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Simplified treatment algorithm for the management of trauma-induced hemorrhage without viscoelastic testing

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ABSTRACT

Uncontrolled bleeding after major trauma remains a significant cause of death, with up to a third of trauma patients presenting with signs of coagulopathy at hospital admission. Rapid correction of coagulopathy is therefore vital to improve mortality rates and patient outcomes in this population. Early and repeated monitoring of coagulation parameters followed by clear protocols to correct hemostasis is the recommended standard of care for bleeding trauma patients. However, although a number of treatment algorithms are available, these are frequently complex and can rely on the use of viscoelastic testing, which is not available in all treatment centers. We therefore set out to develop a concise and pragmatic algorithm to guide treatment of bleeding trauma patients without the use of point-of-care viscoelastic testing. The algorithm we present here is based on published guidelines and research, includes recommendations regarding treatment and dosing, and is simple and clear enough for even an inexperienced physician to follow. In this way, we have demonstrated that treatment protocols can be developed and adapted to the resources available, to offer clear and relevant guidance to the entire trauma team.

The treatment of hemorrhage after major trauma is a significant challenge in routine clinical practice. Injuries account for over five million deaths each year, with uncontrolled post-traumatic bleeding remaining one of the leading causes of death among these patients.[1–3] Additionally, up to a third of trauma patients present with signs of coagulopathy at admission to hospital, and trauma-induced coagulopathy is associated with increased transfusion requirements, complications, and mortality.[2 4–7] As such, rapid identification and correction of coagulopathy is vital to reduce mortality and improve outcomes for bleeding trauma patients.

Current guidelines recommend early and repeated monitoring of hemostasis in trauma patients, either with viscoelastic testing methods or with standard laboratory tests (SLTs, eg, prothrombin time and Clauss fibrinogen testing).[2 8 9] As viscoelastic testing is based on assessment of whole blood samples, it is able to provide a more accurate assessment of coagulation defects than SLTs, including measurement of clot strength and detection of hyperfibrinolysis.[9–11] Additionally, viscoelastic testing can be conducted at the point of care, with a turnaround time up to 30–60 minutes shorter than that reported for SLTs.[2 10 12 13] However, not all treatment centers have access to viscoelastic testing, and so treatment must be based on the results of SLTs. If these results can be made available in a timely manner, they could be used to guide appropriate hemostasis management in the case of massive bleeding after trauma.

The implementation of goal-directed treatment algorithms can offer a structured approach to bleeding management and can help guide clinicians in appropriate treatment measures.[2 8 9] A number of algorithms for the management of trauma-related bleeding have previously been published[9 14 15]; however, these can be complex and often include the use of viscoelastic tests.

We therefore set out to develop a pragmatic and guideline-based treatment algorithm which would support coagulation management in trauma patients in a timely and efficient manner when viscoelastic testing is not available. After a review of current guidelines, an algorithm was based on published evidence, including a viscoelastic testing-based algorithm[15] and parameters for the estimation of plasma fibrinogen levels based on SLTs.[16] As our objective was to develop an algorithm that was simple and clear enough for even an inexperienced physician to follow, we aimed to reduce and simplify each step while providing enough information to guide appropriate patient management. This algorithm was intended to guide treatment and followed steps that were already established and familiar to the treating physician, such as initiating SLTs. Although based on published evidence, this algorithm represents the approach to resuscitation at our center and has not, as yet, been validated.

The final algorithm is presented in figure 1 and is divided into two sections: a checklist to direct the assessment and treatment of the patient with an accompanying decision tree to guide administration of hemostatic agents as needed. This has been designed for easy reproduction on posters to be displayed in the emergency department or on cards for physicians to carry with them for reference. The algorithm is color-coded throughout, according to the bleeding severity and SLT results, to aid with quick reference.

The checklist begins with basic patient management and initial SLTs, followed by obtaining the patient history, with particular reference to potential known bleeding complications such as prescribed oral anticoagulants. A treatment protocol is then detailed, based on initial coagulation factor concentrate administration followed by the potential to escalate treatment to include a massive transfusion

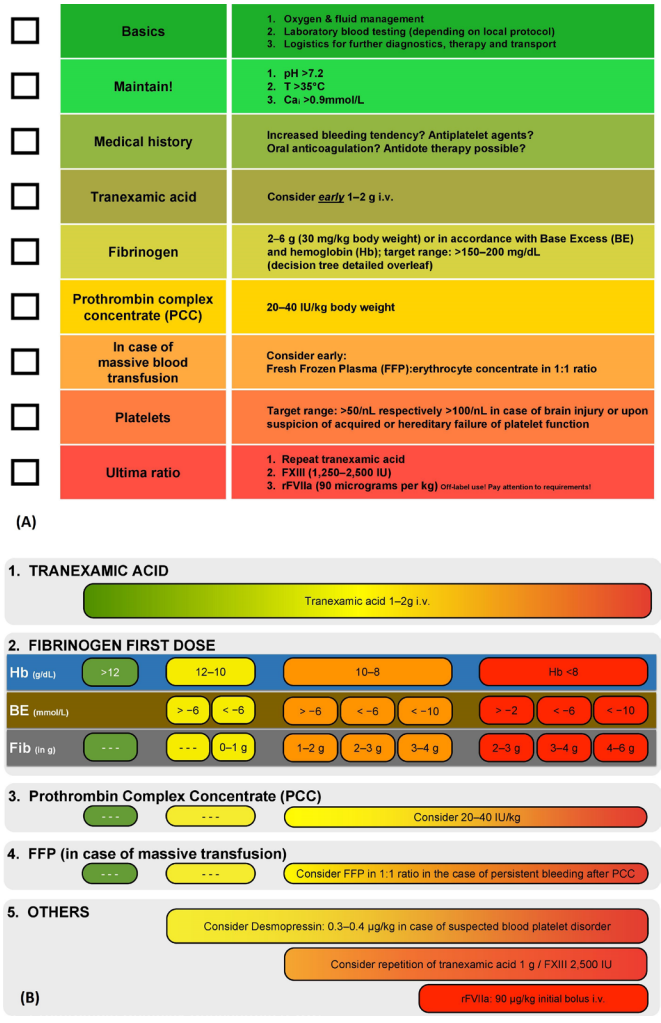

Figure 1 Simplified treatment algorithm for the management of trauma-related bleeding without the use of viscoelastic testing. The algorithm consists of two parts: (A) a checklist to guide assessment and treatment of the patient and (B) a decision tree to guide administration of hemostatic agents.

protocol. Tranexamic acid is suggested for early administration, in line with current treatment guidelines,[2] followed by fibrinogen administration in line with the publication by Schlimp *et al*.[16] For fibrinogen, dosing can be based on weight, or the decision tree (figure 1B) can be used to guide dosing based on base excess and hemoglobin levels instead of estimating the appropriate dose required. We recommend basing the fibrinogen dose on these parameters as this takes into account the extent of the trauma. Additionally, base excess and hemoglobin levels will have been determined as part of the routine blood gas analysis; as such, results will be available within minutes, and clinicians will be experienced in obtaining and interpreting the results.

Administration of prothrombin complex concentrate (PCC) is proposed as the next step. We recommend PCC as the use of factor concentrates for first-line treatment appears to be superior to fresh frozen plasma (FFP),[17 18] particularly as PCC can be given immediately compared with the time required to prepare and administer FFP.[18 19] Additionally, a large volume of FFP is required to significantly increase factor levels, whereas this is not the case for PCC.[20] As there is a lack of data regarding the use of base excess and hemoglobin levels to determine the PCC dose, we have recommended dosing based on body weight. If bleeding persists after PCC administration, a massive transfusion protocol can be initiated. Plasma will only be administered as part of massive transfusion and can be accompanied by platelets if necessary. In severe cases, recommendations are also given for potential further treatment, such as desmopressin, repeated administration of tranexamic acid, and coagulation factors XIII and VIIa. FXIII is known to be an essential contributor to clot strength as it crosslinks and stabilizes fibrin[21] and, in cases of bleeding and low FXIII activity, the European Society of Anaesthesiology (ESA) guidelines recommend its administration (30 IU/kg),[22] hence its inclusion at the end of the algorithm. For rFVIIa, several studies and systematic reviews have demonstrated that rFVIIa administration does not significantly reduce mortality.[22 23] As such, we only included rFVIIa as ultima ratio if all previous steps were unsuccessful and the requirements for rFVIIa administration were met, in line with the ESA guidelines.[22]

It should be noted that this algorithm is only suitable for the initial management of uncontrolled bleeding in the emergency room, particularly after trauma. Later hemostatic management of the patient, for example, in the intensive care unit, will require different treatment guidelines. Additionally, although the administration of fibrinogen according to base excess and hemoglobin levels offers clear and simple guidance on dosing, evidence is currently limited regarding the accuracy of these parameters when used to estimate fibrinogen levels. As such, further research is required to support this guidance.

While many excellent treatment algorithms exist for hemostatic management of trauma-induced bleeding, these are not always practical to administer in day-to-day clinical practice. Treatment recommendations must take into account the available hospital resources, and the knowledge, experience, and time available to clinical staff. As such, simple and clear guidelines can greatly aid clinicians in incorporating up-to-date practices in real-world situations. While viscoelastic testing does appear to offer benefits over SLTs, it must be remembered that this is not available in many treatment centers, and so clear, robust alternatives are vital to ensure patients receive the best possible care. Here we have adapted published guidelines and research to develop a simplified algorithm, adapted to the resources available in our hospital, to guide efficient and appropriate treatment of trauma-induced bleeding. By recommending dosage based on parameters from blood gas analysis, the extent of trauma can be taken into consideration when determining the appropriate dose and the laboratory results can be obtained rapidly. In this way, locally adapted algorithms can be developed, offering clear and relevant guidance for the entire trauma team. Further data and experience will enable refinement of the process and algorithm.

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