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The Key Role of Nurses in Blood Transfusion in Healthcare Setting

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Abstract

Blood transfusion has been a life-saving medical practice for centuries, with its roots dating back to the 17th century. This article delves into the components of blood and the intricate process of blood transfusion, shedding light on the indispensable role that nurses play in ensuring its success. Blood comprises various components, including red blood cells (RBCs), white blood cells (WBCs), platelets, and plasma. Each of these elements serves distinct functions and requires specific transfusion protocols. The transfusion process is a highly regulated series of steps, starting with patient assessment and the selection of compatible donor blood. Nurses, as essential stakeholders in this process, carry out patient assessment, facilitate communication, verify compatibility, monitor the transfusion, and maintain meticulous documentation. Their roles extend beyond the technical aspects, encompassing patient advocacy, quality control, continual education, transfusion reaction management, emotional support, collaboration, patient monitoring, adherence to standards, and emergency response.The article also discusses critical topics related to blood transfusions, such as leukoreduction, irradiated blood products, graft-versus-host disease, and volume-reduced blood components.

Keywords: Blood transfusion; Red blood cells; White blood cells; Platelets; Plasma; Transfusion requisition; Random Donor Platelets; Single Donor Platelets; Fresh frozen plasma; Cryoprecipitate; Leukoreduction.

INTRODUCTION

Blood transfusion is a life-saving medical intervention that has been in practice for over a century[(1)]. It involves the transfer of whole blood or its components from a healthy donor to a recipient, typically a patient in need of specific blood components or volume. Nurses play an indispensable role in the process of blood transfusion, from ensuring compatibility to monitoring patients for adverse reactions and complications. In 1628, English physician William Harvey discovered the circulation of blood. The first recorded successful blood transfusion occurs in England in 1665[(2)]. Physician Richard Lower keeps dogs alive by transfusion of blood from other dogs.American physician Philip Syng Physick performs the first human blood transfusion in 1795 In Philadelphia[(2)].This article explores the components of blood, the transfusion process, and

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the critical role nurses play in making this life-saving procedure successful.

Blood and its Components

Blood is a complex fluid that serves several crucial functions in the body, including oxygen transport, immune response, supply of nutrientsand removal of waste. It primarily consists of red blood cells (RBCs), white blood cells (WBCs), platelets, and plasma[3].

1. **Red Blood Cells (RBCs):** These cells contain haemoglobin, a protein that binds with oxygen, allowing RBCs to transport oxygen from the lungs to tissues throughout the body[4]. Normal human red blood cells (RBCs) usually have a lifespan of about 120 days in the bloodstream before they are taken up by macrophages[5]. RBC transfusions are commonly used to treat anaemia, blood loss due to trauma or surgery, and certain medical conditions.RBC transfusion is indicated to improve oxygen-carrying capacity Transfusion requisition should be viewed as a simple risk-benefit evaluation, with the acuity of the need for oxygen delivery balanced against the evidence of risk associated with each unit delivered[6].

   Packed RBCs areindicated for patients whose Oxygen-carrying capacity may not be adequate with Hb levels as low as 7 g/dL (70 g/L). The normal haemoglobin (Hb) level for males ranges from 14 to 18 g/dL, while for females it ranges from 12 to 16 g/dL[7]. A low haemoglobin level indicates that the patient has anaemia[7].One unit of RBCs increases an average adult's Hb by about 1 g/dL (10 g/L), and the haematocrit (Hct) by about 3%, above the pretransfusion value[8].

   Washed red blood cells (RBCs) are red blood cells that have had most of their plasma, platelets, and white blood cells removed and replaced with saline or another preservation solution. The washing process can remove excess potassium, cytokines, antibodies, and plasma proteins that may cause adverse transfusion reactions. Washed RBCs can also be used to reduce allergic reactions caused by contaminating plasma proteins[9].They are generally given to patients who have severe reactions to plasma such as severe allergies, paroxysmal nocturnal haemoglobinuria, IgA immunization[8].

   WBC-depleted/Leukoreduced packed red blood cells (PRBCs) are red blood cells that have had their white blood cell (WBC) count reduced to almost 99.99%. The process of removing WBCs is called leukoreduction, and it's used to reduce the risk of adverse reactions in people who receive blood transfusions. It is prepared with special filters that remove ≥ 99.99% of white blood cells. They are indicated for patients who have experienced nonhemolytic febrile transfusion reactions, for exchange transfusions, for patients who require cytomegalovirus-negative blood that is unavailable, and possibly for the prevention of human leukocyte antigen (HLA) alloimmunization to help prevent refractoriness to platelet transfusion[8].
2. **White Blood Cells (WBCs):** These cells are essential for the immune system, fighting infections and diseases. WBC transfusions are not as common as RBC transfusions and are usually reserved for specific cases like severe infections or immunodeficiency disorders.
3. **Platelets:** Platelets play a critical role in blood clotting, preventing excessive bleeding. Platelets in the human body typically live for 7–10 days. Platelets are small, anucleate blood cells that are 2–4 μm in diameter and have a discoid shape[10]. Platelet transfusions are given to patients with low platelet counts, often due to conditions like leukaemia or chemotherapy. There are two types of platelet products used for transfusion in patients.
   3.1 **Random Donor Platelets (RDP):** Random donor platelets (RDPs) are platelet units that are prepared from a single unit of donated blood (350–450 ml) within 4–6 hours of collection[11]. The process involves using a centrifuge to separate platelet-rich plasma from the blood, and then consolidating platelets from multiple donors. RDPs contain about 60 ml of plasma, as well as small numbers of red blood cells and leukocytes. Blood banks typically store RDPs for five days at 22°C. If ABO compatible platelets are unavailable, ABO-incompatible platelets can be used as a substitute with little risk.

   RDPs are also known as "pooled platelets". Pooled platelets are a blood component that's made by combining platelet concentrates from multiple donors into a single bag.

   3.2 **Single Donor Platelets (SDP):** It is an Apheresis platelet, derived from donors who spend a couple of hours on a cell separator[12]. Single Donor Platelets

are more potent than Random Donor Platelets. 1 unit of Single Donor Platelets is equivalent to 6-8 units of Random Donor Platelets[13].

4. **Plasma:** Plasma is the liquid component of blood, consisting of water, electrolytes, and proteins, including clotting factors. Plasma transfusions are essential in treating patients with clotting disorders or liver disease.

   Fresh frozen plasma is administered topatients who have a deficiency of coagulation factors with abnormal coagulation findings in the presence of active bleeding. It is also indicated for a planned surgery or invasive procedure in the presence of abnormal coagulation tests, or a planned procedure when vitamin K is inadequate to reverse the warfarin effect, thrombotic thrombocytopenic purpura, and congenital or acquired factor deficiency with no alternative therapy[14].

   Fresh frozen plasma contains all coagulation factors except platelets. Fresh frozen plasma contains fibrinogen, albumin, protein C, protein S, antithrombin, and tissue factor pathway inhibitors. Fresh frozen plasma corrects coagulopathy by replacing or supplying deficient plasma proteins. A standard dose of 10 to 20 mL/kg (4 to 6 units in adults) will raise factor levels by approximately 20%. Increasing roughly 10% of several factors is enough to bring about hemostasis. Also, fresh frozen plasma provides some volume resuscitation, as each unit contains approximately 250 ml.Fresh frozen plasma is stored at -30 Celsius. Before administration, fresh frozen plasma is thawed in a water bath at temperatures between 30 and 37 degrees Celsius for 20 to 30 minutes, or it can be quickly thawed in an FDA-approved device in just 2 to 3 minutes. It is important to administer the plasma right after thawing. If it cannot be given immediately, it should be kept at a temperature of 1 to 6 degrees Celsius. It should be discarded if the thawed fresh frozen plasma is not used in 24 hours. Once thawed, the activity of clotting factors, particularly factor V and factor VIII, decline gradually. After the initial dosage, re-administration may be needed every 6 to 8 hours if there is ongoing bleeding due to the short half-life of factor VII which has a half-life of 2 to 6 hours.[14].

Cryoprecipitate

Cryoprecipitate isa concentrate prepared from fresh frozen plasma, also known as cryo. It is a frozen blood product which contains clotting proteins Fibrinogen, Factor VIII, Factor XIII, and Von Willebrand factor which help to prevent or control bleeding[15]. Each concentrate usually contains about 80 units each of factor VIII and von Willebrand factor and about 250 mg of fibrinogen[8]. Cryoprecipitate is prepared by thawing fresh frozen plasma to 1–6 °C, centrifuging it, and collecting the precipitate[16]. The precipitate is then resuspended in a small amount of plasma and re-frozen for storage[16]. It must be transfused within 6 hours of thawing or 4 hours of pooling[17]. Cryoprecipitate can be used in massive transfusions when a patient needs a large number of blood components at once. It can also be used to provide fibrinogen for patients who can't produce, or treat hypofibrinogenemia, anaemia associated with bleeding, or congenital disorder[18]. Cryoprecipitateis used as a source of fibrinogen in acute DIC with bleeding, treatment of uremic bleeding, cardiothoracic surgery (fibrin glue), and obstetric emergencies[18].

Irradiated Blood Products

Blood irradiation is accomplished by exposing blood to a minimum of 25Gy (2500cGy) of radiation at the centre of the container, thus preventing the replication and engraftment of immunologically competent donor T leukocytes to the recipient[19]. Irradiatedblood products should be provided to patients at high risk for GvHD caused by donor engraftment, patients with severe immunosuppression, bone marrow or stem cell transplant, cytotoxic chemotherapy,congenital immune deficiency, neonatal or intrauterine transfusion, genetically similar recipient-donor pairs, human leukocyte antigen (HLA)matched platelet infusion, and Hodgkin disease[20].

Volume-Reduced Red Blood Cells and Platelets

In cases of severe cardiac compromise and high risk for transfusion-associated circulatory overload (TACO), aproduct may be centrifuged and the supernatant storage media removed. This is mostly used for infants and intrauterine transfusions, where minute volumes are being transfused and patients are at high risk. Reducing the volume of a product causes loss of RBCs and platelets and may affect platelet function. The procedure requires extra time for processing and results in a shortened shelf life of 24h at 1–6°C or 4h at 20–24°C.

Blood Transfusion Process

The blood transfusion process is highly regulated and involves several key steps:

1. **Patient Assessment**: Nurses begin by assessing the patient's condition along with

the treating medical team, confirming the need for a blood transfusion, and ensuring that all necessary tests such as complete blood count and coagulation profile have been conducted to identify the specific blood component required.

2. **Making and Sending Requisition:** When the assessment of the patient has been performed and the type of component requirement is confirmed, the nurses prepare a requisition where they have to write down patient details such as name, age, Gender, hospital registration number, blood group, last test result against blood is requested and medical condition.Along with the Requisition form, Nurses have to send properly labelled 2 ml blood samples in a plain test tube and 2 ml in an EDTA tube for cross-matching and finding compatible donor blood.
3. **Receiving Blood & Components:** Once the blood component is determined and requisition is received by the blood bank, Blood bank personnel select compatible donor blood by cross-matching procedure and they ensure thatcompatible blood type is being given to patients. After confirmation from the Blood Bank, Nurses send the blood release book by mentioning all the demographic information of the patientwhichever was sent earlier during the requisition process so that no error should occur.Hospital Staff should have hospital identity cards who are going for collecting blood bagsfrom the blood bank so that blood can be released to the right person.
4. **Informed Consent**: It is one of the legal responsibilities of nurses to obtain consent from the patient or guardian in case of a minor or unconscious. Nurses should explain the procedure of Blood Transfusion to the patient and their family members, explain the risks and benefits to patients, and answer any questions or concerns. After answering all the queries raised by patient and their family member, Nurses have to obtain informed consent from the patient.
5. **Preparation:** Before initiating the transfusion, nurses prepare the patient and the selected blood component. This involves confirming the patient's identity and labelling the blood bag accurately. Pre-administration Checking is to be done here. All information mentioned in the blood bag and compatibility report should be checked and matched by two registered healthcare personnel. If any mismatch occurs in the information mentioned in the bag and compatibility reportit should be sent backto the blood bank immediately. Patient vital signs arechecked before initiating transfusion and it is confirmed that appropriate consent has been taken before transfusion.
6. **Transfusion Initiation**: Before starting the transfusion, nurses should check again for –
    - Check the patient's notes for the component prescribed, any special requirements e.g. leucodepletion, warming, irradiation etc., and any pre-medication ordered.
    - Ask the patient for - Name, Surname, and Date of Birth, Check these details against the details on the patient's wristband/ compatibility label(on the blood unit) and report.
    - Cross-check the patient's identification against the number on the compatibility report/label by two authorized medical personnel.
    - Beextravigilantwhenchecking theidentity of the unconscious / seriously ill patient.
    - Check the details on the compatibility report - Patient details, Blood group, Check the blood group of patients in the file, Unique donation number – the number on the unit must be matched with that on the compatibility report and the label on blood bag, Segment Number, Expiry date.
    - Look for - Type of component – The label on the unit provides information on the type and volume of the component, Signs of deterioration, leaks or clumping, and any instruction for transfusion from the Blood Bank.
    - Checkingthe unit of blood - Discoloration or signs of any leakage may be the only warning that the blood has been contaminated by bacteria and could cause a severe or fatal reaction when transfused.
    - Thefinal identity check should be undertaken at the patient's bedside immediately before commencing the transfusion.
    - It should be undertaken by two authorized healthcare persons and should be documented in patient's file.
    - Check that there are no discrepancies between the ABO and Rh-D group on blood unit.

After final checking all information administration of blood and blood component is started. Before starting the transfusion procedure nurses has to do following steps:

- Wash hands properly before starting transfusion.
- Verify special needs e.g. filtration, pooling, warming blood.
- After final patient identity check and baseline medical check at the bedside, start transfusion.
- Immediately before transfusion, mix the unit of blood thoroughly by gentle Inversion.
- Use standard transfusion set with filters (170-260 microns) to remove micro aggregates, small clots and other debris.
- IV cannula should be Preferred 16-20, 22 gauge for limited venous access.
- Only isotonic saline can be used with blood components and before administering blood, completely flush all the incompatible IV fluids and drugs with normal saline (0.9%).
- Do not prime the administration set with 5% Dextrose or Ringer Lactate Solutions because Dextrose may cause hemolysis of the red cells and Calcium in Ringer Lactate can lead to clot formation.
- For the first half an hour, patient must be under direct observation.
- Rate of transfusion varies withBlood volume/urgency of volume replacement, Hemodynamic condition, Cardiac status of recipient.
- Initially 1 ml/minute lesser in pediatric patients and 4 ml/minutes after 15 minutes of observation 10-20 ml/kg.
- Rate of transfusion in adult should be approximately 2 mL/minute (120mL/hour) for 1st 15 minutes, then increase rate to infuse over 1 to 2 hours (150-250 mL/hr), or as ordered. Do NOT hang longer than 4 hours.
- Change blood filter every 4 hours.
- Platelet/FFP/Cryoprecipitate should be transfused within 30 – 60 minutes.
- For pediatric patients Platelet/FFP/ Cryoprecipitate should be transfused at rate 10-20 mL/kg/hr.

7. **Continuous Monitoring**: Throughout the transfusion, nurses should closely monitor the patient for any signs of adverse reactions, such as fever, chills, shortness of breath, or rash.

For Monitoring of patients:

- Patients should be transfused in an area where they can be closely observed and have access to a call button.
- The procedure and symptoms of an adverse reaction should be explained to the patient.
- Encourage the patient to notify the nurse immediately if they begin to feel anxious, or if they experience any of the symptoms.
- Monitoring should be done for each and every unit of blood or blood component transfused.
- Frequency of observation to be Before the starting of the transfusion, 15 minutes after starting the transfusion and at least every hour during the transfusion. At the last on completion of the transfusion and4 hours after completing the transfusion.

8. **Documentation**: Accurate documentation of the transfusion process is essential, including the time of initiation, vital signs, and any patient symptoms or reactions.Recording of the patient's vital signs (Temperature, Pulse, Respiration, BP, Fluid balance - oral and IV fluid intake, urinary output and any adverse effects should be done in the patient's case notes/file.Nurses should document type and volume of product transfused, Donation number and blood group of each product/ unit transfused, Time at which transfusion started and completed, change of transfusion set if required and volume of transfusion.
9. **Completion and Follow-up**: After the transfusion is completed, nurses continue to monitor the patient and assess the effectiveness of the procedure.Nurses should check evidence of improved clinical status (HCT, Platelet count, coagulation factors), possibility of DHTR.Disposable of equipment for administration should be done as per policy.

The Vital Role of Nurses

Nurses are central to the blood transfusion process, serving as patient advocates and safety guardians. Their roles include:

1. **Patient Assessment**: Nurses assess the patient's condition and needs, ensuring that a transfusion is the appropriate course of action. A patient's assessment before a blood transfusion includes:

- **History:** Asking the patient about any allergies or previous transfusion reactions.
- **Vital Signs**: Checking the patient's vital signs, including blood pressure, temperature, pulse, respiratory rate, and oxygen levels. Also, note their respiratory sounds and urine output.
- **Identification:** Asking the patient to confirm their full name and date of birth.
- **Pre-existing symptoms**: Identifying any pre-existing symptoms that could be mistaken for a transfusion reaction, such as a rash.
- **Education:** If the patient is able to participate, educate them about the importance of reporting any new symptoms during or after the transfusion.
- **Pre-medications**: Prepare and administer any pre-medications as ordered.

2. **Communication:** Nurses communicate with the patient, explaining the procedure and obtaining informed consent. They also relay critical information between the patient, the blood bank, and the healthcare team.
3. **Transfusion Safety:** Nurses are responsible for verifying the compatibility of the donor blood and the patient's blood type, preventing any errors in the transfusion process.

   Nurses have several roles in ensuring patient safety during blood transfusions, including:

   - **Monitoring**: Nurses monitor vital signs and stay at the patient's bedside during the transfusion. They also monitor for clinical deterioration and detect errors.
   - **Informing patients**: Nurses inform patients about potential reaction symptoms and document any abnormal findings.
   - **Stopping transfusions:** If a reaction occurs, nurses should immediately stop the transfusion and notify the provider. They should also maintain IV access and administer any prescribed medications, such as antihistamines, corticosteroids, or epinephrine.
   - **Managing massive transfusions:** Nurses play a critical role in managing massive transfusions, including coordinating the administration of blood products and identifying complications.
   - **Ensuring identification:** Nurses ensure the correct identification of the patient and blood component at every stage of the transfusion process. This may include making sure the patient wears a patient identification band.
   - **Developing care plans:** Nurses develop care plans and expected outcomes for the transfusion based on the indication.
   - **Completing pre-transfusion tasks:** Nurses often complete pre-transfusion sampling and bedside checks.

4. **Monitoring and Management of Transfusion Reaction:** Nurses have a vital role in monitoring and managing transfusion reactions during and after blood transfusions. Nurses monitor the patient throughout the transfusion, promptly recognizing and managing any adverse reactions or complications.They should be aware of potential reactions and know how to safely and effectively manage them. During a blood transfusion, nurses should**:**
   - Stay at the patient's bedside.
   - Monitor vital signs.
   - Document vital signs.
   - Inform the patient of potential symptoms.
   - Look for signs of a reaction.
   - Stop the transfusion immediately if a reaction is suspected, Disconnect the blood tubing from the patient andinforming the doctor.

     After finishing the transfusion, nurses continue to monitor the patient for any delayed reactions or complications. Their vigilance extends into post-transfusion care, providing an added layer of patient safety.
5. **Documentation and Reporting:**Accurate documentation is critical in maintaining a complete medical record and ensuring patient safety. Nurses meticulously record the details of the transfusion process, which can be invaluable for reviewing the patient's progress and for future healthcare decision-making.
6. **Education:**Nurses educate patients about the procedure, potential side effects, and the importance of post-transfusion follow-up care.

In addition to their fundamental responsibilities in the blood transfusion process, nurses have a multifaceted role that extends beyond the technical

aspects. Here are some additional dimensions to the vital role of nurses in blood transfusion:

1. **Patient Advocacy**: Nurses serve as advocates for the patients, ensuring their rights and well-being are protected throughout the transfusion process. They verify that the patient's informed consent is obtained and that the blood component is administered safely and accurately.
2. **Quality Control:** Nurses help maintain the quality and safety of blood products by verifying the compatibility, ensuring proper storage, and adhering to established protocols and standards. They actively participate in safety checks to prevent any errors.
3. **Continual Education:** Nurses continually educate themselves on best practices and the latest developments in transfusion medicine. They also share this knowledge with their colleagues to ensure that the entire healthcare team is well-informed.
4. **Emotional Support:** Patients undergoing blood transfusions may experience anxiety, fear, or uncertainty. Nurses provide emotional support, ensuring patients feel comfortable and well-informed during the procedure.
5. **Collaboration:** Nurses work closely with the healthcare team, including physicians, laboratory staff, and blood bank personnel, to ensure a coordinated and seamless transfusion process. Effective communication is critical in preventing complications and ensuring the patient's safety.
6. **Adherence to Standards and Protocols:** Nurses adhere to strict protocols and safety standards established by healthcare institutions and regulatory bodies. These standards are in place to safeguard patient well-being and maintain the integrity of the blood transfusion process.
7. **Emergency Response:** In rare cases when severe transfusion reactions occur, nurses are trained to respond swiftly and appropriately, initiating necessary emergency measures and communicating with the medical team.

CONCLUSION

In conclusion, blood transfusions are a vital aspect of modern medicine, and nurses are the linchpin of this life-saving process. Their expertise, vigilance, and dedication ensure that patients receive the right blood components safely and effectively. Nurses play a crucial role in advocating for patient well-being and safety throughout the transfusion process, making them instrumental in delivering quality healthcare. Nurse's roles in blood transfusion encompass not only technical skills but also vital aspects of patient safety, education, advocacy, and emotional support. Their contributions are integral to ensuring the effective and safe administration of blood and blood components. The dedication and expertise of nurses in this life-saving process are a testament to their commitment to patient well-being and quality healthcare.

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