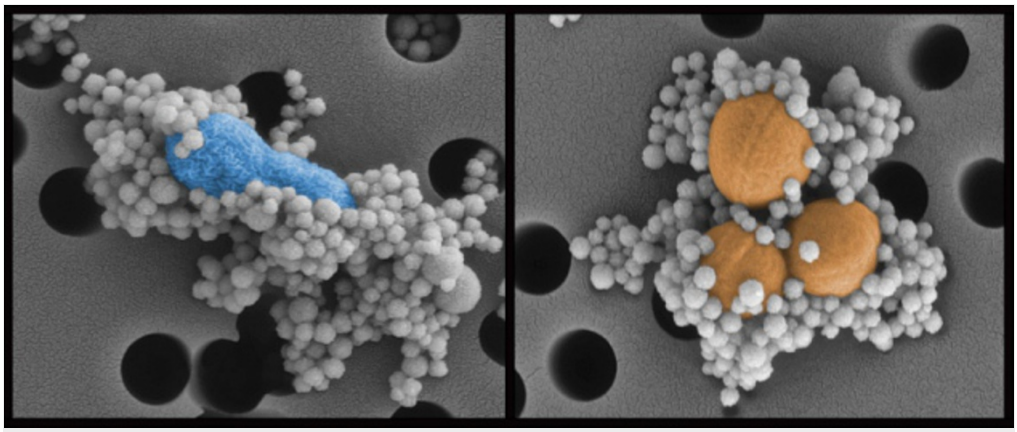
Artificial spleen cleans up blood

Device improves survival in rats after severe infections.

Sara Reardon

14 September 2014



Harvard's Wyss Institute

Magnetic nanobeads in the 'biospleen' device bind to *Escherichia coli* (left) and *Staphylococcus aureus* (right) and remove them from blood.

Researchers have developed a high-tech method to rid the body of infections — even those caused by unknown pathogens. A device inspired by the spleen can quickly clean blood of everything from *Escherichia coli* to Ebola, researchers report on 14 September in *Nature Medicine*[1].

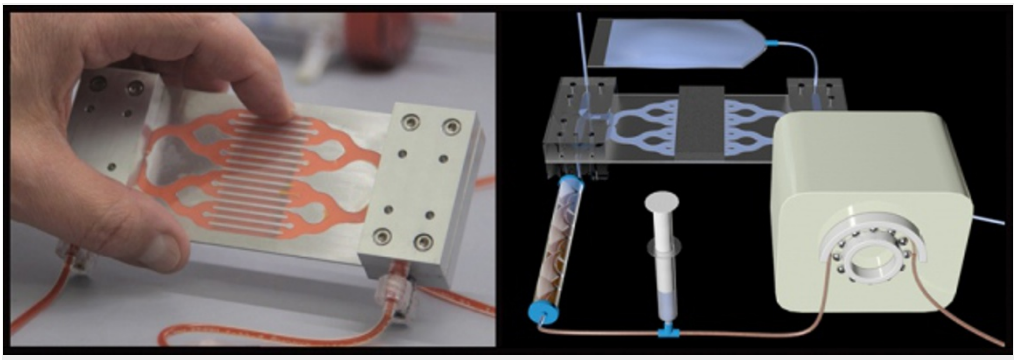
Blood infections can be very difficult to treat, and can lead to sepsis, an often-fatal immune response. More than 50% of the time, physicians cannot diagnose the cause of an infection that has prompted sepsis, and so they resort to antibiotics that attack a broad range of bacteria[2]. This approach is not always effective, and can lead to antibiotic resistance in bacteria.

In search of a way to clear any infection, a team led by Donald Ingber, a bioengineer at the Wyss Institute for Biologically Inspired Engineering in Boston, Massachusetts, developed an artificial 'biospleen' to filter blood.

The device uses a modified version of mannose-binding lectin (MBL), a protein found in humans that binds to sugar molecules on the surfaces of more than 90 different bacteria, viruses and fungi, as well as to the toxins released by dead bacteria that trigger the immune overreaction in sepsis.

The researchers coated magnetic nanobeads with MBL. As blood enters the biospleen device, passes by the MBL-equipped nanobeads, which bind to most pathogens. A magnet on the biospleen device then pulls the beads and their quarry out of the blood, which can then be

routed back into the patient.



Harvard's Wyss Institute

The 'biospleen' uses protein-equipped nanobeads and a magnet to cleanse blood of pathogens.

Spleen screen

To test the device, Ingber and his team infected rats with either *E. coli* or *Staphylococcus aureus* and filtered blood from some of the animals through the biospleen. Five hours after infection, 89% of the rats whose blood had been filtered were still alive, compared with only 14% of those that were infected but not treated. The researchers found that the device had removed more than 90% of the bacteria from the rats' blood. The rats whose blood had been filtered also had less inflammation in their lungs and other organs, suggesting they would be less prone to sepsis.

The researchers then tested whether the biospleen could handle the volume of blood in an average adult human — about 5 litres. They ran human blood containing a mixture of bacteria and fungi through the biospleen at a rate of 1 litre per hour, and found that the device removed most of the pathogens within five hours.

That degree of efficacy is probably enough to control an infection, Ingber says. Once the biospleen has removed most pathogens from the blood, antibiotics and the immune system can fight off remaining traces of infection — such as pathogens lodged in the organs, he says.

Ingber says that the biospleen could also help to treat viral diseases such as HIV and Ebola, in which survival depends on lowering the amount of virus in the blood to a negligible level. His group is now testing the biospleen on pigs.

Nigel Klein, an infection and immunity expert at University College London, says that the biospleen could also allow diagnosticians to collect samples of a pathogen from the blood and then culture it to identify it and determine what drugs will best treat it. As blood transfusion and filtration are already common practices, he expects that the biospleen could move into human clinical trials within a couple of years.

Nature | doi:10.1038/nature.2014.15917

References

1. Kang, J. H. *et al. Nature Med.* http://dx.doi.org/10.1038/nm.3640 (2014).
2. Jones, A. E., Heffner, A. C., Horton, J. M. & Marchick, M. R. *Clin. Infect. Dis.* **50**, 814–820 (2010).

Nature ISSN 0028-0836 EISSN 1476-4687