AI and aerospace models used to optimise blood flow in veins

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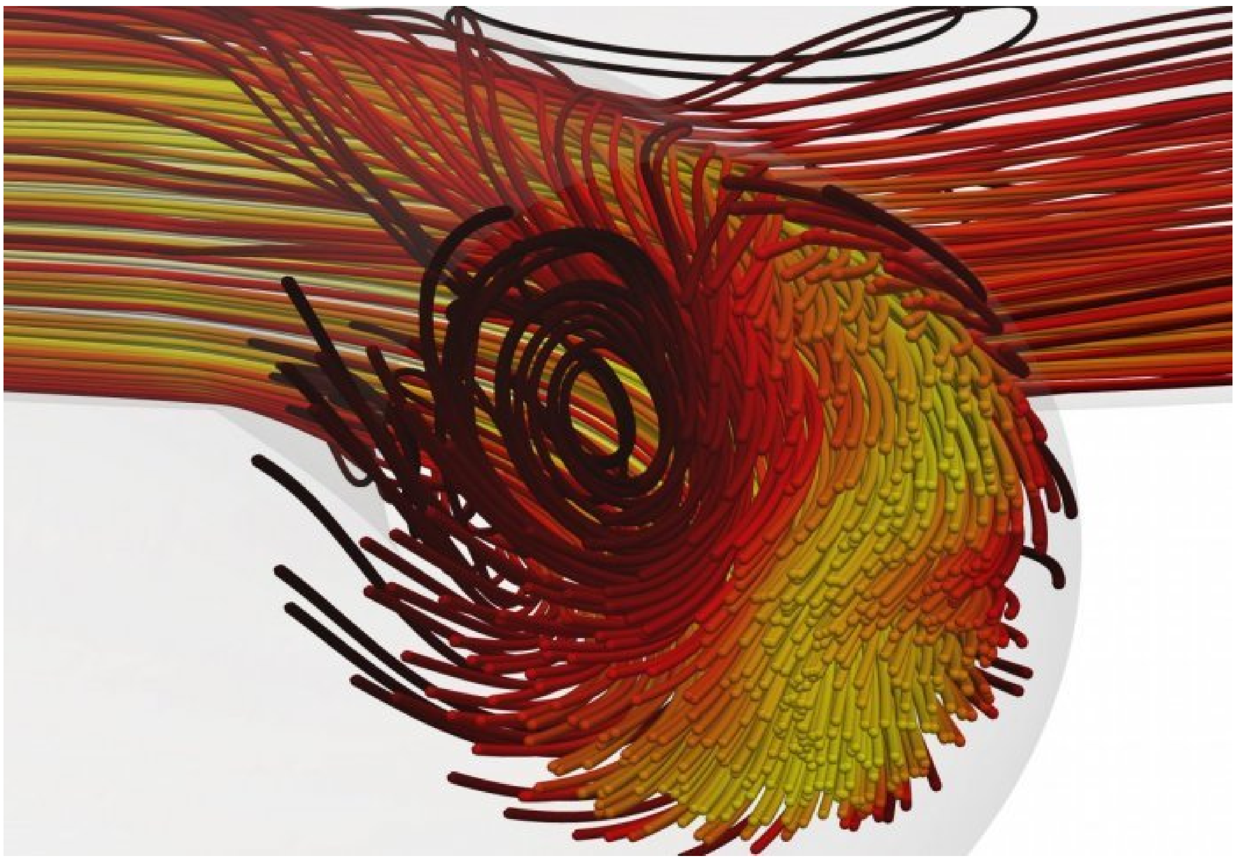

This model shows an improvement in blood flow, thanks to Imperial prototype technology. Credit: Imperial College London

Artificial intelligence has been trained to use aerospace simulation software to design a device that may ultimately improve dialysis for patients.

The team from Imperial College London and their colleagues have used computer modelling techniques - normally employed to simulate how unsteady air pockets flow over a plane - to model how unsteady currents in blood flows in the veins of patients undergoing dialysis.

The study, published in the journal *Physics of Fluids*, was carried out in conjunction with researchers from Hammersmith Hospital, Northwick Park Hospital, and St Mary's Hospital.

When the kidneys stop working properly dialysis can be used to remove waste products and excess fluid from the blood by diverting it to a machine to be cleaned. To connect this machine to the patient a special junction must be formed between an artery and a vein in the patient's wrist or upper arm. This junction is called an arterio-venous fistulae (AVF).

However, due to abnormal and very unsteady blood flow patterns, approximately 50 per cent of AVFs block up and fail within months of their creation because the artery walls inflame, which is known as intimal hyperplasia. This means patients have to undergo another procedure and in some cases repeated procedures. Often patients can run out of regions on the arm where AVF can be carried out, preventing them from using the lifesaving dialysis procedure.

The team have used modelling techniques from the aerospace industry to train a computer, using machine learning algorithms. Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

The AI then went ahead and optimised the shape of an AVF so that the unsteadiness in the blood flow could be suppressed. The prototype device that they have developed to hold the AVF in the optimal shape has so far undergone preliminary tests in pigs, which have been successful.

The next step will involve carrying out trials with pigs for several months at a time to further test the effectiveness of the AVF device. Even if these trials are a success they will be several years away from carrying out clinical trials with patients.

Dr Peter Vincent, co-author from the Department of Aeronautics at Imperial College London, said: "We routinely use computer simulations to study air flow over aeroplanes. These same techniques, can now be used to optimise medical devices, including AVF."

Dr Richard Corbett, co-author from Hammersmith Hospital, added: "Haemodialysis is a life-sustaining treatment used by millions of patients worldwide who have kidney failure. These patients are dependent on arterio-venous fistula (AVF) procedures to clean their blood. However, dysfunction and failure in the AVF is a real problem for these patients, leading to a large number of hospital admissions and extra operations.

"This technology offers great promise for these patients. By improving outcomes from AVF surgery, it could potentially reduce the need for repeated operations, which could and lead to better quality dialysis."

Ultimately, the team hopes that their prototype AVF technology could benefit other medical procedures to optimise the shape of blood vessel connections such as in heart by-pass grafts and kidney transplants.

Provided by Imperial College London