REVIEW PAPER

Enhancing Transfusion Safety: Nurse's Role

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Abstract

Background: Despite strict clinical measures, there are distinct steps in transfusion process which require acute attention. The nurse is responsible for insuring that the right unit is administered to the right patient. Knowledge of risks is essential to administer and monitor transfusions safely.
Aim: This study summarizes the available data concerning transfusion adverse events and provides theoretical and technical aspects for improving transfusion practice.
Methodology: A systematic review in PubMed, MedLine and MDConsult database was conducted. The research limits included English texts, referring to transfusion risks and technological means aiming at transfusion safety.
Results: Blood transfusion is a medical intervention that saves lives and improves the quality of life. The regulations for ensuring the availability and assuring the quality of the blood component cannot avoid transfusion errors, placing patients at risk. Most frequent errors are attributed to practitioners involved in the clinical transfusion process. Based on reports to Serious Hazards of Transfusion (SHOT) the risk of transfusion error is estimated at 1:16,500. Over the last years several committees have recommended guidance for enhancing the safety of blood ordering and administration. Moreover, new technology like barcode on patient wristband manages to improve the performance in each step.
Conclusion: Safe transfusion process depends on a series of linked processes and nurses should take specific measures referring to pre- and post-transfusion stage. Technological innovations could help patients in need of transfusion therapy.

Keywords: Transfusion, errors, safety, nurse, technology

Introduction

Blood components administration is common in clinical practice, especially in surgical and hematological departments. Blood safety and quality regulations refer to the collection, testing, processing, storage and distribution of human blood (Dzik WH, 2007). Over the past two decades, expanded blood donor screening and pathogen laboratory methods have greatly reduced the risk of transfusion-transmitted viral infections. Nowadays, there is a great concern about transfusion practices in clinical departments and nurses have the final opportunity to prevent mistransfusion, through the final bedside check (Mole LJ, Hogg G, Benvie S, 2007).
According to SHOT program (Serious Hazards of Transfusion) about 70% of all reported adverse events are attributed to the incorrect transfused blood component. Furthermore, half of these events involve more than one error in the transfusions process (Gray A, Illingworth J, 2005).
Error risk in transfusion chain is estimated at 1:16,500 and an ABO incompatible transfusion risk at 1:100,000, whereas the risk of death is about 1:1,500,000 (SHOT, 2003). Recently published guidelines recommend careful sample collection, pre-transfusion checking and close monitoring of transfused patient (Rowe R, Doughty H, 2000; Hainsworth T, 2004). Nurses can reduce the error potential by developing safe blood transfusion policies, auditable performance standards and educational initiatives (Gray A, Howell C, Pirie E, 2005).

Methodology

For the purpose of this study, articles are searched in PubMed, MedLine and MDConsult database, by using the keywords: transfusion, errors, safety, nurse and technology. Search limits include access to English full texts with integrated bibliography, published from 2000 to November 2010. A total of 109 articles, guideline instructions and textbook references are found.

Ninety reports involving organ transplantation, tissue banking, transmitted infections and advanced methods concerning the decision to transfuse are excluded.

Transfusion Errors

Blood transfusion saves life, but an error in transfusion process takes life. The number of transfusion errors is underestimated, because only one third of the adverse events have obvious clinical consequences and hospitals do not report all cases to Registration Services. Transfusion process is complex with a number of critical points that offer the possibility of error. Thus, the acute hemolysis due to ABO incompatibility is the final result of failures having occurred during patient identification, sample labelling, prescribing blood component, laboratory testing, collection and administration (Stainsby D et al, 2005). In transfusion medicine, errors may be on account of lack of Knowledge or incomplete information, but more often result from distraction, fatigue, or inattention (Dzik WH, 2007). While it is a medical responsibility to prescribe blood components, the completion of the request form, the pre-transfusion sampling and the administration of the component can be delegated to nursing staff (Sullivan P, 2005).

Request and prescription errors

A decision to transfuse should be based on clinical symptoms and signs supported by laboratory findings. Recent guidelines direct that blood should not be administered prophylactically and the threshold of transfusion is a hemoglobin level 7.00 to 8.00 gr/dL (British Committee for standards in Haematology-Blood Transfusion Task Force, 2001). A transfusion which does not fulfill certain criteria can result in major morbidity and mortality and increase blood shortage. Mismatches between laboratory report and clinical symptoms must be carefully examined, as incorrect results may be due to unsuitable samples or analytical errors. Telephoned reports may be wrongly transcribed or assigned to the wrong patient. Adverse events may also occur from failure to provide the transfusion service with information regarding patient's transfusion history or special blood requirements (e.g. antigen or cytomegalovirus–negative blood, irradiation or leukodepletion of products) (Stainsby D et al, 2005).

After the decision to transfuse, a request form should be completed and send to the transfusion service. The petition form includes the patient's full name, age, disease, transfusion history and previous pregnancies. The necessity of transfusion therapy and the need of special blood procedures like irradiation should also be reported. Errors often occur because blood or other components are ordered for wrong patient or patient is transfused with no irradiated blood (Sullivan P, 2005).

Moreover, before administering the blood component, a consent form should be signed by the patient or qualified representative in urgent situations or when the patient is unable to make that decision. The decision to transfuse should be recorded in the patient's case notes and the blood prescription should provide instructions regarding the pre-medication, rate and volume of transfusion. (British Committee for standards in Haematology–Blood Transfusion Task Force, 2001; Sazama K, 2007).

Errors in collection of pre-transfusion samples

In most countries, the blood sample from the prospective recipient is taken for ABO and Rhesus testing, antibody screening and crossmatch. Errors in blood sampling are especially dangerous as they can initiate a wrong process. It was estimated that 14% of ABO incompatible transfusions were due to sample collection errors (Linden JV et al, 2000). Practices resulting in wrong blood in tube include labelling of sample tubes away from the bedside, failure to check patient's identity and the use of preprinted labels (Cummins D et al, 2000). A multicenter international study of 650,000 samples submitted to transfusion services reported that the median frequency of miscollected samples was 1 in 1986 (Dzik WH et al, 2003). In addition, poor techniques in blood sampling can result in erroneous hemoglobin result and inappropriate decision to transfuse with severe consequences.

In order to avoid the risk of sampling errors, nurse staff should have the appropriate training. Samples must be taken from a free flowing venipancture site, the tube filled to capacity and adequately mixed. (Stainsby D et al, 2005). Patient's identity should be carefully checked and the sample labelling should be done before leaving the patient. The label details include: date, patient's full and patronymic name, date of birth,

code number, clinic origin and signature (Gray A, Illingworth J, 2005).

Laboratory errors

Approximately 30% of wrong blood events arise in the laboratory (Linden JV et al, 2000). These errors usually take place outside of core hours, when there is limited staff number that may be inexperienced and work under pressure. Furthermore, problems in interpretation and documentation could emerge due to urgent blood grouping using manual techniques. Adequate staffed transfusion service throughout the 24-hours period is essential for reducing laboratory errors and "out-of-hours" transfusion request should be restricted to those that are clinically imperative (Stainsby D et al, 2005).

Errors in blood collection and administration

The stage of greatest risk in transfusion chain is collection of the blood component from blood refrigerator and its administration to the patient. Errors at these stages constituted 40% of wrong blood events reported to SHOT in 2003 and it is estimated that 1 in 14,000 transfusions involved ABO-incompatibility. Blood checking away from the bedside, distraction of nursing staff, patient's wristband missing, defaced or hidden and transfusion performance in clinical urgent situations are some of the factors that facilitate the occurrence of these events (Stainsby D et al, 2005). Undoubtedly, these errors can be fatal and only good luck sometimes prevents a bad outcome.

Consistently, the commonest error is a failure to carry out a pre-transfusion "bedside" check. The basic elements of this check include positive patient identification, matching wristband to the blood compatibility label, matching patient's identity with blood request form and review of compatibility and expiry data information. The pre-transfusion checking must be repeated for each component administered. If there are any discrepancies at this point, the transfusion must not start until they have been resolved (Gray A, Illingworth J, 2005; Dzik WH, 2007).

Practical Aspects For Nursing Care

Administration sets and filters

Filters are used to retain clots and other debris from blood components. Standard in-line blood filters have a pore size of 170 microns. The set could not be used for longer than four hours, because the risk of bacterial contamination is increased substantially. Sets for platelets and fresh frozen plasma infusion have a shorter line and smaller filter (Mole LJ, Hogg G, Benvie S, 2007).

Intravenous infusion

Blood and other components are usually infused to an adult through 18-20 gauge needle. A 24-gauge or larger thin-walled scalp vein needle may be used for children and adults whose large veins are inaccessible. During transfusion process, only 0.9% sodium chloride solution can de administered. Other solutions or medications must not be added to blood components (British Committee for standards in Haematology–Blood Transfusion Task Force, 2001).

Leukocyte reduction filters

Special "third generation" filters are available that can reduce effectively the leukocyte number in the red cells or platelets to less than 5×10^6, a level that reduces the risk of HLA allo-immunization (Human Leukocyte Antigen, HLA), cytomegalovirus transmission, Creutzfeld – Jacob disease and non-hemolytic reactions. The available leukodepletion methods are divided into pre-storage and selective leukodepletion, the former is performed during blood collection, the later uses bedside filters. There are special filters for red cells and platelets that differ in technology used for leukocyte removal and should be used according to manufacturer's directions (Ratko TA et al, 2001).

Infusion devices

Electromechanical infusion devices permit infusion at controlled rate and may alert the process when a problem has occurred. In some cases red cells may undergo hemolysis, however, without clinical significance.

External pressure devices

They are used to infuse large quantities of red cells in a short period of time. These devices are coupled with wide lumen catheter and the maximum pressure should be 300mmHg. Standard sphygmomanometers apply uneven pressure and should not be used.

Blood warmers

These devices are used in urgent cases, which demand an elevated flow rate (>50 ml/kg/h in adults and >15 ml/kg/h in children) and in case of cold-agglutinins presence. They also used to

prevent hypothermia, cardiac arrhythmias and/or arrest when a large amount of blood is transfused. Currently, there are many available devices on the market like countercurrent heat exchange, dry heat, thermostatically controlled water bath, in-line microwave. Warming devices must be equipped with a warning system to prevent excessive heat (British Committee for standards in Haematology–Blood Transfusion Task Force, 2001).

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Duration and infusion rate

The appropriate transfusion rate depends on patient's condition and should be specified by the physician. The transfusion must be started slowly (2 ml/min) for the first 15 minutes, because of increased risk of severe reaction during this period. A unit of red cells must be infused over 3-4 hours; platelet and fresh frozen plasma are administered at approximately 50 ml/hour over the critical period and if no problem is observed the rate can be increased (Gray A, Howell C, Pirie E, 2005).

Patient Monitoring

Every patient receiving a transfusion should be monitored throughout the process and nurse's role at this stage is crucial. The patient's vital signs (temperature, heartbeat pulses, respiratory rate and blood pressure) should be checked and recorded before transfusion and 15 minutes after the initiation of the process and then every hour. The rate of component's flow should be regulated according to physician's orders (Gray A, Illingworth J, 2005).

Patient should be observed periodically for signs and symptoms of transfusion-related reactions. Upon completion of the transfusion, vital signs should be checked and compared with previous values.

Equally important is the laboratory assessment of transfusion therapy, measuring hemoglobin, platelet count, PT/INR, APTT and fibrinogen. The time of such testing may vary for each patient, depending on clinical condition (New York State Council on Human Blood and Transfusion Services and New York State Board for Nursing, 2008).

Transfusion Reactions

Transfusion-related reactions usually are underestimated because many symptoms are not specific. The fatality rate is 1 to 1.2 cases per 100,000 patients who receive a transfusion (Sazama K, 1990).

Generally, they can be classified as acute or delayed. Acute reactions occur during transfusion or within hours after transfusion completion. Common clinical manifestations include fever, chills, nausea, vomiting, diarrhea, flushing, itching, urticaria, bronchial wheezing, dyspnea, headache, hypertension, chest pain, backache, circulatory collapse, respiratory failure, shock (Cherry T, 2008). In case of delayed transfusion reactions, symptoms and signs are observed in the days, months or even years following a transfusion and could not be explained by the patient's medical condition. Clinical presentation of the later events usually consist of fever, rash, elevated liver functions, jaundice, elevated lactate dehydrogenase, bleeding disorders (Brecher M, 2005).

Acute Reactions (Hoffman R, 2005).

A) Immune- mediated reactions

- Acute hemolytic reaction due to incompatibility between donor's and patient's blood
- Febrile, non-hemolytic reactions related to infused white blood cells or cytokines
- Allergic reactions (mid) to plasma proteins
- Allergic reactions (severe) due to antibody-antigen reaction
- Transfusion-related acute lung injury (TRALI syndrome) due to reaction between donor HLA or white blood cell antibody and recipient leukocyte

B) Non- immune- mediated reactions

- Bacterial contamination of blood component
- Circulatory overload, when the blood administration is faster than the circulation can accommodate
- Air emboli, due to air pumped into patients by roller pumps contained in various transfusion devices
- Hypothermia, in case of rapid infusion of large quantities of refrigerated blood

Delayed Reactions (Hoffman R, 2005).

A) Immune-mediated reactions

- Delayed hemolytic reaction due to an erythrocyte antibody, developed as a result of pregnancy or transfusion in the past
- Allo-immunization to erythrocytes antigens
- Allo-immunization to HLA and HPA (Human Platelet Antigens, HPA)
- Graft-vs-host disease, when donor T-lymphocytes attack recipient tissues

- Post-transfusion purpura due to the antibody presence against foreign platelet antigen
- Immunomodulatory effects

B) Non-immune- mediated reactions

- Iron overload
- Transmission of infectious agents (e.g. viruses, parasites)

Patients should be award about the possible adverse events during transfusion process and encouraged to notify nursing staff if they have symptoms like shivering, flushing, pain or shortness of breath. If the reaction occurs, the transfusion must be stopped immediately and doctor must be informed. Normal saline infusion is useful in order to maintain intravenous line and patient's hemodynamic stability (Stainsby D, 2007).

Nurse must reconfirm patient and unit identification. Patient's blood and urine specimen along with the remaining blood unit must be send to the Blood Bank. The reaction must be recorded in the patient case notes.

The Application of New Technology

Over the last few years, technological innovations have improved transfusion conditions and restricted the risk of human errors. Machines cannot be distracted, do not make arbitrary thoughts that lead to error and are much better to repetitive matching. The challenge for practitioners is the appropriate use of the technology, which is based on specific training courses.

Technological Advances in Blood Collection And Labeling

Handheld devices identify patient's data from wristband and are coupled with small automated printers that create specimen labels using data taken directly from patient's wristband. (Aller R, 2005)

Technological Advances in Blood Administration

Barcode at the bedside is a stable and inexpensive mean of machine-readable identification. It is based on the use of special wristbands with a barcode, whereas the unit label is of the same structure. At the bedside a nurse scans both the patient and the unit using a handheld reader to verify the accuracy of the bedside check. Barcode technology is very useful for "one-day" transfusion depended patients who enter hospital (Sandler SG, Langeberg A, Dohnalek L, 2005).

Radiofrequency identification technology (RFID) uses a chip holding much more data than barcode system, which include blood group, allo-antibodies detection and special blood needs. In addition RFID chips are simply interrogated by proximity to a passive electronic reader without any user's contribution (Dzik WH, 2007)

Discussion

Nurses have a crucial role in transfusion process beginning with blood sampling and ending with blood administration. Errors that result in inappropriate transfusion remain the largest risk and usually occur when details of patient's identification are overlooked. Nearly all transfusion steps can be complicated by life-threaten mistakes starting with prescription and request form, sampling and labelling, laboratory testing, collection and administration of blood product. Nursing training courses could educate on transfusion risk elimination and facilitate nurse's intervention and decision making. The knowledge of pathophysiology of transfusion reactions, symptoms and management could improve patient's monitoring.

Nursing staff should be aware about recent technological achievements in planning and management of transfusion medicine. Recent technological advances improve performance in each point of transfusion chain. Technology concerning pre-transfusion blood labelling and barcode identification system has successfully assured the process. The above combined with the development of technical skills and the rational use of available devices can improve nursing care. The big challenge is to familiarize practitioners with the use of the available resources in routine practice.

Good transfusion practices, successful educational initiatives and references systems of adverse events could manage to reduce the number of transfusion errors. Thus, clinical guidelines, quality assurance programs and systems for reporting and investigating adverse events should be available in all hospitals, preventing harmful consequences.

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