



Blood Transfusion Knowledge and Nursing Practice in Tertiary Hospitals: An Evidence-Based Review

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Abstract

Background: Blood transfusion is an indispensable therapeutic intervention in modern internal medicine, playing a pivotal role in the management of acute hemorrhage, severe anemia, hematological disorders, malignancies, chronic kidney disease, and critically ill patients. Despite substantial advances in transfusion medicine, blood transfusion remains a high-risk clinical procedure because it involves multiple sequential processes that require strict adherence to evidence-based protocols. Errors occurring at any stage of the transfusion pathway, particularly patient identification, blood component verification, administration, monitoring, and documentation, may result in serious adverse events, including acute hemolytic transfusion reactions, transfusion-associated circulatory overload, transfusion-related acute lung injury, transfusion-transmitted infections, and even patient mortality. As healthcare professionals directly responsible for the preparation, administration, monitoring, and evaluation of blood transfusions, nurses play a central role in ensuring transfusion safety and improving patient outcomes. Consequently, their knowledge, clinical competence, and adherence to standardized transfusion practices represent fundamental determinants of safe and effective transfusion therapy.

This review aims to comprehensively examine the current evidence regarding nurses' knowledge and clinical practice of blood transfusion within internal medicine settings. It explores the essential principles of transfusion medicine, nursing responsibilities throughout the transfusion process, common knowledge deficiencies, and practice-related challenges that may compromise patient safety. Furthermore, the review discusses the recognition and management of transfusion-related complications, identifies individual and organizational factors that influence nursing performance, and highlights evidence-based educational and quality-improvement strategies to strengthen transfusion competency. Recent advances in digital healthcare, competency-based education, electronic transfusion systems, barcode-assisted patient identification, simulation-based training, and clinical decision support systems are also reviewed as emerging approaches to optimize transfusion safety.

Current evidence consistently demonstrates that although nurses generally possess satisfactory knowledge of basic transfusion principles, significant deficiencies persist in several critical areas, particularly patient identification procedures, blood component handling, recognition and immediate management of transfusion reactions, adherence to institutional protocols, and comprehensive documentation. These deficiencies are influenced by inadequate continuing education, variable clinical experience, excessive workload, staffing limitations, and inconsistent implementation of evidence-based guidelines. Strengthening nursing education through structured competency-based training, continuous professional development, standardized institutional protocols, technological integration, and regular clinical auditing can substantially improve adherence to safe transfusion practices. Ultimately, enhancing nurses' knowledge and clinical competency is essential for minimizing transfusion-related errors, improving patient safety, and ensuring the delivery of high-quality transfusion care.

Keywords: Blood Transfusion, Knowledge, Nursing Practice



Introduction

Blood transfusion remains one of the most frequently performed and life-saving therapeutic interventions in modern healthcare, serving an indispensable role in the management of patients with acute hemorrhage, severe anemia, hematological disorders, malignancies, chronic kidney disease, and other complex conditions commonly encountered in internal medicine. Advances in donor screening, blood component processing, compatibility testing, and hemovigilance systems have substantially improved transfusion safety over recent decades. Nevertheless, blood transfusion continues to represent a high-risk clinical procedure because it involves multiple interdependent steps that require meticulous coordination among healthcare professionals. Even a single error during patient identification, blood component verification, administration, or monitoring may result in severe adverse events that compromise patient safety and clinical outcomes. Consequently, contemporary transfusion medicine emphasizes the appropriate use of blood products together with rigorous adherence to standardized safety protocols throughout the transfusion process. [1]

Within internal medicine departments, blood transfusion is routinely administered to patients presenting with diverse acute and chronic medical conditions, including gastrointestinal bleeding, hematologic malignancies, chronic kidney disease, autoimmune disorders, liver disease, and critically ill patients requiring intensive care. These patients frequently possess advanced age, multiple comorbidities, and physiological vulnerabilities that increase their susceptibility to transfusion-related complications. Therefore, transfusion decisions extend beyond correction of laboratory abnormalities and require comprehensive clinical assessment, individualized risk-benefit evaluation, and continuous patient monitoring. The increasing adoption of restrictive transfusion strategies and patient blood management programs further highlights the importance of evidence-based transfusion practices aimed at maximizing therapeutic benefit while minimizing unnecessary exposure to blood products and their associated risks. [2]

Nurses occupy a central position throughout the transfusion pathway and are directly responsible for implementing many of the safety measures that determine successful transfusion outcomes. Their responsibilities encompass patient assessment, verification of physician orders, confirmation of patient identity, inspection of blood components, preparation of transfusion equipment, administration of blood products, monitoring for transfusion reactions, prompt recognition and management of adverse events, accurate documentation, and effective communication with multidisciplinary healthcare teams. Since nurses perform the majority of bedside transfusion activities, their clinical competence and adherence to institutional protocols have a direct influence on preventing preventable transfusion errors and improving patient safety. Accordingly, maintaining a high level of



transfusion knowledge and clinical competency has become an essential component of professional nursing practice in internal medicine settings. [3]

Despite considerable improvements in transfusion medicine, evidence from multiple countries consistently demonstrates that important deficiencies remain in nurses' knowledge and adherence to recommended transfusion practices. Commonly reported gaps include inadequate understanding of transfusion indications, improper patient identification procedures, limited familiarity with blood component handling, delayed recognition of transfusion reactions, incomplete documentation, and inconsistent compliance with institutional guidelines. These deficiencies may be influenced by several factors, including insufficient continuing education, limited practical experience, excessive workload, staffing shortages, absence of standardized competency assessment, and variations in hospital transfusion policies. Addressing these challenges requires continuous professional development supported by evidence-based educational interventions and robust institutional quality improvement programs. [4]

Although numerous individual studies have evaluated nurses' knowledge and transfusion practices in different healthcare settings, the available evidence remains fragmented, with considerable variation in study populations, assessment tools, institutional policies, and reported outcomes. Furthermore, recent advances in patient blood management, transfusion safety recommendations, digital health technologies, competency-based education, and hemovigilance systems warrant an updated synthesis of the current evidence. Therefore, this review aims to comprehensively evaluate contemporary evidence regarding blood transfusion knowledge and nursing practice in internal medicine, emphasizing nurses' responsibilities throughout the transfusion process, identifying existing knowledge and practice gaps, examining factors influencing clinical performance, and discussing evidence-based strategies that can enhance transfusion safety and improve patient outcomes. [5]

Overview of Blood Transfusion in Internal Medicine

Blood transfusion is an integral component of supportive care in internal medicine and has evolved from the administration of whole blood to a highly specialized discipline centered on the selective use of individual blood components. Modern transfusion practice is based on component therapy, allowing clinicians to replace the specific deficient blood constituent while minimizing unnecessary exposure to other components. Packed red blood cells (PRBCs), platelet concentrates, fresh frozen plasma (FFP), cryoprecipitate, and coagulation factor concentrates each possess distinct therapeutic indications, storage requirements, and safety considerations. This targeted approach not only improves clinical efficacy but also reduces transfusion-related complications, conserves valuable blood



resources, and supports the principles of patient blood management. [6]

In internal medicine, blood transfusions are frequently indicated for patients with symptomatic anemia secondary to chronic kidney disease, hematologic malignancies, gastrointestinal hemorrhage, autoimmune diseases, chemotherapy-induced bone marrow suppression, liver disease, and various chronic inflammatory disorders. The decision to transfuse should never rely solely on laboratory values but should instead integrate the patient's clinical presentation, hemodynamic stability, evidence of tissue hypoxia, ongoing blood loss, cardiovascular reserve, and comorbid conditions. Such individualized clinical assessment has become the cornerstone of contemporary transfusion medicine and is fundamental to achieving optimal patient outcomes while avoiding unnecessary transfusions. [7]

Red blood cell transfusion remains the most commonly administered blood component in internal medicine because its primary objective is to restore oxygen-carrying capacity in patients with clinically significant anemia. Over the past two decades, substantial evidence has shifted clinical practice from liberal transfusion strategies toward restrictive transfusion thresholds. Large randomized clinical trials have demonstrated that, for most hemodynamically stable hospitalized adults, maintaining a restrictive hemoglobin threshold of approximately 7–8 g/dL provides outcomes comparable or superior to more liberal strategies while reducing unnecessary exposure to donor blood and transfusion-related complications. Nevertheless, transfusion decisions should always be individualized in patients with active bleeding, acute coronary syndromes, or severe cardiovascular disease. [8]

Other blood components play equally important roles in the management of selected medical conditions. Platelet transfusions are indicated for severe thrombocytopenia or platelet dysfunction associated with active bleeding or invasive procedures. Fresh frozen plasma is primarily administered to replace multiple coagulation factor deficiencies in patients with active bleeding or urgent invasive interventions, whereas cryoprecipitate is reserved for acquired or congenital hypofibrinogenemia. Appropriate selection of blood components requires careful understanding of their indications, contraindications, and expected therapeutic benefits to avoid inappropriate utilization and unnecessary transfusion-related risks. [9]

Although advances in donor selection, infectious disease screening, leukoreduction, compatibility testing, and hemovigilance have markedly improved transfusion safety worldwide, blood transfusion remains associated with potentially serious complications. Acute hemolytic transfusion reactions, febrile non-hemolytic reactions, allergic reactions, transfusion-associated circulatory overload (TACO), transfusion-related acute lung injury (TRALI), and delayed immunologic complications continue to contribute to patient morbidity and occasional mortality. Importantly, many serious adverse events result not from blood product defects but from preventable human errors occurring during patient



identification, specimen labeling, bedside verification, or blood administration. Consequently, safe transfusion practice depends equally on scientific advances in transfusion medicine and strict adherence to standardized clinical protocols by the multidisciplinary healthcare team, particularly nursing staff. [10]

Role of Nurses in Blood Transfusion

Nurses are the primary healthcare professionals responsible for ensuring the safe administration of blood transfusions and play a pivotal role throughout every phase of the transfusion process. Their responsibilities extend beyond the technical administration of blood products to include comprehensive patient assessment, verification of transfusion orders, and identification of potential contraindications, patient education, continuous monitoring, and recognition of adverse reactions, documentation, and effective communication with the multidisciplinary team. Because nurses remain at the patient's bedside before, during, and after transfusion, they represent the final and most critical safeguard against preventable transfusion errors. Consequently, their clinical competence and adherence to evidence-based protocols directly influence transfusion safety, quality of care, and patient outcomes. [11]

Before initiating transfusion, nurses are responsible for performing a systematic pre-transfusion assessment that establishes both patient eligibility and procedural safety. This assessment includes confirming the physician's prescription, verifying informed consent, reviewing the patient's medical history for previous transfusion reactions or allergies, evaluating baseline vital signs, assessing venous access, and ensuring that the prescribed blood component is clinically appropriate. Equally important is the meticulous bedside verification process, during which patient identity is confirmed using at least two unique identifiers and matched with the blood unit and compatibility documentation. Since patient misidentification remains the leading cause of acute hemolytic transfusion reactions, strict compliance with this verification process is considered the most effective strategy for preventing catastrophic transfusion errors. [12]

During blood administration, nurses must maintain continuous vigilance while adhering to institutional transfusion protocols. The transfusion should be initiated promptly after blood release from the blood bank using an approved blood administration set with an appropriate filter and compatible intravenous solution, typically 0.9% normal saline. The patient should be closely observed throughout the initial 15 minutes, as most severe acute transfusion reactions occur during this critical period. Serial monitoring of temperature, blood pressure, heart rate, respiratory rate, and oxygen saturation facilitates early identification of adverse events and allows immediate intervention before clinical deterioration occurs. Accurate regulation of infusion rates according to the patient's clinical condition, age,



cardiovascular status, and prescribed blood component further contributes to minimizing transfusion-related complications. [13]

Prompt recognition and management of transfusion reactions constitute one of the most important nursing responsibilities. Nurses must be capable of identifying both common and life-threatening complications, including febrile non-hemolytic transfusion reactions, allergic reactions, acute hemolytic reactions, transfusion-associated circulatory overload (TACO), and transfusion-related acute lung injury (TRALI). At the first suspicion of an adverse reaction, the transfusion should be discontinued immediately while maintaining intravenous access with normal saline. The responsible physician and blood bank should be notified without delay, and the blood unit, administration set, and appropriate patient samples should be returned for laboratory investigation according to institutional hemovigilance protocols. Early recognition and timely intervention substantially reduce morbidity and may be lifesaving in severe transfusion reactions. [14]

Following completion of the transfusion, nurses continue to play an essential role in evaluating therapeutic effectiveness and ensuring comprehensive documentation. Post-transfusion assessment includes reassessment of vital signs, evaluation of clinical response, observation for delayed adverse reactions, and verification that the prescribed blood component has been completely administered within the recommended time frame. Complete documentation should include patient identification, blood component details, unit number, compatibility verification, transfusion start and completion times, vital sign recordings, patient tolerance, any adverse reactions encountered, and interventions performed. Thorough documentation not only fulfills legal and professional responsibilities but also strengthens hemovigilance systems, facilitates quality improvement initiatives, and provides valuable information for future transfusion management. Continuous patient education regarding delayed symptoms that require immediate medical attention further reinforces patient safety beyond hospital discharge. [15]

Nurses' Knowledge of Blood Transfusion

Comprehensive knowledge of blood transfusion is fundamental to safe nursing practice and constitutes one of the most important determinants of transfusion safety. Nurses are expected to possess an integrated understanding of transfusion indications, blood components, compatibility principles, patient identification procedures, administration techniques, monitoring requirements, recognition of adverse reactions, and institutional policies. Because nurses participate in nearly every stage of the transfusion process, deficiencies in theoretical knowledge can rapidly translate into clinical errors that jeopardize patient safety. Consequently, international transfusion guidelines emphasize that transfusion competency should be regarded as an essential professional requirement rather than a desirable skill,



with regular competency assessment incorporated into continuing nursing education. [16]

Knowledge of blood components and their clinical indications forms the foundation of evidence-based transfusion practice. Nurses should understand the therapeutic purpose of packed red blood cells, platelet concentrates, fresh frozen plasma, cryoprecipitate, and specialized blood products, together with their storage conditions, administration requirements, and expected clinical outcomes. Equally important is recognizing that transfusion decisions should be individualized according to the patient's clinical status rather than relying exclusively on laboratory values. Familiarity with restrictive transfusion strategies, patient blood management principles, and evidence-based transfusion thresholds enables nurses to participate more effectively in multidisciplinary clinical decision-making and reinforces appropriate utilization of blood resources. [17]

Another essential domain of nursing knowledge involves the pre-transfusion verification process, which remains the most effective safeguard against preventable transfusion errors. Nurses must understand the importance of confirming patient identity using at least two independent identifiers, matching compatibility documentation with the blood component, inspecting blood products for abnormalities, confirming expiration dates, and ensuring appropriate storage and transportation conditions before administration. Studies evaluating nursing knowledge consistently demonstrate that patient identification and bedside verification represent the areas with the greatest potential for error, emphasizing the need for repeated competency assessment and strict adherence to standardized institutional protocols. [18]

Knowledge regarding the recognition and management of transfusion reactions is equally critical because delayed identification may result in significant morbidity or mortality. Nurses should promptly recognize early manifestations such as fever, chills, dyspnea, urticaria, hypotension, back pain, hemoglobinuria, respiratory distress, and circulatory overload. Immediate discontinuation of the transfusion, maintenance of intravenous access using normal saline, notification of the treating physician and blood bank, and initiation of institutional hemovigilance procedures constitute the standard response to suspected transfusion reactions. A thorough understanding of these emergency interventions enables timely management while minimizing the severity of adverse outcomes. [19]

Evidence from numerous international studies demonstrates that although nurses generally possess satisfactory knowledge of routine transfusion procedures, substantial deficiencies remain in several critical domains, including compatibility testing, blood component storage, transfusion timing, and identification of severe transfusion reactions, institutional policy awareness, and post-transfusion documentation. These knowledge gaps appear consistently across different healthcare systems and are associated with limited continuing education, infrequent competency reassessment, variable clinical



exposure, and inconsistent implementation of standardized transfusion training programs. Such findings highlight the necessity of structured educational initiatives that combine theoretical instruction with simulation-based learning and periodic competency evaluation to ensure sustained adherence to evidence-based transfusion practice. [20]

Nursing Practice during Blood Transfusion

The translation of knowledge into safe clinical practice is fundamental to ensuring effective blood transfusion. Although nurses may possess adequate theoretical understanding, consistent adherence to standardized transfusion procedures ultimately determines patient safety. Safe nursing practice encompasses a sequence of carefully coordinated activities beginning with patient preparation and extending through blood administration, continuous monitoring, management of complications, and post-transfusion evaluation. Each stage represents an essential safety checkpoint, and failure to comply with established protocols may increase the likelihood of preventable transfusion-related adverse events. Consequently, international transfusion standards emphasize that every transfusion should be performed according to evidence-based institutional policies supported by continuous competency assessment and clinical audit. [21]

Pre-transfusion nursing practice begins with comprehensive patient preparation and meticulous verification procedures. Nurses should confirm the physician's order, ensure informed consent has been obtained, assess the patient's clinical condition, establish appropriate intravenous access, and record baseline vital signs before collecting the blood product. At the bedside, patient identity must be verified using at least two independent identifiers and matched precisely with the blood component label, compatibility report, and medical records. The blood unit should also be inspected for correct labeling, expiration date, physical integrity, abnormal discoloration, leakage, or evidence of contamination before administration. These verification procedures represent the most effective strategy for preventing ABO-incompatible transfusions and other potentially fatal identification errors. [22]

During blood administration, nurses are responsible for maintaining strict compliance with recommended transfusion procedures while continuously observing the patient's clinical condition. Blood should be transfused using a dedicated administration set equipped with an appropriate filter, and only isotonic normal saline should be used concurrently unless otherwise specified. The transfusion should commence promptly after blood release from the blood bank, and the initial infusion rate should permit careful observation during the first 15 minutes, when most acute transfusion reactions occur. Continuous assessment of temperature, pulse, blood pressure, respiratory rate, oxygen saturation, and the patient's subjective symptoms enables early detection of adverse events and facilitates immediate



intervention when necessary. [23]

Effective nursing practice also requires prompt recognition and systematic management of transfusion-related complications. At the earliest indication of a suspected reaction, the transfusion should be stopped immediately while maintaining venous access with normal saline. The patient's clinical status should be reassessed without delay, and the treating physician and blood bank should be informed according to institutional protocols. Appropriate laboratory investigations should be initiated, and the implicated blood unit together with the administration set should be returned for evaluation. Simultaneously, supportive measures should be instituted according to the patient's clinical presentation while ensuring comprehensive documentation of the event to facilitate hemovigilance reporting and future risk reduction. [24]

Following completion of the transfusion, nursing responsibilities continue through careful post-transfusion assessment and documentation. Patients should be evaluated for therapeutic response as well as delayed transfusion reactions, which may develop several hours or days after blood administration. Accurate documentation should include patient identification, blood component information, compatibility verification, start and completion times, serial vital signs, volume transfused, patient tolerance, adverse reactions, and all interventions performed. High-quality documentation supports continuity of care, fulfills legal and professional obligations, facilitates institutional quality assurance, and contributes to national hemovigilance systems that monitor transfusion safety and identify opportunities for continuous improvement. [25]

Blood Transfusion Reactions and Their Nursing Management

Although blood transfusion is generally considered a safe therapeutic intervention, it remains associated with a spectrum of adverse events ranging from mild allergic manifestations to life-threatening complications. Transfusion reactions may be classified as acute or delayed and as immunological or non-immunological according to their underlying pathophysiology. The severity of these reactions varies considerably, but all require prompt recognition and appropriate management to minimize patient morbidity and mortality. Since nurses maintain continuous bedside contact with patients during transfusion, they are usually the first healthcare professionals to identify early clinical deterioration, making their knowledge and vigilance essential components of transfusion safety. [26]

Acute transfusion reactions typically occur during transfusion or within the first 24 hours after administration. The most frequently encountered reactions include febrile non-hemolytic transfusion reactions, mild allergic reactions, acute hemolytic transfusion reactions, transfusion-associated



circulatory overload (TACO), transfusion-related acute lung injury (TRALI), bacterial contamination, and hypotensive reactions. Clinical manifestations may include fever, chills, urticaria, dyspnea, chest or back pain, hypotension, hypertension, tachycardia, respiratory distress, hemoglobinuria, and altered consciousness. Because these symptoms often overlap with those of the patient's underlying illness, careful clinical assessment and continuous monitoring are required to differentiate transfusion reactions from disease progression. [27]

Delayed transfusion reactions develop days to weeks after transfusion and are generally more difficult to recognize because symptoms may be subtle or nonspecific. Delayed hemolytic transfusion reactions, alloimmunization against red cell antigens, post-transfusion purpura, iron overload in chronically transfused patients, and transfusion-associated graft-versus-host disease represent important delayed complications. Although less common than acute reactions, these conditions may significantly influence long-term patient outcomes, particularly among individuals with hematological disorders or those requiring repeated transfusions. Appropriate patient follow-up, laboratory monitoring, and comprehensive documentation are therefore essential components of post-transfusion care. [28]

The cornerstone of nursing management is the immediate response to suspected transfusion reactions. At the first indication of an adverse event, the transfusion should be discontinued immediately while maintaining intravenous access with normal saline using new administration tubing if indicated. The patient's airway, breathing, circulation, and vital signs should be reassessed promptly, followed by immediate notification of the treating physician and blood bank. The remaining blood component, administration set, and appropriate patient blood samples should be submitted for laboratory investigation according to institutional hemovigilance protocols. Early intervention not only improves clinical outcomes but also facilitates accurate identification of the reaction and prevents recurrence in future transfusions. [29]

Beyond immediate clinical management, nurses contribute substantially to institutional hemovigilance and continuous quality improvement. Every suspected transfusion reaction should be thoroughly documented, including the onset of symptoms, clinical findings, nursing interventions, physician notifications, laboratory investigations, treatment provided, and patient outcomes. Accurate reporting enables healthcare institutions to identify trends, investigate preventable errors, evaluate protocol adherence, and implement targeted corrective measures. Participation in national hemovigilance systems has become an increasingly important strategy for strengthening transfusion safety, reducing preventable adverse events, and improving evidence-based clinical practice through continuous surveillance and multidisciplinary learning. [30]



Factors Influencing Knowledge and Clinical Practice

The quality of nursing knowledge and clinical practice in blood transfusion is determined by a complex interaction of individual, organizational, and healthcare system factors. While professional education provides the theoretical foundation for safe transfusion practice, the translation of knowledge into consistent clinical performance depends on continuous learning, institutional support, availability of standardized protocols, and a positive patient safety culture. Understanding these determinants is essential for developing targeted interventions that improve transfusion competency and reduce preventable errors in internal medicine departments. [31]

Educational preparation and continuing professional development are among the strongest predictors of nurses' transfusion competency. Nurses who receive structured education in transfusion medicine during undergraduate training and participate in regular in-service educational programs consistently demonstrate higher knowledge scores and better adherence to evidence-based practices than those without formal training. Furthermore, competency-based education that combines theoretical instruction with simulation exercises and periodic reassessment has been shown to improve knowledge retention, clinical confidence, and decision-making during both routine transfusions and emergencies involving transfusion reactions. [32]

Clinical experience also plays an important role in shaping transfusion practice, although experience alone does not always guarantee competency. Nurses who frequently administer blood products generally develop greater technical proficiency and confidence in recognizing transfusion-related complications. However, prolonged clinical experience without regular updating of knowledge may result in outdated practices or reduced adherence to recently published guidelines. Consequently, healthcare institutions should ensure that all nursing staff, regardless of years of experience, undergo periodic competency assessment and continuing education to maintain alignment with current evidence-based recommendations. [33]

Healthcare system factors substantially influence the ability of nurses to comply with safe transfusion practices. Excessive workload, inadequate nurse-to-patient ratios, staff shortages, frequent interruptions during medication administration, limited availability of equipment, and absence of standardized transfusion checklists may all compromise protocol adherence. Similarly, poor communication among physicians, nurses, laboratory personnel, and blood bank staff increases the likelihood of delays, documentation errors, and patient misidentification. Establishing standardized workflows, improving interprofessional collaboration, and integrating electronic transfusion management systems can significantly reduce human error and strengthen patient safety throughout the transfusion process. [34]



Institutional policies and organizational culture are equally important determinants of transfusion safety. Hospitals that implement comprehensive transfusion policies, mandatory competency assessment, routine clinical audits, and non-punitive incident reporting systems generally achieve higher compliance with evidence-based practice. A positive safety culture encourages nurses to report near-miss events, participate in quality improvement initiatives, and seek clarification whenever uncertainty exists regarding transfusion procedures. Such organizational environments promote continuous learning, strengthen multidisciplinary collaboration, and contribute to sustainable improvements in transfusion safety and overall quality of patient care. [35]

Strategies to Improve Knowledge, Competency, and Patient Safety

Improving transfusion safety requires a comprehensive strategy that addresses both individual competency and organizational performance. Educational interventions alone are insufficient unless they are supported by standardized clinical protocols, effective leadership, multidisciplinary collaboration, and continuous quality improvement initiatives. Modern patient safety frameworks emphasize that transfusion-related errors are usually multifactorial and arise from weaknesses within healthcare systems rather than isolated individual mistakes. Therefore, successful improvement programs should combine competency-based education with system redesign to establish a sustainable culture of safe transfusion practice within internal medicine departments. [36]

Continuous professional education remains the cornerstone of improving nursing competency in blood transfusion. Structured educational programs should provide comprehensive training on blood component therapy, patient blood management principles, bedside verification procedures, recognition and management of transfusion reactions, documentation standards, and institutional policies. Simulation-based learning has emerged as an effective educational approach because it allows nurses to practice both routine transfusion procedures and emergency management of transfusion reactions in a controlled environment without compromising patient safety. Regular competency assessments and mandatory refresher training further ensure that theoretical knowledge is maintained and translated into safe clinical practice. [37]

The implementation of standardized protocols and technological innovations has significantly strengthened transfusion safety worldwide. Bedside checklists, standardized transfusion documentation forms, barcode-assisted patient identification systems, electronic blood tracking, computerized physician order entry, and electronic clinical decision support systems reduce human error by improving patient identification, ensuring accurate blood component verification, and promoting adherence to institutional guidelines. Integration of these technologies with electronic health records enhances



traceability throughout the transfusion process while facilitating real-time documentation, incident reporting, and quality monitoring. [38]

Clinical audit and hemovigilance programs represent essential quality improvement tools for evaluating compliance with transfusion standards and identifying opportunities for system improvement. Regular review of transfusion documentation, bedside practice, transfusion reactions, and near-miss events enables healthcare institutions to detect recurrent deficiencies and implement targeted corrective actions. Constructive feedback, multidisciplinary case discussions, and root-cause analysis encourage continuous professional learning while strengthening collaboration between nurses, physicians, laboratory personnel, and blood bank staff. These quality assurance activities reinforce accountability and support the development of safer transfusion practices throughout healthcare organizations. [39]

Future improvements in transfusion safety will increasingly depend on integrating advanced technologies with competency-based healthcare delivery. Artificial intelligence, predictive clinical decision support, electronic hemovigilance platforms, smart infusion technologies, and machine-learning algorithms capable of identifying patients at increased risk for transfusion-related complications have the potential to further enhance patient safety. Nevertheless, technological innovation cannot replace clinical judgment or nursing vigilance. Sustainable improvements will continue to rely on highly competent nurses who combine scientific knowledge, critical thinking, meticulous protocol adherence, effective communication, and patient-centered care to ensure the safe administration of blood transfusions in internal medicine practice. [40]

Conclusion

Blood transfusion is a vital intervention in internal medicine, but its safety depends greatly on nurses' knowledge, vigilance, and adherence to standardized practice. Evidence shows that nurses are central to every stage of the transfusion process, from patient identification and blood administration to monitoring, reaction management, documentation, and hemovigilance reporting. Persistent gaps in knowledge and practice highlight the need for continuous competency-based education, simulation training, clear institutional protocols, clinical auditing, and supportive safety culture. Strengthening nursing competency in blood transfusion is therefore essential to reduce preventable errors, improve patient outcomes, and ensure safe, high-quality transfusion care in internal medicine departments.

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