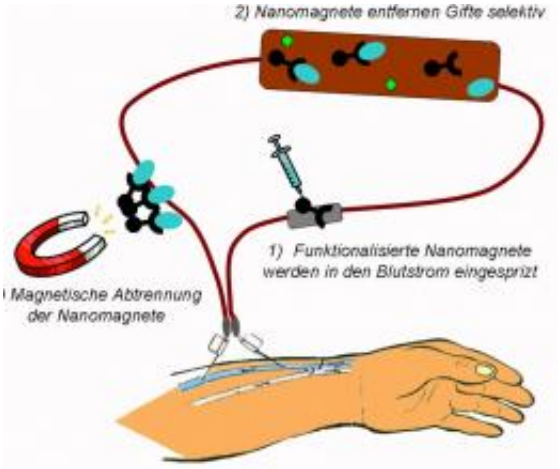
Nanomagnets purify blood

August 25 2010



The illustration shows how the nanomagnet purifier works. (Picture: ETH Zurich)

Swiss scientists have succeeded in clearing a toxin from blood in just a few minutes, using specially produced nanomagnets. The procedure appears promising. If the method can be put into practice, it could one day help people with blood poisoning quickly and efficiently.

They are just 30 nanometers in diameter, and less than a gram of them is enough to clear the blood of the entire human body of a specific toxin within a few hours: specially prepared nanomagnets. At least this is what has been demonstrated in the first in-vitro trials with human blood.

Specific magnets

In her doctoral thesis under ETH professor Wendelin Stark, Inge Herrmann from the Institute of Chemistry and Bioengineering Sciences at ETH Zurich has, in cooperation with the University Hospital Zurich, equipped the minute magnets in such a way that they can bind disease-causing substances in the blood to themselves. The scientists tested the properties of their functionalised magnets with human whole blood. Since blood has a high viscosity, they mixed relatively strong magnets with the blood by gently swinging it. In less than five minutes the magnets had almost completely bonded the corresponding toxin to themselves. “The speed with which the molecules bond to the magnets depends on their binding constant”, says Herrmann. “The higher the constants, the faster the antibody of the magnet, for example, binds to the antigen”. Following the successful procedure, the scientists “fished” the magnets out of the blood with a permanent magnet fitted to the exterior of the vessel.

“Fishing” for molecules of various sizes

The pore-free, smooth surface of the magnets has two great advantages: a great capacity for binding and good accessibility for the substances that are to be bound, the ligands. This prevents slow diffusion in pores, such as occurs with conventional methods. Another important aspect of the method is that contaminants of different sizes and weights can be removed from the blood selectively, whilst vital substances of a similar size, such as antibodies from the immune system or plasma proteins, remain in the blood.

Small molecules that can make a person ill when they are present in excess, such as urea, potassium or creatinine, are conventionally removed from the blood circulation through dialysis, filtration or absorption methods. However, the body’s own disease-causing substances or introduced toxins sometimes have molecules that are too large to allow them to be eliminated with such methods, since otherwise

vital molecules would also be lost. Up to now, the only solution has been a complete exchange of the blood plasma. If we were to succeed in putting into practice blood purification using specific magnets, the scientists are convinced that this would be a great medical breakthrough. For Herrmann, what is interesting above all is that the magnets can bond even the smallest molecules in the pico-molar range to themselves. This is particularly important in the case of proteins, which are responsible for inflammatory processes.

Promising approach

In contrast to an earlier study, in which work was conducted with about 45 times as many magnets and in which the red blood cells were destroyed, the scientists could not detect any negative effects on the physiology of the blood. Neither the red blood cells nor the blood coagulation were impaired. Fears that the magnets could release too much iron into the blood are unfounded, they say. For one thing, they are encased with a carbon shell, and for another they are very resistant to acid and temperature. And even if, in spite of everything, over half the magnets were dissolved in the blood, the amount of iron thus released would be smaller than that which is given in the case of iron deficiency.

Whether the procedure can be successfully applied to a living organism is to be tested in a subsequent stage. If so, it could be an ideal supplement to conventional treatments in the case of serious poisoning, sepsis, metabolic disorders and autoimmune diseases.

More information: Herrmann I.K. et al.: Blood Purification Using Functionalized Core/Shell Nanomagnets, *Small* 2010, 6, 1388-1392. DOI:10.1002/smll.201000438

Provided by ETH Zurich