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EMERGENCY BLOOD TRANSFUSION AND ITS COMPLICATIONS

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Abstract

Background: *Blood transfusion intervention is one of the crucial steps when dealing with any shocked patient. Apart from the decision of whether to administrate blood or not, other important decisions are to decide what type of transfusion to administrate, how much to transfuse, and when exactly to administrate blood transfusion. There are many limitations of the use of whole blood transfusion. One major concern when administrating blood is the risk of transmitting infections. Other concerns regarding blood transfusion include the continuous availability of blood when needed, the costs for preparing blood, and shelf life of blood, and in some areas, the presence of religious considerations that forbid blood transfusion.*

Methodology: *We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1985, through February 2017. The following search terms were used: blood transfusion, hemorrhagic shock, blood products transfusion, complications of blood transfusion, trauma induced coagulopathy*

Aim: *In this review, we aim to study the requirement of emergency blood transfusion, the types of transfusions, and the complications associated with them.*

Conclusion: *Blood transfusion is an essential medical intervention that may be needed in the emergency department. Transfusion can include either whole blood, or its products, depending on the need. More complications are associated with whole blood transfusion, such as infections, coagulopathy, hypothermia, and citrate toxicity.*

Keywords: *Blood Transfusion, Emergency Measure, Hypovolemic Shock, Hemorrhagic Shock*

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INTRODUCTION:

Blood transfusion is considered one of the important and essential medical interventions in current medical care. Generally, the role emergency clinicians and the emergency department is to decrease the morbidities and mortality of patients. However, this can be challenging usually, as it is not generally easy to make the best choice in acute settings. This applies to blood transfusion therapies which need good clinical judgment to decide their use or not in patients in the emergency department.

When dealing with a patient with unstable hemodynamic status due to severe trauma, hemorrhage, shocks, or any other reason, emergency doctors and anesthesiologists are responsible for the resuscitation of this patient along with the recovery of normal hemodynamic status. Therefore, these doctors must be properly trained to deal with life-threatening and serious cases along with the underlying cause, which usually is challenging. This makes it important to have sufficient comprehension of the pathophysiology of shocks and the mechanisms in which a blood transfusion or any other intervention will act in a patient with hemodynamic instability. In addition, sometimes the surgical interventions may lead to loss of blood, which may be significant in some cases.

We can say that transfusion intervention is one of the crucial steps when dealing with any shocked patient. Apart from the decision of whether to administrate blood or not, other important decisions are to decide what type of transfusion to administrate, how much to transfuse, and when exactly to administrate blood transfusion. These questions have been important and got a lot of focus from emergency doctors along with researchers in this field. Physiologically, blood itself should theoretically be the best agent used for resuscitation of any patient. However, in real practice, there are many limitations of the use of whole blood transfusion. One major concern when administrating blood is the risk of transmitting infections. Despite advances in screening techniques, and the globally increased awareness on this issue, transfusion still has risk of transmitting infections, and no health system has recorded the presence of zero infections rate in their patients following blood transfusion. Other concerns regarding blood transfusion include the continuous availability of blood when needed, the costs for preparing blood, and shelf life of blood, and in some areas, the presence of religious considerations that forbid blood transfusion.

METHODOLOGY:

• Data Sources and Search terms

We conducted this review using a comprehensive search of MEDLINE, PubMed, and EMBASE, January 1985, through February 2017. The following search terms were used: blood transfusion, hemorrhagic shock, blood products transfusion, complications of blood transfusion, trauma induced coagulopathy

• Data Extraction

Two reviewers have independently reviewed the studies, abstracted data, and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

The study was approved by the ethical board of King Abdulaziz University Hospital

Hemorrhagic Shock

The presence of acute severe blood loss can lead to failure of physiological compensation by the body, leading to poor tissue oxygenation and perfusion. In these cases, the patients will go into what is called hemorrhagic shock. Hemorrhagic shocks can result from many cases including trauma, surgical procedures, and obstetric surgeries, along with other less common causes.

Normally, acute loss of blood will lead to the initiation of several physiological mechanisms that involve multiple systems in the body including the respiratory system, the cardiovascular system, the renal system, and the endocrine system. In addition, the presence of pain and the cognition of injury will act with the decreased preload to induce the ‘fight or flight’ status, which will start with a sudden decrease in blood pressure. This is due to the involvement of many mechanisms including the sudden decrease of the intravascular volume, and the decrease in peripheral resistance [1]. Following this, the baroreceptors will be stimulated by the decreased blood pressure leading to a reduction in the vagal tone and an increase in cardiac output associated with tachycardia. Then the sympathetic stimulation by the release of catecholamines will lead to the constriction of less important vessels to provide more blood flow within more important vessels. This will lead to partial compensation of lost blood in the vital organs [2].

In addition to the previous mechanisms, and in the presence of more severe hemorrhage, the endocrine

system will be stimulated to release the antidiuretic hormone, which will act to preserve water and sodium in the body. Moreover, the acute decline in blood pressure will lead to the stimulation of the juxtaglomerular apparatus and rennin secretion. The resulting angiotensin II will cause constriction of vessels and the release of aldosterone by the adrenal cortex. Aldosterone will further act to preserve the body content of water and sodium and will increase the excretion of hydrogen to compensate for acidosis. Acute blood loss can also induce coagulation system activation along with platelets adhesion at the injury site. This will act with the reduction of blood flow due to vasoconstriction to form a clot in the bleeding site to stop the hemorrhage. When there is a bleeding, the body will act by all these mechanisms to assure the presence of sufficient perfusion for vital tissues, even in relatively severe cases. However, the continuation of bleeding, especially severe bleeding, will eventually lead to the failure of these mechanisms to compensate for the whole lost volume, leading to significant complications or even death in more severe cases [3].

From a cellular aspect, the reduction in the delivery of oxygen into the cells will cause metabolism to become anaerobic. This will be followed by the uptake of fluids from the extracellular compartment leading the hibernation of cell and finally death [4]. In addition, the presence of ischemia within the cell will read to inflammatory mediators release into the circulation together with the products of cellular metabolism. When this status persists for longer that the cell can tolerate, this will lead to the development of irreversible injury along with a triad with hypothermia, coagulopathy, and acidosis. Patients who reach this stage and develop this triad have a risk of resuscitation failure [5].

When the bleeding is controlled, the prognosis of the patient following the shock will mostly be determined by the rate of resuscitation, the use of the right method for resuscitation, the response of body organs to resuscitation of a cellular level, and the levels of inflammatory mediators that have been released to the circulation. Some patients can survive the acute shock but die later from multiple systems failure.

Trauma Induced Coagulopathy (TIC)

In patients with trauma that led to severe damage, the commonest cause of mortality within the first hour is hemorrhage. Moreover, about half deaths within the first day following the injury can be attributed to hemorrhage [6]. Previously, many thought when trauma patients are resuscitated, they will develop coagulopathy due to the dilution of procoagulant factors along with depletion of their levels and/or development of factors dysfunction. However, more recent studies have shown that up to 40% of shocked patients with severe trauma have coagulopathy before even presentation to the emergency department. Patients with coagulopathy at presentation have been found to have significantly worse prognosis and survival [7].

This coagulopathy, also known as trauma-induced coagulopathy, is a result of dysfunctions of the endothelial tissue, dysfibrinogenemia, dysfunction of platelets, and a status of imbalance between procoagulant factors and anticoagulant factors. The presence of the lethal triad (acidemia, hypothermia, and resuscitation-related coagulopathy) has been known to exacerbate trauma-induced coagulopathy and lead to even worse prognosis of shocked patients [8].

After the discovery that coagulopathy could be associated with trauma itself and can present rapidly and dramatically, protocols of severely shocked patients management and hemorrhage management have been modified significantly to address this issue. More recent protocols have been attempting to decrease rates of coagulopathy following trauma or shock by more use of blood transfusion, application of more care during resuscitation, and early providing platelets, plasma, and coagulation factors in order to restore the balance. Studies have also discussed how appropriate these measures will be to be also used in shocked non-traumatic patients.

Blood Transfusion

When making a decision to administrate blood transfusion in a shocked patient, many factors must be taken into consideration including the clinical picture, the cardiac function, the amount of lost blood, the current state of bleeding, and the possible need for surgical interventions. The main target of blood transfusion is to provide recovery of lost blood and thus the capacity of blood to deliver oxygen to the tissues. The type of blood transfusion is generally based on thorough assessment and evaluation of the current status of the patient.

Whole blood

The use of whole blood for resuscitation of shocked patients has been significantly decreasing lately due to the presence of separate blood components available for transfusion. Generally, the use of whole

blood transfusion is limited by lack of sufficient clotting factors, high concentrations of potassium, high concentrations of ammonia, and high concentrations of hydrogen ions. On the other hand, the use of whole blood transfusion can successfully expand the volume and increase the capacity to deliver oxygen to tissues. However, whole blood transfusion can also lead to a volume overload status before deficient components are completely replenished.

Packed red blood cells

The most important and clinically-relevant of hemorrhagic shock is the failure of oxygen to be delivered sufficiently to tissues. Therefore, in many cases, the early administration of RBCs can be the most vital step when resuscitating a shocked patient. in patients who have lost more than 25% of their total blood volume, crystalloids are usually needed in addition to RBCs transfusion. Therefore, many recommend presence of readily available 'O' RBCs for transfusion in any emergency department to provide life-saving management for rapidly deteriorating patients [9].

Fresh frozen plasma

Fresh frozen plasma is generally used during the resuscitation of trauma patients who need clotting factors. In a patient with massive bleeding or a patient with coagulopathy, one unit of fresh frozen plasma can be administrated with the administration of every four or five RBCs units. The use of fresh frozen plasma must always be associated with strict monitoring of clotting times, levels of fibrinogen, activated partial thromboplastin time, and prothrombin time. In trauma cases that only needs volume expansion, the administration of fresh frozen plasma is not recommended. However, some protocols recommend the administration of fresh frozen plasma before coagulopathy development in cases of severe blood loss, as this can decrease the rates of development of coagulopathy [10].

The decision of the use of fresh frozen plasma must generally be made on a case-basis aiming to decrease the severity of the condition before irreversible damage occurs. Therefore, no set formula for plasma administration is present or recommended. Assessment of shocked patients before planning the best management must include checking for the presence of hypothermia and acidosis as these two can significantly reduce the efficacy of clotting factors [11]. Some recommend the use of thromboelastographic analysis to accurately detect the presence of coagulopathies [12].

Another challenging decision is the decision of the exact amount of plasma that is required to correct the coagulopathy, which differs among patients according to different factors. The determination of the best time to administrate plasma is another important factor that significantly affect the response to therapy. When plasma transfusion is administrated pre-operatively, it is recommended for it to be used as short as possible before the surgical operation as this has been found to be associated with best outcomes [13].

Platelets

The administration of platelets in cases with shock-associated thrombocytopenia should be preceded by a thorough assessment of the underlying cause of thrombocytopenia, the current status of the bleeding, and the need for surgical procedures. However, no solid evidence is present on how and when exactly to administrate platelets transfusion. In clinical practice, most physicians recommend the transfusion of platelets to prevent the development of bleeding when the platelets count is less than 10,000/µl. Transfusion of platelets is also recommended when the platelets count is less than 50,000/µl in patients who are in active bleeding or who require surgical interventions. The presence of platelets count that is less than 50,000 /µl has been associated with worse survival outcomes in these patients. Administration of platelets transfusion must be associated with strict continuous measurement of the platelets count to assure the achievement of acceptable platelets count and maintain this level. This is important because some patients do not always achieve satisfactory improvement in platelets count even following platelets transfusion. These cases usually have high ever, associated infection, DIC, severe hemorrhage, and/or splenomegaly [14].

Hemoglobin-based oxygen carriers

The use of hemoglobin-based oxygen carriers is a new method that has several advantages including achieving sufficient oxygen delivery to tissues without requiring cross-matching and with no risk of transmitted infections. hemoglobin-based oxygen carriers solutions can be derived from humans or animals and generally include hemoglobin tetramers or hemoglobin dimers. The half-life of hemoglobin-based oxygen carriers is usually shorter than the half life of RBCs and ranges from hours to days

maximally [15;16].

Studies on the use of hemoglobin-based oxygen carriers have been showing promising outcomes. However, one major concern with their use is the potential increase in systolic blood pressure that is due to the resulting vasoconstriction of vessels. Therefore, research is still needed to study the efficacy and safety of hemoglobin-based oxygen carriers for the use in traumatic patients [17;18].

Recombinant erythropoietin

One potential complication of bleeding and shock is the inhibition of the production of erythrocytes, which results from the release of cytokines into the circulation [19]. Therefore, the use of recombinant erythropoietin transfusion therapy in patients with major trauma has been found to be effective in improving erythropoietin concentrations [20].

Early administration of recombinant erythropoietin in traumatic patient can significantly decrease the need for later blood transfusion. A prospective multi-centric clinical trial has concluded that the administration of recombinant erythropoietin once per week in severely ill patients led to a significant decline in the rates of blood transfusions in these patients. Moreover, patients who received recombinant erythropoietin showed significantly higher hemoglobin and hematocrit [21]. Later studies on other populations showed similar benefits associated with recombinant erythropoietin therapy [22]. Moreover, the use of recombinant erythropoietin has been found to be associated with improved overall survival in traumatic patients. However, one study has observed the development of thrombotic events following recombinant erythropoietin administration [23]. One major advantage of recombinant erythropoietin is the ability to administrate it in patient who refuse whole blood transfusion for religious reasons [24;25].

Cryoprecipitate

Cryoprecipitate is used to compensate for deficiencies in von Willebrand factor, clotting factor VIII, and fibrinogen. Cryoprecipitate is generally not needed when fresh frozen plasma is administrated. However, an exception of this is the decline of fibrinogen concentrations to become less than 100 mg/dl [26].

Factor VIIa

The use of recombinant factor VIIa is generally recommended in either traumatic or non-traumatic patients who are in active bleeding that is refractory to all other lines of treatment. Recombinant factor VIIa has been found to stop the bleeding, decrease the requirement of blood transfusion, and enhance clotting functions [27]. In a recently published trial on traumatic patients, the adjuvant use of recombinant factor VIIa therapy resulted in sufficient control of bleeding that led to significantly less rates of blood transfusion. However, further studies on the use of recombinant factor VIIa therapy in shocked patients must be conducted before reaching any conclusions [28].

Desmopressin acetate

The use of desmopressin acetate therapy can be used in bleeding patients as an adjuvant therapy to improve associated coagulopathy. It acts by stimulating the secretion of von Willebrand factor and increasing the concentrations of both factor VII and von Willebrand factor [29].

Special Situations

Emergency transfusion

In some patients, immediate blood transfusion must be administrated without waiting for further evaluation or investigations to save their lives. In these patients, the most important thing is to perform a compatibility test before blood administration along with antibodies screening. In extremely emergent cases where there is no time for even a compatibility test, the use of group ‘O’ packed RBCs is recommended.

Massive transfusion

The term ‘massive transfusion’ refers to the use of ten or more units in blood for transfusion within less than twenty-four hours to compensate for huge loss of blood. Another definition for massive transfusion is the transfusion of blood to replace a volume that is more than 50% of circulating blood within a period that is shorter than three hours. Massive transfusion is usually needed in patients with severe acute bleeding, especially those who need surgical procedures [30].

Risks and Complications

Blood transfusion should be administrated with extreme caution as it can be associated with different complications and long-term morbidities. Initially,

the rapid transfusion of blood can lead to the development of clinical hypothermia that will increase the severity of coagulopathy. Hypothermia can also worsen oxygen delivery leading to deteriorating of the patient's general status and increasing the risk of developing myocardial infarction. Blood warming devices can be used to decrease the rate of hypothermia development [31].

Blood transfusion can also induce citrate toxicity which will lead to the development of clinically significant hypocalcemia. This is usually associated with decreased blood pressure, worsening of coagulopathy, decreased cardiac functions, and increased excitability of muscles. In some cases, metabolic alkalosis can also occur due to bicarbonate accumulation [31].

Another major concern following blood transfusion is the development of hypokalemia. Risk of developing hypokalemia increases with longer durations of storage of blood. In severe cases, this can lead to serious arrhythmias, and cardiac arrest. Patients who receive massive blood transfusion are also at risk of developing volume overload [31].

CONCLUSION:

Blood transfusion is an essential medical intervention that may be needed in the emergency department. Transfusion can include either whole blood, or its products, depending on the need. More complications are associated with whole blood transfusion, such as infections, coagulopathy, hypothermia, and citrate toxicity.

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