News
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* * * * * * Unique process is making medical plastics more blood compatible.

DALLAS--A process for making plastic materials more blood compatible is being developed by a team of medical scientists at The University of Texas Southwestern Medical School. The results may revolutionize the effectiveness of plastics used in surgery, artificial organs and in containers used for the storage of blood.

Plastics implanted within the human body--artificial blood vessels and heart assist devices--along with catheters, artificial kidneys, heart-lung machines and other delicate surgical aids, have met with limited success because of natural protective mechanisms in the blood.

These synthetic devices are made of materials which cause an activation of the blood's defenses, including clotting and immune responses.

In short-term exposure to blood, i.e. minutes to hours, the plastic devices usually perform satisfactorily. But with longer term use, the plastics become coated with material from the blood, leading to clot formation. These clots at times break off with the pressure of flowing blood, and they can be trapped in vital organs. This may lead to complications, including death.

Working under an American Heart Association, Texas Affiliate grant, the research team includes bioengineering graduate student Mark Munro, who originated the idea, and his sponsoring professor Dr. Robert Eberhart, associate professor of engineering and surgery. Working with them are vascular surgeon Dr. Bruce Brink, Dr. Morton Prager of the surgery-biochemistry faculty, second year medical student Steven Ellsworth, radiologist Dr. Padmakar Kulkarni and Dr. Alfred Quattrone, formerly a faculty associate in pathology who is working as a consultant.

Research by the Southwestern team is designed to treat a broad range of plastics with a unique coating application. This may improve their blood compatibility for indefinitely long periods of time. Experimental trials of artery substitutes are now in progress in laboratory animals. Yet, according to Eberhart, much work remains to be done before the application to humans can be made. The team does agree, however, that the concept appears sound and results to date have been very promising.

The secret lies in coating the plastics with a protein, albumin, which is naturally found in the blood. This disguises the plastic and "fools" the blood into withholding its defenses. In order to keep the albumin from washing off in the flowing bloodstream, another coating is involved. This consists of a chemical analog of a free fatty acid (an analog is a chemical look-alike) which is covalently bound to the plastic.

Albumin, functioning in the blood as a carrier, picking up substances and releasing them in other areas, has a natural affinity for free fatty acids. With the fatty acid analog covering the plastic, the albumin is attracted to the analog molecules and densely covers the surface. This excludes from the surface other blood proteins which promote blood clotting and cell adhesion.

One novelty of this method is that when the surface-bound albumin molecules reach the end of their biological life, they are released from the surface, re-exposing the analog molecule covering to other blood proteins. Yet, owing to the continuing affinity of this fatty acid substitute for albumin, new albumin molecules favorably compete with other proteins, and recover the surface. This maintains the desired passivation of the plastic (passivation includes prevention of coagulation and cell adhesion to the surface).

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Without the albumin coating untreated plastics are perceived by the body as hostile and foreign materials. Eberhart explains that almost immediately after blood exposure, untreated plastics become overlayed with a film of fibrinogen and other blood serum proteins. Next, fibrinogen, a soluble protein in the blood, converts into the insoluble fibers of fibrin. These fibers proliferate as a fine network, which traps other elements in the blood, forming blood clots. As blood circulates, this accumulation of coagulated substances increases. Other proteins deposit on the surface to attract platelets (tiny blood cells) which in turn aggregate to further obstruct the blood flow.

White blood cells are also activated by contact with plastics. They deposit in such numbers that their population in the circulating blood is depleted. Since they normally function to fight off infection in the body, their preoccupation with battling the foreign plastic further cripples the body's defenses.

Material deposits from blood on untreated plastic surfaces can be measured in thicknesses up to a millimeter in long-term exposure, says Eberhart. This debris obstructs the flow of blood in artificial arteries and veins and also prevents the filtration of nutrients and metabolic wastes in artificial lungs and kidneys.

The Southwestern researchers are finding methods of coating many different plastic types--each with their own chemical properties. While they say that much testing needs to be done, the coating procedure may well produce a vastly improved success rate in application of surgical plastics which come in contact with blood.

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