# Researchers develop low volume resuscitant for prehospital treatment of severe hemorrhagic shock

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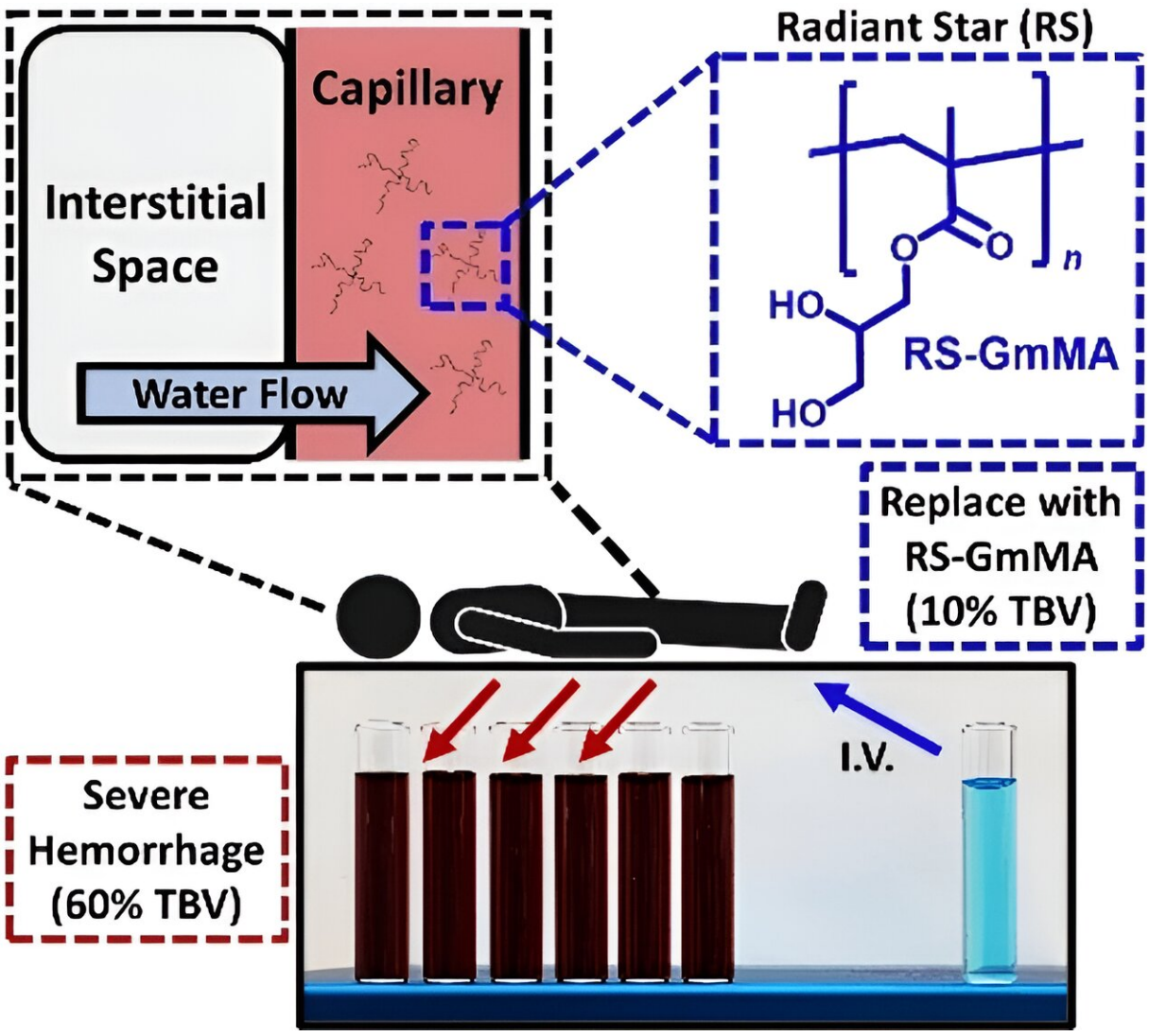


Credit: *Angewandte Chemie International Edition* (2024). DOI:

10.1002/anie.202402078

Extensive blood loss after injuries is life-threatening and must be counteracted as fast as possible. Relatively small volume injections of solutions of a novel star-shaped polymer could compensate for the loss of fluid without disrupting coagulation, according to a new study published in the journal *Angewandte Chemie International Edition*. This makes it particularly interesting for preclinical treatment of hemorrhagic shock.

Traumatic injuries account for a large portion of morbidity and death; in the U.S., they are the primary cause of death in people under 46 years of age. In cases of heavy blood loss, time is a critical factor because shock can set in within minutes or hours after injury—often before a patient reaches a clinic.

Blood pressure collapses, tissue no longer gets enough blood. The lack of oxygen forces tissues into anaerobic respiration, inducing lactic acidosis. Cellular sodium pumps shut down and water flows from the blood vessels into the surrounding tissues. This further reduces blood volume and exacerbates the state of shock.

In addition, inflammatory reactions set in that flood the tissue with toxic metabolites when blood flow later resumes, possibly causing multiple organ failure.

The primary intervention used in such cases is replacement of the lost fluid volume with substances such as saline solution. This requires several liters of the liquid to be warmed to physiological temperature—which is impractical outside of a clinic. The large volumes administered also dilute clotting factors and raise blood pressure, which

can lead to further hemorrhage.

For this reason, modern resuscitation strategies (Damage Control Resuscitation, DCR) purposely limit the administration of fluids and instead rely on whole blood transfusions, which reduce clotting problems, inflammation, and the mortality rate. In the field, in an ambulance or in a rescue helicopter, this remains impracticable, particularly due to low supply.

The alternatives currently under development include synthetic low-volume resuscitants (LVR), solutions that are highly effective in small amounts, such as polyethylene glycol PEG20K. These substances generate osmotic gradients that pull bodily fluids out of tissues and back into the blood vessels. This reduces the volume required for treatment and keeps blood pressure low. However, PEG20K disrupts blood clotting and can cause allergic reactions.

A team led by Nathan J. White and Suzie H. Pun at the University of Washington (Seattle, U.S.) has now developed a novel LVR. By using a special, controlled polymerization process (RAFT), they were able to synthesize many variations of methacrylate-based polymers with different compositions, molecular weights, and properties. Among these, a polymer shaped like a radiant star proved to be an effective LVR with no negative effect on blood clotting.

After loss of about 60% of blood volume in rat models, a use of 10% of this volume of the new polymer solution was able to refill the blood vessels enough to return blood pressure to the desired window and overcome shock.

Even high doses of polymer produced no observable adverse effects on blood clotting or organs, demonstrating that the new radiant star polymer is an improvement over colloidal resuscitants currently in development.

**More information:** Trey J. Pichon et al, Engineering Low Volume Resuscitants for the Prehospital Care of Severe Hemorrhagic Shock, *Angewandte Chemie International Edition* (2024). DOI: 10.1002/anie.202402078