Prehospital Damage-Control Resuscitation

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Severe hemorrhage from injury claims the lives of nearly 50,000 Americans every year. Because many of these deaths occur in young, vital people, this number translates to an astounding loss of almost 2,000,000 years of productive life. Recent studies indicate that performing temporizing measures to control bleeding, minimizing factors that exacerbate hemorrhage, and shortening the time to definitive hemostasis may prevent some of these deaths, but more research is needed. Because most deaths occur within 2 hours after an injury, severe hemorrhage is the ultimate time-sensitive condition.

Many different approaches have been taken to solve this vexing problem. The landmark study by Bickell et al. involving patients with penetrating injuries of the torso showed that withholding preoperative crystalloid solution was superior to using goal-directed, crystalloid-based therapy in an urban environment. Rapid transport of these patients — even by police rather than by emergency medical services — is essential. Moreover, in patients with severe hemorrhage of the arms or legs, prehospital application of a tourniquet is both safe and beneficial.

But what about patients who have blunt injuries and longer transport times? The options for preventing further hemorrhage, replacing blood loss, and bolstering the body’s hemostatic pathways in these patients remain limited. Military antishock trousers designed to augment proximal perfusion while limiting ongoing hemorrhage have been shown to be ineffective and potentially even harmful. More recently, the Resuscitation Outcomes Consortium evaluated various options for prehospital crystalloid and colloid resuscitation, but this study was halted early for futility and for possible harm to patients who did not receive blood. However, in this issue of the Journal, the investigators in the Prehospital Air Medical Plasma (PAMPer) trial report on a generalizable intervention that appears to improve survival in patients with trauma who are bleeding and at risk for hemorrhagic shock: prehospital plasma resuscitation.

Of course, delivering hemostatic resuscitation to patients who are bleeding as soon as possible after injury makes intuitive sense. During World War II, freeze-dried plasma was administered routinely in the prehospital setting. Unfortunately, in many cases, this “field plasma” was the only blood product given, and it proved to be inadequate to save the lives of patients who were in severe hemorrhagic shock. More recently, the concept of “damage-control resuscitation” has emerged, wherein plasma, platelets, and red cells are transfused in nearly equal proportions and administration of nonhemostatic crystalloid solution is minimized. This approach has clearly improved outcomes in patients who survive transport to the trauma center, which begs the question of whether damage-control resuscitation could be started during transport.

A recent study of blood products administered in the prehospital setting to combat casualties during helicopter transport showed a survival benefit, and now, the investigators of the PAMPer trial have confirmed a similar benefit in severely injured civilian patients. In this pragmatic, randomized, controlled trial, 230 patients with unstable vital signs were administered 2 units of plasma before any other resuscitation fluid (plasma group), and 271 patients with unstable vital signs received prehospital crystalloid solu-
tion alone or crystalloid solution and red cells (standard-care group) before they arrived at a trauma center. Mortality at 30 days was lower in the plasma group than in the standard-care group (23.2% vs. 33.0%, P=0.03).7 Transfusion of plasma did not delay the transport time to the trauma center (42 minutes in the plasma group and 40 minutes in the standard-care group), and with the addition of 2 units of plasma, the ratio of plasma to red cells administered in the plasma group was close to 1:1, which is consistent with the principles of damage-control resuscitation. Air medical providers from 27 individual bases performed these transfusions safely with very few reported adverse events. Thus, based on the percentage-point difference in mortality between the two treatment groups, the number of patients that would need to be treated for one additional patient to survive (10 patients) favors prehospital plasma, whereas the number of patients that would need to be treated to cause harm cannot be calculated.

Plasma is relatively inexpensive; however, there are some logistic challenges associated with prehospital administration. Plasma requires cold storage and careful monitoring of temperature, and the viable shelf life of the product must also be considered. Fresh-frozen plasma that has been thawed, as was used in this trial, has a shelf life of approximately 5 days. This short shelf life results in an increased risk of waste and the need for more frequent resupply of inventory. As an alternative, never-frozen liquid plasma, with its 26-day shelf life, mitigates these issues. Freeze-dried plasma (not approved by the Food and Drug Administration) does not require cold storage and has a 2-year shelf life, which make it an attractive option for resource-limited locations and mass-casualty situations. Finally, refrigerated whole blood has a shelf life of 21 days and offers the benefit of both platelets and oxygen delivery, making it perhaps the ideal product for prehospital resuscitation. Although these various alternative products are being explored, the PAMPer trial has shown the benefits and safety of prehospital plasma administration, which should motivate trauma center personnel and air medical crews across the country to consider implementing this lifesaving approach.

Disclosure forms provided by the author are available with the full text of this editorial at NEJM.org.

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