatibility, wrong identification of patients, non-monitoring of patients' given transfusion, non-reporting of complications and adverse reactions, and the incorrect adjusted flow rate were among the commonest errors made by nurses in the blood transfusion process.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In this chapter, the most important findings are highlighted and implications for further research drawn from the findings. Some recommendations are offered to draw attention to the current levels of nurses' knowledge on blood transfusion.

Summary

The study sought insight into the issues of blood transfusion to ascertain whether the nurses in Ghana possess good knowledge on blood transfusion practices and its associated errors. This was done by providing various variables that are believed to influence the knowledge of nurses on blood transfusion.

A descriptive survey was employed for the study and a self-developed questionnaire to solicit for respondents' view. The respondents were sampled purposively. Means and Standard deviations were used to answer research questions whilst the hypothesis was tested with the Independent Sample t-test.

Key Findings

The main findings from the study are as follows:

1. Generally, the nurses had excellent knowledge of the entire four main patient-related to the phases of blood transfusion. This is because of the relatively high average knowledge scores they obtained on the various phases. Specifically, they scored 2.79, 2.80, 2.64 and 2.83, respectively on phases I, II, III, and IV of the blood transfusion process where mean below 1.5 – Poor knowledge; Mean above 1.5 – 2.0 –

Good Knowledge ; 2.0 – 2.5 – Very Good Knowledge; 2.5 – 3.0 – Excellent Knowledge.

2. There was a significant difference in the knowledge levels of the nurse in the four phases. They scored higher knowledge scores on phase IV compared to phases II, I and III in that order of importance.
3. The non-checking of vital signs before, during and after transfusion, blood incompatibility, wrong identification of patients, non-monitoring of patients' given transfusion, non-reporting of complications and adverse reactions, and the incorrect adjusted rate flow were among the commonest errors made by nurses in the blood transfusion process.

Conclusions

Though the majority of the nurses acknowledged they have not received any training from the hospital following the commencement of their clinical work. Higher knowledge scores obtained could be attributed to the recent completion of school, competency of practice over the years and available avenue for continuing higher education within the Cape Coast metropolis as well as self-education from the expertise of other health professionals within the healthcare team.

However, this study has identified a problem that needs immediate attention. Alternatively, the non-checking of vital signs before, during and after transfusion, blood incompatibility, wrong identification of patients, non-monitoring of patients' during transfusion, non-reporting of complications and adverse reactions, and the incorrect adjusted rate flow were among the commonest errors made by nurses in Ghana on the blood transfusion process. Without rectifying the current situation, patients' right to receive good quality

care will continue to be violated resulting in poor patient outcomes and possible death. These findings are worrying and put the life of every patient prescribed to receive blood transfusion in danger.

Recommendations

Recommendations for this study have been grouped in relation to the subheadings below.

Policy Development and Planning

There should also be pragmatic measures by health authorities to establish policies that seek to retain and motivate long serving staff in our various hospitals. Findings from this study strongly indicated adequate knowledge of the blood transfusion process in relation to duration of service.

Education and Training

1. It recommended that the Ministry of Health and Ghana Health Service should organize more medical education on blood transfusion practices so as to put nurses in a better stead.

2. Nurses should be given the opportunity to further their education. This is because the finding of the study has shown that the higher the level of one's education the more knowledgeable he/she is with regards to blood transfusion practices

3. It is again recommended that in-service training should be organized for nurses from time to time to update them to the use of best practices available. This will expose them to new trends in intravenous therapy which will enhance the health of patients

4. There is also strong advocate for the training of blood transfusion safety officer (BTSO) in our various hospitals whose primary duty is to carry out, supervisor and ensure safety in blood transfusion procedures.

Clinical and Nursing Practice

1. Clinical nursing practice must emphasize evidenced based practices and strict adherence to facility protocols to minimise chance of error occurrence.

2. Nursing quality assurance units must be established and empowered to periodically reward and reprimand bad nursing practices in various units of the hospital to enhance and promote better client healthcare outcome.

Suggestions for Further Research

Further research should be conducted involving more members in the multidisciplinary team who are directly involve in the blood transfusion process such as physicians, medical laboratory personnel and blood donation organizers.

REFERENCES

AABB. (2004). *Guidelines for Pneumatic tube delivery systems: Validation and use to transport blood.* Bethesda, MD: Author.

AABB. (2009). *Circular of information for the use of human blood and blood components.* Retrieved on May 12, 2014 from http://www.aabb.org/resources/bct/Documents/coi0809r.pdf

AABB. (2011). *U.S. biovigilance network*. Retrieved on July 02, 2014 from www.aabb.org/programs/biovigilance/us/Pages/default.aspx

Adams, K. W., & Tolich, D. (2011). Blood transfusion: The patient's experience. *AJN, 111*(9), 24-30.

Aguilar, A., van der Putten, W., & Maguire, G. (2006). Positive patient identification using RFID and wireless networks," in *HISI 11th Annual Conference and Scientific Symposium*, Nov. 2006. Retrieved on August 13, 2014 from http://citeseerx.ist.psu.edu/viewdoc/download?

Allain, J.-P., S. Owusu-Ofori, and Bates, I. (2004). Blood transfusion in Sub-Saharan Africa. *Transfusion Alternatives in Transfusion Medicine, 6*(1), 16-23.

American Hospital Association. (2012). Fast facts on U.S. hospitals. *AHA Resource Center American Hospital Association.* Retrieved from http://www.aha.org/research/rc/stat-studies/fast-facts.shtml 157

American Nurses Credentialing Center. (2012). *Magnet recognition: Program overview*. Retrieved from www.nursecredentialing.org/Magnet/Progra

Anders, S., Miller, A., Joseph, P., Fortenberry, T., Woods, M., Booker, R., France, D. (2011). Blood product positive patient identification:

comparative simulation based usability test of two commercial products. *Transfusion, 51*(11), 2311-2317.

American Organization of Nurse Executives. (2012). *About AONE, the American organization of nurse executives*. Retrieved from http://www.aone.org

Askeland, R.W., McGrane, S., Levitt, J. S., Dane, S. K., Greene, D. L., Vandeberg, J. A., Kemp, J. D. (2008). Improving transfusion safety: Implementation of a comprehensive computerized bar code-based tracking system for detecting and preventing errors. *Transfusion, 48*(7), 1308-1317.

Askeland, R. W., McGrane, S., Reifert, D. R., & Kemp, J. D. (2009). Enhancing transfusion safety with an innovative bar-code-based tracking system. *Healthcare Quarterly*, *12*, 85-89.

Aulbach, R., Brient, K., Clark, M., Custard, K., Davis, C., Gecomo, J., & Ho, J. O. (2010). Blood transfusions in critical care: Improving safety through technology and process analysis. *Critical Care Clinics of North America, 22*(4), 179-190.

Australian and New Zealand Society of Blood Transfusion LTD & Royal College of Nursing Australia. (2011). *Guidelines for the administration of blood products*. Retrieved from http://www.anzsbt.org.au/publications/documents/ANZSBT_Guidelines_Adminis tration_Blood_Products_2ndEd_Dec_2011_Hyperlinks.pdf

Barbara, J. A. J., Regan, F. A. M., & Contreras, M. (2008). *Transfusion microbiology*. New York: Cambridge University Press.

Badger, F., & Werrett, J. (2005). Room for improvement? Reporting response rates and recruitment in nursing research in the past decade. *Journal of Advanced Nursing, 51*(5), 502-510.

Baffa. A. (2011, May 5). *The 5 rights of safe transfusion practice: rethinking nursing's role in transfusion therapy.* Retrieved from www.bloodmanagement.com

Balas, E. A., & Boren, S. A. (2000). Managing clinical knowledge for health care improvement. In: Bemmel J., McCray A. T. (Eds.), *Yearbook of medical informatics 2000: Patient-centered systems* (pp. 65-70). Stuttgart: Schattauer Verlagsgesellschaft mb

Bates, I., Chapotera, G.K, McKew, S, & van den Broek, N. (2008). Maternal mortality in Sub Saharan Africa: The contribution of ineffective blood transfusion services. *Bjog*, *115*, 1331–1339.

Bayraktar, N., & Erdil, F. (2000). Blood transfusion knowledge and practice among nurses in Turkey. *Journal of Intravenous Nursing*, *23*(5), 310-317.

Blajshman, M. (2007). Incidence and significance of the bacterial contamination of blood components. *Development Biology,* 108(2), 59–67.

Berwick, D. M. (2003). Disseminating innovations in health care. *JAMA, 289*(3), 1969-1975.

Billings, D. M., & Halstead, J. A. (2005). *Teaching in nursing: A guide for faculty*. St. Louis, Missouri: Elsevier Saunders.

Bishop (2008). Patient safety and efficiency in transfusion therapy. *Transfusion Medicine Reviews, 21*(1), 49-57.

Bradbury, M., & Cruickshank, J. (1995a). Blood and blood transfusion reactions: 1. *British Journal of Nursing, 4*(14), 814-817.

Brooks, J. P. (2005). Reengineering transfusion and cellular therapy processes hospital wide: Ensuring the safe utilization of blood products. *Transfusion, 45*(4), 159-171.

Burgess, F. A. (1937). Simplified blood transfusion. *The American Journal of Nursing, 37*(9), 967-968.

Burgess, R. (2006). Blood transfusion in A&E. *Emergency Nurse, 13*(10), 18-22.

Cable, R., Carlson, B., Chambers, L., Kolins, J., Murphy, S., Tilzer, L., et al. (2007). Practice guidelines for blood transfusion: A compilation from recent peer reviewed literature. Retrieved from http://www.redcross.org/wwwfiles/ocuments/WorkingWiththeRedCross/practiceguidelinesforbloodtrans

Cable, R., Fatemeh. M., & Edward. N. (2007*). Limited effectiveness of donor deferral registries for transfusion-transmitted disease markers.* New York: ARCNET Research Group.

Callery, M. F., Culhane, M. B., Francis, C. K., Harrington, P., Pavel, J. D., & Snyder, E L. (1990). *Transfusion therapy guidelines for nurses*. New York: U.S. Department of Health & Human Services.

Centers for Disease Control and Prevention (2002). Guideline for the prevention of intravascular catheter-related infections. Retrieved from http://www.cdc.gov/mmwr/PDF/rr/rr5110.pdf

CareFusion. (2013). *Pyxis® transfusion verification: Positive patient and transfusion identification*. Retrieved from

www.carefusion.com/medicalproducts/medicationnagement/point-of-care-verification/pyxis-transfusionverification. Aspx

Chan, J. C. W., Chu, R. W., Young, B. W. Y., Chan, F., Chow, C. C., & Pang, W. C. (2004). Use of an electronic barcode system for patient identification during blood transfusion: 3-year experience in a regional hospital. *Hong Kong Med J, 10*(3), 166-171.

Clark, C. T. (2009). Transfusion-related acute lung injury: clinical features and diagnostic dilemmas. *Journal of Infusion Therapy, 32*(3), 132-136.

Clark, P, Rennie, I., & Rawlinson, S. (2001). Effect of a formal education programme on safety of transfusions. *British Medical Journal, 323*(7321), 1118-20.

Cohen, L., Manion, L., & Morrison, K. (2005). *Research methods in education* (5th ed.). New York: Routledge Falmer.

Colazzi, P. (1978). Psychological research as the phenomenologist views it. In D. S. Valle & M. King (Eds.), *Existential phenomenological alternative for psychology*. New York, NY: Oxford University Press.

Davies, A., Staves, J., Kay, J., Casbard, A., & Murphy, M. F. (2006). End-to-end electronic control of the hospital transfusion process to increase the safety of blood transfusion: strengths and weaknesses. *Transfusion, 46*(3), 352-364.

de Graaf, J. D., Kajja, I., Bimenya, G. S., Postma, M. J., & Sibinga, C.T. (2009). Bedside practice of blood transfusion in a large teaching hospital in Uganda: An observational study. *Asian J Transfusion Science, 3*, 60-65.

Despotis, G., Eby, C., & Lublin, D. M. (2008). A review of transfusion risks and optimal management of perioperative bleeding with cardiac surgery. *Transfusion, 48*(1), 2-30.

Dillman, D. A. (2000). *Mail and internet Surveys: A tailored design method*. New York: John Wiley & Sons, Inc.

Division of Healthcare Quality Promotion. (2010). Biovigilance component. *National Healthcare Safety Network (NHSN) Manual, 3,* 1-30.

Durosinmi, M. A, Mabayoje, V. O. & Akinola, N. O. A. (2003). A retrospective study of prevalence of antibody to HIV in blood donors at Ile-Ife, Nigeria. *Niger Postgrad Medicine Journal, 10*, 220–223

Dzik S. (2007). Radio frequency identification for prevention of bedside errors. *Transfusion, 47*(8), 125-129.

Dzik, W.H. (2003). Emily Cooley lecture 2002: Transfusion safety in the hospital. *Transfusion, 43*(9), 1190-1199.

Dzik, W. H., Corwin, H., Goodnough, L. T., Higgins, M., Kaplan, H., Murphy, M., & Yomtovian, R. (2003). Patient safety and blood transfusion: new solutions. *Transfusion Medicine Reviews, 17*(3), 169-180.

Dzik, W. H. (2007). New technology for transfusion safety. *British Journal of Haematology, 136*(2), 181-190.

Estabrooks, C., Thompson, D. S., Lovely, J. J. E., & Hofmeyer, A. (2006). A guide to knowledge translation theory. *The Journal of Continuing Education in the Health Professions, 26*(1), 25-36.

Emmanuel, J. C. (1994). Blood transfusion systems in economically restricted countries. *Vox Sang, 67*(3), 267–269.

Epstein, J. S. (2010). Alternative strategies in assuring blood safety: An overview. *Biologicals, 38*, 31–5.

Faber, J. C. (2002). Haemovigilance around the world. *Vox Sanguinis, 83*(1), 071–076.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191.

Fawcett, J., & Garity, J. (2009). *Evaluating research for evidence-based nursing practice*. Philadelphia: F.A. Davis.

FDA/Center for Biologics Evaluation and Research. (2011). *Fatalities reported to FDA following blood collection and transfusion: Annual summary for fiscal year 2011*. Boston: U.S. Government Office of Compliance and Biologics Quality.

Fiona, N., Erdil, F., Narki, B., & Moura, Y. (2009). Blood transfusion knowledge and practice among nurses in Turkey. *Journal of Intraven Nursing, 23*(5), 310-317.

Fitzgerald, M., Hodgkinson, B., & Thorp, D. (2000). Blood transfusion from the recipient's perspective. *Journal of Clinical Nursing, 8*(5), 593-600.

Fraser, S. W. (n.d.). *Adoption exercise*. Retrieved from The Institute of Healthcare Improvement

Friedman, A. J., Cosby, R., Boyko, S., Hatton-Bauer, J., Turnbull, G; Patient Education Panel. (2009). *Effective teaching strategies and methods of delivery for patient education*. Retrieved from https://www.cancercare.on.ca/common/pages/UserFile.aspx?fileID=60065

Friedman, M., Arja, W., Batra, R., Daniel, S., Hoehn, D., Panix, A. M., Vergara, N. (2012). Informed consent for blood transfusion: what do medicine residents tell? What do patients understand?. *American Journal of Clinical Pathology, 138*(4), 559-565.

Goodnough, L. & T., Monk, T. G. (2000). Blood conservation in patients undergoing non-cardiac surgery. *Curr Opin Anaesthesiol, 13*(3), 365-70.

Green, A. (2011, April). *The impact of changes in health care on nursing education and nursing practice: the IOM/RWJ future of nursing initiative & the accountable care act (ACA)*. Presented at the Texas Nurses Association District #9 Spring Meeting, Texas Woman's University, Houston, Texas.

Hainsworth, (2000), Blood conservation in patients undergoing non-cardiac surgery. *Curr-Opin Anaesthesiol, 13*(3), 365-70.

Hartley, A. (1940). Nursing care in blood transfusion. *AJN, 40*(3), 247-252.

Heddle, N. M., Fung, M., Hervig, T., Szczepiorkowski, Z. M., Torretta, L., Arnold, E., Lane, S., Murphy, M. F., & the BEST Collaborative. (2012). Challenges and opportunities to prevent transfusion errors: a Qualitative Evaluation for Safer Transfusion (QUEST). *Transfusion.* Advance online publication.

Heimann, L. (1938). The nurse in blood transfusion. *AJN, 38*(4), 408-413. Stable URL: http://www.jstor.org/stable/3414334

Hijji, B., Parahoo, K., Hossani, M.M., Barr, O., & Murray, S. (2010). Nurses' practices of blood transfusion in the United Arab Emirates: An

observational study. *Journal of Clinical Nursing, 19*(23-24), 3347-3357.

Hodgkinson, B., Fitzgerald, M., Borbasi, S., & Walsh, K. (1999). Towards safer blood transfusion practice. *Journal of Quality in Clinical Practice, 19*(1), 63-67.

Hogg, G., Pirie, E. S., & Ker, J. (2006). The use of simulated learning to promote safe blood transfusion practice. *Nursing Education in Practice, 6*(4), 214-223.

Houck, D., & Whiteford, J. (2007). Improving patient outcomes: transfusion with infusion pump for peripherally inserted central catheters and other vascular access devices. *Journal of Infusion Nursing, 30*(6), 341-344.

Hyson, C. (2009). *Exploring blood administration safety in nursing practice* (Master's thesis). Available from ProQuest Dissertation and Theses database. (AAT MR50264)

Ingrand, P., Surer-Pierres, N., Houssay, D., & Salmi, L. R. (1998). Reliability of the pretransfusion bedside compatibility test: association with transfusion practice and training. *Transfusion, 38*(11-12), 1030-1036.

Kemp, J. D. (2009). Enhancing transfusion safety with an innovative bar-code-based tracking system [Abstract]. *American Journal of Medical Quality, 14*(2), 31-38.

Knowles, S. (Ed.), & Cohen, H. on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. (2011). *The 2010 Annual SHOT Report*. Retrieved from http://www.shotuk.org/wp-content/uploads/2011/10/SHOT-2010-Report1.pdf

Knowles, S. & Poole, G. (2005). *Blood transfusion in hospitals*. Oxford: Blackwell Publishing.

Koppel, R., Wetterneck, T., Telles, J. L., & Karsh, B.-T. (2008). Workarounds to barcode medication administration systems: their occurrences, causes and threats to patient safety. *Journal of the American Medical Informatics Association, 15*(4), 408-423.

Kovner, C. T., Brewer, C. S., Yingrengreung, S., & Fairchild, S. (2010). New nurses' views of quality improvement education [Abstract]. *Joint Commission Journal on Quality & Patient Safety, 36*(1), 29-35.

Landis, R. J., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33,* 159-174.

Lara A M, Kandulu J & Chisuwo L. (2007). Laboratory costs of a hospital-based blood transfusion service in Malawi. *Journal of Clinical Pathology, 60,* 1117–11201

Lee, D. H. (2003). Differences in the perception of blood transfusion risk between laypeople and physicians. *Transfusion. 43*(6), 772-778.

Leech, N. C., Barrett, K. C., & Morgan, G. A. (2005). *SPSS for intermediate statistics: Use and interpretation* (2nd ed.). Mahwah, NJ: Lawrence Earlbaum Associates

Lemmer, K. E. (1938). Blood transfusions. *AJN, 39*(4), 403-407.

Lincoln, Y.S., & Guba, E. G. (1985). *Naturalistic inquiry*. Newbury Park, CA: Sage. Linden, J. V., Wagner, K., Voytovich, A. E., & Sheehan, J. (2000). Transfusion errors in New York State: an analysis of 10 years' experience. *Transfusion, 40*(10), 1207-1213.

Linden, J. V., Wagner, K., Voytovich, A. E., Sheehan, J. (2007). Transfusion errors in New York State. *Transfusion, 40,* 1207-1213.

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

Liu, D., Grundgeiger, R., Sanderson, P. M., Jenkins, S. A., & Leane, T. A. (2009). Interruptions and blood transfusion checks: lessons from the simulated operating room. *Anesthesia and Analgesia; 108*(1), 219-222.

Lynn, M. R. (1986). Determining and quantification of content validity. *Nursing Research, 35,* 382-385.

Lum, G., & D'Amarino, M. J. (2009). Use of laboratory robots for transport and delivery of blood products. *LabMedicine, 40*(9), 517-522.

Magid, D. J., Sullivan, A. F., Cleary, P. D., Rao, S. R., Gordon, J. A., Kaushal, R., . . . Blumenthal, D. (2009). The safety of emergency care systems: results of a survey of clinicians in 65 U.S. emergency departments [Abstract]. *Annals of Emergency Medicine, 53*(6), 715-723.

Massachusetts General Hospital. (2005). *Pneumatic tube system guidelines.* Massachusetts: Sage

Medicines and Healthcare products Regulatory Agency (MHRA), (2010). *Report on the UK Regulation of Blood Safety and Quality 2005*. Retrieved from http://www.mhra.gov.uk/home/groups/dtsbs/documen

Ministry of Health [Ghana]. (2007). National Blood Policy for the Health Sector. Republic of Ghana. Available at: nbsghana.org/wp-content/uploads/2012/07/ National-Blood-Policy-Ghana.pdf

Miyata, S., Kawai, T., Yamamoto, S., Takada, M., Isatani, Y., Kuro, M. (2004). Network computer-assisted transfusion-management system for accurate blood component-recipient identification at the bedside. *Transfusion, 44*(3), 364-372.

Melnyk, B. M. & Fineout-Overholt, E. (2011). *Evidence-based practice in nursing and healthcare: A guide to best practice.* Philadelphia: Lippincott, Williams & Wilkins.

Mole, L., Hogg, G., Benvie, S. (2007). Evaluation of a teaching pack designed for nursing students to acquire the essential knowledge for competent practice in blood transfusion administration. *Nurse Edu. Pract. 7,* 228-237

Murphy, M. F., & Kay, J. D. (2004). Barcode identification for transfusion safety. *Current Opinion in Hematology, 11*(5), 334-338. .

Narvios, A. B., Lichtiger, B., & Newman, J. L. (2004). Underreporting of minor transfusion reactions in cancer patients. *Medscape General Medicine,* *6*(2), 17. Retrieved from http://www.medscape.com/viewarticle/475118_print

National Haemovigilance Office (NHO) (2009). Report 2008e2009. http://www.giveblood.ie/Clinical_Services/Haemovigilance/Publications/NHO_Report 2008_2009.pdf (accessed 06.12.12.).

National Blood Authority Australia (2010). Australian Haemovigilance Report. Retrieved from www.nba.gov.au/haemovigilance/nba_

National Blood Resource Education Program's Nursing Education Working Group. (1991a). Choosing blood components and equipment. *AJN, 91*(6), 42-46.

National Blood Resource Education Program's Nursing Education Working Group. (1991b). Autologous Transfusion. *AJN, 91*(6), 47-48.

National Blood Resource Education Program's Nursing Education Working Group. (1991c). Preventing and managing transfusion reactions. *AJN, 91*(6), 48-50.

National Blood Resource Education Program's Nursing Education Working Group. (1991d). Building a safe community blood supply. *AJN, 91*(6), 51-52.

National Healthcare Safety Network (NHSN) Division of Healthcare Quality Promotion, National Center for Preparedness, Detection, and Control of Infectious Diseases Centers for Disease Control and Prevention. (2010). *NHSN Manual, Biovigilance Component, Hemovigilance Module.*

Neoteric. (2010). *Blood track hemosafe: Blood management beyond the blood bank.* Boston: Free Press.

Novis, D. A., Miller, K. A., Howanitz, P. J., Renner, S. W., & Walsh, M. K. (2003). Audit of transfusion procedures in 660 hospitals: a College of American Pathologists QProbes study of patient identification and vital sign monitoring frequencies in 16,494 transfusions. *Archives of Pathology & Laboratory Medicine*, *127*(5), 541- 548.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.).New York: McGraw-Hill.

Ohsaka, A., Kobayashi, M., & Abe, K. (2008). Causes of failure of a barcode-based pretransfusion check at the bedside: experience in a university hospital. *Transfusion Medicine, 18*(4), 216-222.

Oladapo, O. T., Lamina, M. & Fakoya, T. A. (2006). *Maternal deaths in Sagamu in the new millennium: A facility-based retrospective analysis*. London: Sage

Osborn, D. A. (1967). Errors in blood transfusion. *The British Medical Journal, 4*(4478), 550-551.

Pagliaro, P., & Turdo, R. (2008). Transfusion management using a remote-controlled, automated blood storage. *Blood Transfusion, 6,* 101-106.

Pagliaro, P., Turdo, R., & Capuzzo, E. (2009). Patients' positive identification systems. *Blood Transfusion,* 7, 313-318.

Parris, E. E., & Grant-Casey, K. (2007). Promoting safer blood transfusion practice in hospitals. *Nursing Standard, 21*(41), 35-28.

Pfadt, E., & Carlson, D. S. (2005). Transfusion-associated graft-versus-host disease. *Nursing, 35*(2), 88-93.

Pirie, E. A., & Gray, M A. (2007). Exploring the assessors' and nurses' experience of formal assessment of clinical competency in the administration of blood components. *Nurse Education in Practice, 7*(4), 215–227.

Polit, D. F., & Beck, C. T. (2012). *Nursing Research: Generating and Assessing Evidence for Nursing Practice.* Philadelphia: Lippincott Williams & Wilkins.

Potter, P., Wolf, L., Boxerman, S., Grayson, D., Sledge, J., Dunagan, C., & Evanoff, B. (2005). Understanding the cognitive work of nursing in the acute care environment. *JONA, 35*(7-8), 327-335.

PsychData™, LLC. (2006). *PsychData user manual*. Retrieved from https://www.psychdata.com/content/PsychData-Users-Manual.pdf

Public Health Service (PHS) Biovigilance Working Group (BWG). (2009). *Biovigilance in the United States: Efforts to bridge a critical gap in patient safety and donor health.* Retrieved from U.S. Department of Health and Human Services website:http://www.hhs.gov/ash/bloodsafety/biovigilance/ash

Pulse oximetry. (2013). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Pulse_oximetry

Rath, C. E. (1955). The prevention and management of blood transfusion hazards. *AJN, 55*(3), 323-326.

Research Lifeline. (2012). *Survey statistical tool for calculating the margin of error in survey data analysis: Basic statistical testing for margin of error between two proportions/percentages*. New York: Research Lifeline

Reza, P., Aziz, S., Ali, M., Marjan, M., & Reza, T. (2009). Evaluation of knowledge of healthcare workers in hospitals of Zabol city on proper methods of blood and components transfusion. *Asian Journal of Transfusion Science, 3*(2), 78-81.

Robinson, L. (2009). A summary of diffusion of innovations. *Enabling Change*. Retrieved from http://www.enablingchange.com.au/Summary_Diffusion_Theory.pdf

Roche, M., Diers, D., Duffield, C., & Catling-Paull, D. (2010). Violence toward nurses, the work environment, and patient outcomes. *Journal of Nursing Scholarship, 42*(1), 13-22.

Rogers, E. M. (2003). *Diffusion of innovations.* New York: The Free Press.

Ronsmans, C. & Graham, W. J. (2006). Lancet maternal survival series steering group. Maternal mortality: who, when, where, and why. *Lancet, 368*, 1189–200.

Rowe, R., & Doughty, H. (2000). Observation and documentation of beside blood transfusion. *British Journal of Nursing, 9*(16), 1054-1058.

Royal College Nursing (RCN). (2004). *Right blood, right patien right time.* London: RCN.

Saillour-Glenisson, F., Tricaud, SL, Mathoulin-Pelissier, S., Bouchon, B., Galperine, I., Fialon, P., & Salmi, L. R. (2002). Factors associated with nurses' poor knowledge and practice of transfusion safety procedures in Aquitane, France. *International Journal for Quality in Health Care, 14*(1), 25-32.

Sarna, L., Bialous, S. A., Wells, M., Kotlerman, J., Wewers, M. E., & Froelicher, E. S. (2009). Frequency of nurses' smoking cessation interventions: report from a national survey. *Journal of Clinical Nursing, 18*(14), 2066-2077.

Saxena, S., Ramer, L., & Shulman, I. A. (2004). A comprehensive assessment program to improve blood-administration practices using the FOCUS-PDCA model. *Transfusion, 44*(9), 1350-1356.

Shander, A., & Popovsky, M. A. (2005). Understanding the consequences of transfusion related acute lung injury. *Chest, 128*(5), 598-604.

Silliman, C. C., Boshkov, L. K., Mehdizadehkashi, D. J., Elzi, D. J., Dickey, W. O., Podlosky, L. (2003). Transfusion-related acute lung injury: epidemiology and a prospective analysis of etiologic factors. *Blood, 101*(2), 454-462.

Shuriquie, M., While, A., & Fitzpatrick, J. (2008). Nursing work in Jordan: an example of nursing work in the Middle East. *Journal of Clinical Nursing*, *17*(8), 999-1010.

Spiess, B. D. (2007). Risks of transfusion: risks of transfusion. Retrieved from http://www.medscape.com/viewarticle/567848

St. Claire. (1923). Technic of blood transfusion at Lakeside Hospital. *AJN*, *23*(9), 738- 742.

Stainsby, D., Russell, J., Cohen, H., & Lilleyman, J. (2008). Reducing adverse events in blood transfusions. *British Journal of Haematology*, *131*(1), 8-12.

Tapko, J., Mainuka, P. & Diarra-Nama, A. J. (2006). *Status of blood safety in the WHO African Region: Report of the 2006 Survey*. Brazzaville: WHO.

Tanley, P. C., Wallas, C. H., Abram, M. C., & Richardson, L. D. (1987). Use of a pneumatic tube system for delivery of blood bank products and specimens. *Transfusion*, *27*(2), 196-198.

Taylor, C. (Ed.), Cohen, H., Mold, D., Jones, H., et al., on behalf of the Serious Hazards of Transfusion (SHOT) Steering Group. (2010). *The 2009 Annual SHOT Report.* Retrieved from http://www.shotuk.org/wpcontent/ uploads/2010/07/SHOT2009.pdf

Taylor, C. J. C., Murphy, M. F., Lowe, D., & Pearson, M. (2008). Changes in practice and organisation surrounding blood transfusion in NHS trusts in England 1995- 2005. *Quality and Safety in Health Care, 17*(4), 239-243.

Toman, C. (1998). Crossing the technological line: blood transfusion and the art and science of nursing, 1942-1990. MQ36747. (Master's thesis). Available from ProQuest Dissertations and Theses database. (304505766).

The Joint Commission. (2011). *National patient safety goals*. Retrieved from http://www.jointcommission.org/assets/1/6/2011_NPSGs_HAP.pdf

The Joint Commission. (2012, August 2). *Hospital and critical access hospital CoP changes*. Retrieved from http://www.jointcommission.org/assets/1/23/jconline_Aug_1_12.pdf

Thomas, J.J., & Hannon, T. (2010). Underrecognition and underreporting of transfusion related adverse events. *Transfusion, 50*(2), 50-63.

Toman, C. (1998). Crossing the technological line: blood transfusion and the art and science of nursing, 1842-1990. MQ36747. (Master's thesis). Available from ProQuest Dissertations and Theses database. (304505766).

Tucker, A. L., & Spear, S. J. (2006). Operational failures and interruptions in hospital nursing. *HRS: Health Services Research, 41*(3), 643-662.

Turner, C. L., Casbard, A. C., & Murphy, M. F. (2003). Barcode technology: its role in increasing the safety of blood transfusion. *Transfusion, 43*(9), 1200-1208.

Trends in Maternal Mortality: 1990 to 2010: WHO, UNICEF, UNFPA and TheWorldBankEstimates.Geneva:WorldHealthOrganisation.www.unfpa.org/webdav/site/global/shared/documents/publications/2012/Trends_in_maten-al_mortality_A4-1.pdf 2.

Uebersax, J. (2009). Kappa coefficients. John Uebersax Enterprises LLC. Retrieved from http://www.john-uebersax.com/stat/kappa.htm

University of Twente. (2010). Diffusion of innovations theory. Retrieved from http://www.utwente.nl/cw/theorieenoverzicht/Theory%20clusters/Communication

U.S. Centers for Disease Control and Prevention. (2011). *The National Healthcare Safety Network (NHSN) Manual, Biovigilance Component Hemovigilance Module.* Retrieved from http://www.cdc.gov/nhsn/PDFs/Biovigilance/BV-Protocol-1-3-1-June-2011.pdf

U.S. Department of Health and Human Services, Food and Drug Administration, Center for Biologics Evaluation and Research. (2010). *Blood and blood products*. Washington D.C. U.S. Department of Health & Human Services

U.S. Department of Health & Human Services. (2011). *The 2009 national blood collection and utilization survey report.* Washington D.C. U.S. Department of Health & Human Services.

U.S. Department of Health and Human Services. (2011, April 25). Request for information (RFI) to identify and obtain relevant information from public or private entities with an interest in biovigilance (Notices). *Federal Register, 76*(79).

U.S. Department of Health and Human Services, CDC. (2011). *Guidelines for the prevention of intravascular catheter-related infections, 2011.* Retrieved from http://www.cdc.gov/hicpac/pdf/guidelines/bsi-guidelines-2011.pdf

U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services (2012). *Critical access hospital*. Washington D.C. U.S. Department of Health & Human Services.

U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services (2013). *Meaningful use.* Washington D.C. U.S. Department of Health & Human Services.

Vamvakas, E. C., & Blajchman, M. A. (2009). Transfusion-related mortality: the ongoing risks of allogeneic blood transfusion and the available strategies for their prevention. *Blood, 113*(15), 3406-3417.

Walraven, G., Telfer, M., Rowley, J., & Ronsmans, C. (2000). Maternal mortality in rural Gambia: Levels, causes and contributing factors. *Bull World Health Organ, 78*, 603– 13.

White, A. M. (1990). *Work factors important and satisfying to staff registered nurses employed in midsize hospitals across the United States* (Doctoral dissertation). Retrieved from CINAHL Plus with Full Text database.

Wier, L. M., Pfuntner, A., Maeda, J., Stranges, E., Ryan, K., Jagadish, P., Collins-Sharp, B., & Elixhauser, A. (2011). *HCUP facts and figures: Statistics on hospitalbased care in the United States, 2009*. Rockville, MD: Agency for Healthcare Research and Quality, 2011.

Wilkinson, J., & Wilkinson, C. (2001). Administration of blood transfusions to adults in general hospital settings: a review of the literature. *Journal of Clinical Nursing, 10*(2), 161-70.

World Health Organization. (n.d.). *The Clinical Use of Blood Handbook*.

WHO, UNFPA, UNICEF and AMDD. *A handbook on monitoring emergency*

obstetric care. Geneva: WHO.

APPENDICES

APPENDIX A

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD

INFORMED CONSENT FORM

Title: Knowledge and Practice of Blood Transfusion among Nurses in Ghana: Experiences from the Cape Coast Teaching Hospital, Cape Coast.

Principal Investigator: Ebenezer Tetteh

Address: School of Nursing and Midwifery

University of Cape Coast

Cape Coast

General Information about Research

The purpose of this study is to assess the knowledge and practice of blood transfusion among nurses. The study involves gathering data about the existing knowledge and the practice of blood transfusion process by the Ghanaian nurse. Nurses knowledge and practice of the phases of the blood transfusion processes such as preparation before blood bag collection, blood pack collection, pre-transfusion initiation nursing responsibilities and post transfusion nursing activities would be examined and compared if differences and errors exist.

Participants mainly registered nursing staff (selected through convenient sampling techniques) of this study are expected to spend approximately 35 minutes to respond to a questionnaire. The questionnaire contains

demographic information and likert type scale questions that relate to the research questions.

Procedures

To find answers to some of these questions, I invite you to take part in this research project. If you accept, you will be required to fill out a survey which will be provided and collected by myself. You are being invited to take part in this survey because I feel that your experience as a registered nurse can contribute effectively to this study.

The questionnaire is composed of closed and opened questions and is broadly divided into two sections. The sections: A contains questions on demographic data and B covers questions on knowledge and practices of blood transfusion among nurses.

If you do not wish to answer any of the questions included in the survey, you may skip them and move on to the next question. The questionnaire will be distributed and collected by myself. The information recorded is considered confidential, and no one else except me will have access to your survey. The expected duration of the survey is about 35 minutes**.**

Possible Risks and Discomforts

The study process will not entail any harmful effects on participants.

Possible Benefits

There will be no financial reward for respondents. However, respondents (nurses) and beneficiaries of nursing care (patients) would benefit from the findings of the study.

Alternatives to Participation

There will be no introduction of any intervention/treatment to participants.

Confidentiality

Confidentiality will be ensured through the enforcement of anonymity of your responses (participants will not indicate their names and institutions on the questionnaires). Additionally, the names of participants will not be included in any report.

Compensation

There will be no compensation because the study will not involve any harmful process.

Additional Cost

Apart from the time that will be used to respond to the questionnaire no other cost will be incurred by the participants.

Voluntary Participation and Right to Leave the Research

Participation in the study is voluntary. Participants can decide to withdraw without any penalty.

Contacts for Additional Information

If you have any question about the study you can contact the principal investigator Ebenezer Tetteh through 020-4545827 or email address etetteh@live.com.Further information could be obtained from the supervisor of this study Dr. Mate Siakwa (020-5613404).

Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board of University of Cape Coast (UCCIRB). If you have any questions about your rights as a research participant you can contact the IRB Office

between the hours of 8:00 a.m. and 4:30 p.m. through the landlines 0332135351/0289670793(4) or email address: irb@ucc.edu.gh . You may also contact the Chairman, Prof. Albert A. Addo-Quaye through mobile number 0243-189593 when necessary.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research on the knowledge and practice of blood transfusion among nurses have been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_____ _____

Date Name and signature or mark of volunteer

APPENDIX B

UNIVERSITY OF CAPE COAST

SCHOOL OF NURSING

BLOOD TRANSFUSION KNOWLEDGE AND PRACTICE

QUESTIONNAIRE

Please answer these questions to the best of your ability. You are at liberty not to answer any parts of this questionnaire if you feel uncomfortable. Thank you for your participation.

RESIDENCE_____ UNIT _____

Blood Transfusion Knowledge and Practice Questionnaire

Nb: Please Tick and Indicate The Best Response(S) You Are Selecting.

PART A: SOCIO-DEMOGRAPHIC DATA

1. **Age:**
   21-25 [ ]

   26-30 [ ]

   31-35 [ ]
   above 35 [ ]
2. **Sex**:
   male[ ]
   female [ ]

3. **Religion:**

   Christian [ ] (Specify).....,
   Islam [ ],
   Traditionalist [ ],
   Others [ ]

4. **Marital Status:**

   Married [ ],

   Single [ ],

   Divorced [ ],

   Others (specify)……

5. **What is your highest level of education in nursing or midwifery?**
   a) Diploma (specify)……
   b) First Degree (specify)……..
   c) Masters degree (specify)……..
   d) Doctorate (specify)……..
   e) Other (specify) ……..
6. **What is the status of the hospital you are working in**?
   Teaching Hospital [ ],

   Regional Hospital [ ],

   District Hospital [ ],

7. How many blood transfusions do you administer in a week?
   1-3 [ ],
   4-6[ ],
   7-10[ ],
   None [ ],

8. How long have you been working on ward(s) where blood transfusion is usually performed?
   Years --------Months.....
9. Have you ever participated in any educational program in relation to blood transfusion
   While working in this unit?
   Yes. [ ],
   No [ ],
   a. If yes, how many programs have you participated in during the last year? .....

      When? (list month and year) ..... Where? .....

11. What specific area(s) relating to transfusion practice do you feel you would prefer further
training/education?

a. Sampling [ ]
b. Collection of blood bag [ ]
c. Administration [ ]
d. Adverse reactions [ ]
e. None [ ]

Section B.

Patient Preparation

Indicate whether the statement below is True Always (1), True Sometimes (2) Not At All (3)

		1	**2**	**3**
1	The most important phase of the transfusion process is identifying client identity and confirming blood compatibility			
2	Two registered nurses are needed to check physician's order, clients identity ID band, number and compared to blood bag details.			
3	Client is assessed to determined previous reactions to blood transfusions			
4	Ensure that informed consent has been obtained			
5	Check vital signs before transfusion			
6	Obtain intravenous access line			
7	Obtain blood sample for grouping and cross-matching.			

Section C: Blood Pack Collection

8	The blood bag tag, label and requisition form are assessed to ensure that ABO and Rh types are compatible.			
9	Assess blood bag for expiration date			
10	Inspect blood bag for leaks, abnormal colour, clots, excessive air and bubbles.			
11	Blood should be transported from the blood bank to only one client at a time.			
12	Transport blood in a validated blood box			

Section D: Administering the Transfusion

13	Identify the right patient			
14	Maintain standard(universal) precautions			
15	Return blood not administered longer than thirty(30) minutes to blood bank			
16	Check vital signs and lung sounds first fifteen minutes and every hour until completion.			
17	Pre-medicate according to institution's policy.			
18	Infuse blood via administration sets designed specifically for blood			
19	Blood products are made to warm up in microwaves or hot water			

20	Determine rate of infusion by physician order or by facility protocol			
21	Start transfusion slowly and monitor for signs and symptoms of transfusion reactions especially in the first 15 minutes.			
22	Encourage client to report any unusual feeling or manifestation.			
23	Document client's tolerance to the transfusion process.			
24	Monitor appropriate laboratory values and document procedure.			

Section E: Post Transfusion Nursing Activities And Issues

25	Documentation of relevant information including vital signs			
26	Observation for transfusion reaction			
27	For the first 10-15 minutes it is essential to physically observe the patient for possible transfusion reaction.			
28	Carry out emergency treatment in case of transfusion reaction as ordered			
29	Blood products administered within four (4) hours after collection reduces complication.			

Section F: Complications Related to Blood Transfusion

30	Patient identification error is the most commonest cause of fatal transfusion reaction			
31	Signs of immediate transfusion reactions include chills and diaphoresis, muscle aches, back pain or chest pain, rashes, itching, rapid pulse, apprehension, nausea, vomiting or diarrhoea.			
32	Starting the transfusion within 20 minutes after collection from blood bank minimises complications			
33	The first two measures following blood transfusion reaction is to stop the transfusion and keep iv line open with 0.9% normal saline.			
34	Delayed transfusion reaction occurs days to years of transfusion.			

Section G: Blood transfusion protocols.

35	There is a unit protocol guide for administering blood transfusion.			
36	Protocol is clear, concise and simple to follow			
37	Protocol is revised every year			

Section H: Common Transfusion errors

38.What are the common errors in blood transfusion practice among nurses in your ward?

.....
.....
.....

39. What is positive patient identification?

.....
.....

40. What type of blood group is co