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Early resuscitation - what is changed in the treatment of Traumatic Brain Injury (TBI)

Abstract

Background: The classical therapeutic approaches to thetraumatic brain injury (TBI) are based on astandardized care and prevention of secondary brain injuries and insults.Brain is the most sensitive tissue to hypoxemia what consequently burdens maintenance of adequate circulation. The development of hypoxia hypoxemia during traumatic brain injury (TBI) with severe shock and anaemia is the main cause for the development of secondary brain injury, which is responsible for the high fatality of the TBI.

Objectives and method: The aim of this review is to discuss the available literature and guidelines for this field and to find out the possible benefits of early resuscitation.

Results: Initial resuscitation starts with infusions of isotonic crystalloid solutions (e.g. sodium chloride). The main goal of the treatment is to achieve normal blood pressure and adequate oxygen supply to the tissue. Aggressive resuscitation with excessive fluid load in TBI patients may aggravate the brain oedema. The data, about early use of blood and its products in TBI patients with severe haemorrhage are poor with controversial opinions.

Conclusion: The resent published guidelines do not support any specific fluid or specific transfusion practices in this setting.

Keywords: traumatic brain injury, severe bleeding, guidelines

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Introduction

Brain trauma is still one of the most common "diseases" in Europe with an annual incidence rates ranged from 47.3 - 694 /100,000 population (country-level studies).[1] The episodes of severe bleeding in trauma patients are common and are the most frequent cause of death. Traumatic brain injury (TBI) combined with severe bleeding is the most serious medical event which worsen the high mortality rate.

According to epidemiologicaldata, the most frequent causes of trauma deaths are the severity of the injury and the severity of haemorrhage where uncontrolled bleeding contributes to 30% to 40% of all trauma deaths.[2] The prompt lost of blood produces a hypovolemic shock with anaemia which additionally affects the impaired brain by the trauma. It is often associated with acidosis, hypothermia and coagulopathy. Therefore, the treatment of severe bleeding in TBI patients has the highest priority and requires emergent resuscitation and surgery with subsequent use of enormous amounts of RBPs and blood products. In 2003 Brohi K. and his colleagues published the results of their research. They identified an acute traumatic coagulopathy (ATC) which is responsible for bleeding after trauma.[3] Such haemorrhage combined with ATC is difficult to control by current resuscitation protocols.[4]

Guidelines for early resuscitation

To have a proper strategy for resuscitation of a TBI patient with severe bleeding is necessary to manage the hemodynamic withfluids load, but to protect the brain from the further injuries. It was shown that the major causes of the development of second brain injury were hypotension, ischemia and anaemia.[6] The haemorrhage and developed hypovolemia of these patients dictate an aggressive approach in fluid treatment with the aim to achieve a normal MAP and hyper dynamic CI. The specificity of the treatment of TBI patients is to secure safe perfusion of the injured brain through an adequate cerebral perfusion pressure, which generally requires a systolic blood pressure well above 100 mmHg.

The main dilemma in decision making is the choice of right fluid for resuscitation. Crystalloids are routinely used for treatment of shock. Saline solution (0.9 %) is preferable for patients with brain trauma. The adequate blood volume for polytraumatized patients or ventilated is greater than normal, so the risk for over infusion exists that can aggravated the brain oedema. The American hospital consortium guidelines recommended the use of colloids until blood products become available after an initial infusion with crystalloids.[7]

The concept of use of hypertonic solutions ("short volume resuscitation") for patients with severe head injuries and haemorrhages has several advantages. It was shown that their use has conclusive benefit. They produces quick volume replacement and are more effective than mannitol in controlling episodes of elevated ICP.[8,9] With the purpose to achieve stable circulatory function and hemodynamic, beside the determination of adequate blood volume, the use of inotropic support or vaso-constriction is necessery. The goal of the treatment of the TBI patients with severe bleeding, is to attain the O_2ER on tha ranges between 0,25-0,30 and normalisation of the lactate level.[10]

Transfusion protocols

The excessive administration of fluids triggers a cascade of events that disturbs the coagulation. The head injured patients are prone to develop acute coagulation disorders due to local tissue release of thromboplastin, the fluids dilute clotting factors and lower platelets, and simultaneously hyperchloremia leading to acidosis, hypocalcaemia and hypothermia are developed. It is reported that the frequency of these disorders has been as high as 22.7%.[11] In such circumstances the risk for further bleeding increases and anaemia is profound. Following the guidelines for traumatic brain injury (TBI)

patients, maintenance ofhematocrit (HT) at 30 -35% is desirable and transfusion of packed red blood cell (pRBC) is advised.[5]

The use of blood and its products produces unique quick and efficient replacement of the blood volume and rapid correction of anaemia. According to the valuable literature concerning this topic, it is amazing that, there are widespread transfusion practice variations. Even that anaemia develops in about 50% of hospitalized patients with traumatic brain injury (TBI)[12] the decision for transfusion of pRBC preferably is based on more sophisticated multimodal neurologic monitoring, as brain tissue oxygen tension values ($PtiO_2$ levels) or lactate:pyruvate ratio, than on simple lab (e.g Hb or HT).

Despite the controversies about transfusion practice in TBI, in 2009 in Critical Care Medicine The recommendation for clinical use of red blood cells transfusion were published. This is a huge document with a Section dedicated to the neuro trauma patients. The main problem in this document is that it elaborates only the use of red blood cells but not the other blood components.[13]

In this document in section III D. "the Recommendations Regarding RBC Transfusion in Patients with Neurologic Injury and Diseases" is concluded that there are insufficient data to support Level 1 Recommendations on this topic. Recommendation Level 2 is about the finding that there is no benefit of a "liberal" transfusion strategy (transfusion when Hb < 10 g/dL) in patients with moderate-to-severe traumatic brain injury. The recommendation Level 3 is for decisions regarding blood transfusion in patients with subarachnoid haemorrhage (SAH). They must be assessed individually since optimal transfusion triggers are not known and there is no clear evidence that blood transfusion is associated with improved outcome.[13]

In the same document in addition is discussed the rational approach in clinical practice and it is as follow: --"The relationship between anaemia and these complications is not well established. RBC transfusion has been used in TBI to prevent cerebral ischemia by maximizing oxygen-carrying capacity post blood loss and dilution with crystalloid fluid replacement..... There is little evidence to support this practice, and the ultimate effects of transfusion on neurologic and functional outcome have not been well studied.... Patients with severe TBI should not have a different transfusion threshold than other critical care patients.[13]"

According the literature, few randomized trials evaluate liberal versus restrictive transfusion strategies in patients with TBI.Several studies suggest that anaemia below a haemoglobin (Hb) concentration of 7 g/dL results in impaired brain function and below 10 g/dL may influence the outcome from TBI.[14,15] Peiniger et al., in 2011 through a retrospective analyses demonstrate that using an early and more balanced ratio between fresh frozen plasma concentration (FFP) and packed red blood cell (pRBC) transfusions in TBI patients with developed acute traumatic coagulopathy (ATC) have potential survival benefits. They conclude that patients with ATC requiring massive transfusion within the first 24h after hospital admission (pRBC≥10) have survival benefit from transfusion strategies using an early and more balanced ratio between FFP and pRBC (FFP:pRBC>1:2).[4,16-22,23]

In 2006 Leal-Noval SR and his colleagues investigated the effect of the erythrocyte transfusion on cerebral oxygenation in patients with severe traumatic brain injury. They found that the most benefit from erythrocyte transfusion had the patients with low baseline $PtiO_2$ levels (< 15 mmHg).[24]

It is recommended to use albumin in order to keep the level of oncotic pressure in the ranges from 12 - 14 mmHg.[25] Eikelboom et al.,[26] with the purpose to rationalize the use of blood and blood products in severe bleeding, used of recombinant activated factor VII (rFVIIa) in patients with life-threatening hemorrhage. The benefits of presenting drug still are under the audit.[26] Administration of exogenous erythropoietin may have a small impact in further reducing the need for transfusion, or hemoglobin-based blood substitutes (HBBSs).[27]

Discussion

There is evidence about association between hypotension and poor outcome in patients with head injuries [28]. Depth and duration of hypotension, but not hypoxemia, has been shown to trend in a dose-response manner with the 3-month functional Glasgow Outcome Scale Score.[29]

Patients with head injuries treated with delayed resuscitation have been shown to experience progressive intracerebral swelling and increased ICP, as well as higher lactate/piruvate ratios as result of delayed restoration of CBF. The ABCDE resuscitation approach for trauma patients should be followed in the pre hospital settings. After the care of the airway and ventilation the intravenous fluids should be administered as soon as possible to avoid hypotension, and a transfusion regimen using a high FFP:pRBC ratio (FFP:pRBC>1:2) is advised. According the European Guidelines for Optimal blood use: " *Transfusion of the right unit of blood to the right patient at the right time, and in the right condition and according to appropriate guidelines."* Unfortunately there is a lack of randomised studies specified for TBI and bleeding.

Conclusion

There is strong evidence that the TBI patients with severe bleeding have benefits of aggressive resuscitation in first 24 hours. The treatment of moderate and severe head injuries begins with initial cardiopulmonary stabilization by ATLS guidelines. The initial resuscitation of a patient with a head injury is of critical importance to prevent hypoxia and hypotension. Early use of pRBC in a balanced massive transfusion ratio is advised. There is evidence that the concept of early resuscitation with balanced transfusion practice increase the survival of TBI patients with severe bleeding.

Although no strict guidelines exist that define the use of blood and blood products in prehospital settings.

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Conflicts of interest

None.

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