Editorial

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Femoral blood gas analysis, a new promising tool to assess hemorrhagic shock status

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Blood loss is the most common cause of hypotension in patients with trauma. Nevertheless, when substantial tissue trauma occurs, it exacerbates haemorrhagic shock by triggering immunological and inflammatory reactions[1]. The concept of 'traumatic shock' extends beyond the realm of mere blood loss and tissue ischaemia. Hence, it is valuable to monitor biomarkers of tissue ischaemia or the presence of an 'oxygen debt', such as lactate.

Current modalities to predict blood transfusions in cases of trauma

Elevated levels of these indicators or failure to return them to normal values are correlated with an increased risk of mortality[2]. There is often a need for massive transfusion in trauma patients experiencing haemorrhagic shock, typically characterised by the necessity for at least 10 units of packed red blood cells (PRBCs) within a 24 h period[3]. Hence, it becomes imperative to promptly identify individuals with significant blood loss to initiate timely resuscitation measures, that is, blood transfusion, if needed. In order to predict the need for blood transfusion in trauma patients, several parameters were evaluated. Quickly evaluated clinical parameters, such as hypotension, tachycardia, diminished mental status, and penetrating injuries, each serve as independent predictors of the need for massive transfusion (MT)[4]. Various scoring systems have been developed to assist healthcare professionals in making the decision to activate a Massive Transfusion Protocol (MTP). One of these is the ABC score, which is likely to be clinically beneficial when it comes to guiding the decision of whether to initiate an MTP. The ABC score is easily calculable, and its essential components are gathered during the initial patient assessment, eliminating the need for awaiting laboratory results. Additionally, it has been proven effective in rural and prehospital settings[5]. The prehospital ABC score is computed based on the patient's highest recorded heart rate, lowest systolic blood pressure, and the results of the focused assessment with sonography for trauma (FAST) exam, all of which were obtained before the patient's arrival at the trauma centre[6]. Hence, the ABC score is one of the simplest scores in terms of calculation complexity[7]. The findings of one study indicate that the Revised Assessment of Bleeding and Transfusion (RABT) score, which is a modification of the ABC score, serves as a practical and effective tool for predicting the requirement for MT. In comparison to the ABC score, the RABT score demonstrated superior performance for forecasting the need for MT. The RABT score is computed based on a 4-point scoring system, considering factors such as the type of trauma, shock index, presence of a pelvic fracture, and a positive FAST result. A RABT score ≥ 2 is employed as the threshold for predicting the need for MT, defined as the requirement for at least 10 units of packed red blood cells within 24 h[8]. The findings of another study have revealed that the majority of machine learning (ML) methods outperform both the ABC and RABT scores in predicting the requirement for MBT in trauma patients[9].

Femoral blood gas analysis

To our knowledge, so far, very few study has been undertaken to evaluate the capacity of ΔPCO2 fem, SvO_2 fem, and arterial blood lactate in predicting the necessity for red blood cell transfusions within the initial 6 h (pRBCH6) or the implementation of emergency haemostatic procedures subsequent to severe trauma[10]. Previously, in the setting of severe trauma, the venous to arterial PCO_2 difference and venous O_2 saturation have hardly been studied. To date, Elevated ΔPCO_2 fem and reduced SvO_2 fem are indicative of a reduction in lower limb tissue perfusion, likely attributed to the extent of blood loss in patients who have experienced trauma. For determining the blood gas values, the blood sample is obtained via femoral catheterization. The findings of this particular study revealed that when it came to predicting the need for red blood cell transfusion in cases of haemorrhage, ΔPCO_2 fem and SvO_2 fem seemed to exhibit greater sensitivity in comparison to blood lactate levels[10]. Following an active haemorrhage, it would seem that the drop in cardiac output, which leads to peripheral vasoconstriction and diminished blood flow to the lower extremities, can be identified more promptly by an increase in ΔPCO_2 fem and a decrease in SvO_2 fem, rather than relying on the blood lactate levels. Blood flow is indeed rapidly diminished in musculocutaneous tissues, such as the lower limbs, as part of a protective mechanism to ensure continued perfusion of vital organs, such as the heart and brain[11]. This phenomenon may explain the early elevation of ΔPCO_2 fem and the decrease in SvO_2 fem.

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Outcomes and effectiveness of FBG analysis

Hence, the outcomes suggest that ΔPCO_2 fem and SvO_2 fem exhibit a greater sensitivity in comparison to blood lactate levels when it comes to predicting the requirement for immediate blood transfusion or the implementation of haemostatic procedures upon the admission of severe trauma patients. It was noted that 25% of the patients included in that study, who were transfused with RBC during the first 6 h of management, had normal blood lactate levels but indeed high ΔPCO_2 fem and/or low SvO_2 fem values. Furthermore, monitoring the progression of ΔPCO_2 fem and SvO_2 fem over time might also serve as a valuable tool for evaluating the effectiveness of transfusion therapies aimed at reinstating optimal tissue perfusion. The research revealed that ΔPCO_2 fem and SvO_2 fem can be utilised as easily accessible parameters for evaluating the correlation between tissue blood flow, particularly in the lower limbs, and metabolic demands following severe trauma. In the trauma bay's initial phase, standard cardiac output monitoring tools, like cardiac ultrasound or thermodilution, are typically unavailable. Furthermore, conventional macro-haemodynamic indicators, such as heart rate and mean blood pressure, often demonstrate poor correlation with cardiac output in states of haemorrhagic shock[11].

These findings have not only deepened our comprehension of trauma care but have also paved the way for various alternative indicators to assess the alignment between tissue blood flow and metabolic requirements in individuals with trauma. The significance of this research cannot be sufficiently emphasised, underscoring the vital role of continuous exploration and advancement in the realm of trauma medicine.

Limitations

There are a few limitations to this method. Femoral blood gas analysis can only be conducted in patients with arterial and central venous femoral catheters, a procedure which is typically reserved for critically ill patients admitted to the ICU, exhibiting conditions such as shock and traumatic brain injuries[12]. Consequently, its infrequent application limits it to a limited sample size. Another limitation is that the baseline values for ΔPCO_2 fem and SvO_2 fem are unknown, the huge differences between these parameters were indicative of haemorrhage induced loss in tissue blood flow.

In the future, there is a need for additional studies conducted across multiple tertiary healthcare settings encompassing larger sample sizes, in order to determine the range of normal values for ΔPCO_2 fem and SvO_2 fem and to further elucidate the efficacy and limitations of this approach, thereby enhancing the comprehension regarding the need for femoral blood gas analysis.

Conclusion

Blood loss-induced hypotension in patients with trauma can be complicated by immunological and inflammatory responses, necessitating timely blood transfusions. Clinical parameters and scoring systems can aid in identifying patients who require massive transfusion. Femoral blood gas analysis, particularly ΔPCO_2 fem and SvO_2 fem, offers a more sensitive approach than lactate levels for predicting transfusion needs and assessing tissue perfusion. However, its application is limited to patients with femoral catheters, warranting further research to explore its broader utility in healthcare settings. Continuous exploration and advancement in trauma medicine are crucial for improving patient outcomes and enhancing our understanding of trauma care.

Ethical approval

As we are submitting a review, so we do not require ethical approval from any department.

Consent

This study does not include any individual patient, so no consent will be required.

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Author contribution

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; Have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors declare no conflict of interest.

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