Self-expanding polyurethane polymer improves survival in a model of noncompressible massive abdominal hemorrhage.


BACKGROUND: Intracavitary noncompressible hemorrhage remains a significant cause of preventable death on the battlefield. Two dynamically mixed and percutaneously injected liquids were engineered to create an in situ self-expanding polymer foam to facilitate hemostasis in massive bleeding. We hypothesized that intraperitoneal injection of the polymer could achieve conformal contact with sites of injury and improve survival in swine with lethal hepatoportal injury.

METHODS: High grade hepatoportal injury was created in a closed abdominal cavity, resulting in massive noncoagulopathic, noncompressible hemorrhage. Animals received either standard battlefield fluid resuscitation (control, n = 12) or fluid resuscitation plus intraperitoneal injection of hemostatic foam (polymer, n = 15) and were monitored for 3 hours. Blood loss was quantified, and all hepatoportal injuries were inspected for consistency.

RESULTS: Before intervention, all animals initially experienced severe, profound hypotension and near-arrest (mean arterial pressure at 10 minutes, 21 [5.3] mm Hg). Overall survival at 3 hours was 73% in the polymer group and 8% in the control group (p = 0.001). Median survival time was more than 150 minutes in the polymer group versus 23 minutes (19-41.5 minutes) in the control group (p < 0.001), and normalized blood loss in the polymer group was 0.47 (0.30) g/kg per minute versus 3.0 (1.3) g/kg per minute in the controls (p = < 0.001). All hepatoportal injuries were anatomically similar, and the polymer had conformal contact with injured tissues.

CONCLUSION: Intraperitoneal polymer injection during massive noncompressible hemorrhage reduces blood loss and improves survival in a lethal, closed-cavity, hepatoportal injury model. Chronic safety and additional efficacy studies in other models are needed.