EDITORIAL

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Timing of Fluid Resuscitation in Trauma

The resuscitation of hypotensive patients with hypovolemia who have sustained penetrating injuries traditionally follows the management principles outlined in the American College of Surgeons Advanced Trauma Life Support course.[1] These principles consist of the establishment of a patent airway, ventilation with oxygen, and fluid resuscitation with crystalloid and colloid solutions. The goal is to establish adequate perfusion of cerebral and myocardial tissue with well-oxygenated blood.

Conventional treatment at the scene of the event includes airway and oxygen management followed by rapid transportation to a trauma center.[2] No time should be wasted gaining intravenous access, but fluid resuscitation can be established en route if possible. Resuscitation teams in the hospital begin fluid resuscitation at flow rates of up to 1 liter per minute. The patient is evaluated, and, if indicated, surgery is performed to control massive hemorrhage within one hour of the injury. Up to now, the controversy in fluid resuscitation has been over which type of fluid to use. Traditionally, patients in hemorrhagic shock are given 3 ml of an isotonic solution for every 1 ml of estimated blood lost. Recently, hypertonic saline and hyperoncotic dextran have been used to preserve intravascular volume and decrease the total volume of fluid necessary for resuscitation.[3]

The practice of initiating fluid resuscitation as soon as practicable has now been challenged. On the basis of experiences in World War I indicating that fluid resuscitation before definitive surgical control of hemorrhage could be detrimental,[4] Bickell et al.[5] conducted a prospective, controlled trial in hypotensive adult patients with penetrating injuries to the torso to determine whether it is beneficial to delay fluid resuscitation until the time of operative intervention. Their results are reported in this issue of the Journal. The authors are experienced in conducting studies in the prehospital environment, and their research is well respected. Although this arena poses logistic problems, they designed a comprehensive protocol minimizing the obstacles. The paramedical service of the city of Houston is known to be well organized and closely monitored by physicians to ensure quality.

Fluid resuscitation is often delayed in patients with ruptured abdominal aortic aneurysms. In such patients, it is conventional practice to minimize fluid resuscitation and to tolerate hypotension until surgical exploration is performed. In a study by Bickell et al. of swine in which a 5-mm aortotomy had been performed to simulate uncontrolled hemorrhage,[6] the animals that were not resuscitated with fluid all survived and, at autopsy, each was found to have an extraluminal thrombus tamponading the aortotomy. Animals that were resuscitated with a hypertonic solution of saline and dextran had a substantial rate of mortality; the rate was even more pronounced in a third group of animals resuscitated with Ringer's lactate solution.

Normal hemostatic mechanisms can control hemorrhage from a substantial injury, but if the injury is too extensive, the patient will lose a substantial amount of blood unless treated. The clinical dilemma, therefore, resides in the fact that if one waits too long to control bleeding, the patient with a severe injury may die of exsanguination. But maximal fluid resuscitation may increase the bleeding, preventing the formation of a protective thrombus or dislodging it once the intraluminal pressure exceeds the tamponading pressure of the thrombus.

Bickell et al. have demonstrated in their new study[5] that hypotensive patients who were not given intravenous fluids until the time of operation tolerated the hypovolemic insult and had a better survival rate than a matched group of

patients who received traditional fluid resuscitation before surgery.[5] The mean length of time from injury to arrival in the operating room was remarkably short in both groups. Despite the lack of fluid resuscitation the mean increase in systolic blood pressure was 41 mm Hg from the time of their arrival at the trauma center to the time of operative intervention (from 72 mm Hg to 113 mm Hg).

This is an impressive increase, but it may be partly explained by the fact that the patients who died in the emergency department did not have comparison blood-pressure measurements in the operating room. The severity of hemorrhage varies greatly among patients with penetrating torso injuries. At one end of the spectrum are patients with severe injuries, who may exsanguinate, and at the other end are those with less severe injuries, in whom the interval between injury and operative control and fluid resuscitation may not be so critical.

The importance of this study lies in the fact that it is a prospective, randomized trial, which is not an easy study to perform in a crisis environment. The mortality rate in both groups was substantial, but the factors contributing to that mortality were not well defined. Was it the specific organ injured, the number of organs injured, the amount of bleeding, or the length of time that elapsed before surgery that resulted in death? The relation of these variables differs in each patient. A study involving a cohort of more severely injured patients (e.g., those with a blood pressure of less than 40 mm Hg) would shed light on these questions. Another unanswered question, especially with respect to patients with extreme hypotension, is the relation to the outcome of the interval between the injury and the start of fluid resuscitation. The survival rate in the group in which fluid resuscitation was delayed was 70 percent, and it was 62 percent in the group that received immediate fluid resuscitation ($P = 0.04$). The causes of death are not clearly stated. Could maximal fluid resuscitation in the delayed-resuscitation group have extended their survival until they arrived in the operating room, or were these patients so severely injured that no intervention would have succeeded?

Patients with penetrating torso injuries are losing blood volume, and in the absence of the intravenous administration of fluids, their intravascular volume is decreasing. It is only a matter of time before there is insufficient red-cell mass and plasma volume to sustain aerobic metabolism. If an immediate exploratory operation cannot be performed, resuscitation with crystalloids and packed red cells is indicated. There are ethical and legal implications if surgery is delayed because of logistic problems or the transient lack of an operating room or team for a patient who is exsanguinating after trauma and who is not given fluid replacement.

This study has the potential to alter clinical care and change public policy concerning the resuscitation of injured patients. It is very important, however, to caution prehospital providers, physicians in emergency departments, and surgeons. Before we adopt the practice of withholding fluid resuscitation from patients with extensive bleeding at the scene of an event and in the emergency department, further controlled studies are needed that will stratify the severity of hemorrhage and corresponding hypotension and identify the specific cause of death.

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