

# First synthetic organ transplant

[Article written by Fergus Walsh](#)



Synthetic trachea

**I've held a few strange body parts in my hands over the years - all I should stress, in the line of work. They have ranged from mechanical heart pumps to hi-tech prosthetic limbs.**

But none more life-like than the synthetic trachea manufactured by scientists from [University College London](#). The team, lead by Professor Alex Seifalian, have patented a nanocomposite material which was used to create the first completely synthetic windpipe.

It was transplanted into a patient whose own windpipe was damaged by cancer. The operation was done in Sweden at the [Karolinska University Hospital](#) in conjunction with the Karolinska Institute. You can read [the background to the story](#) by my colleague Michelle Roberts, who interviewed the patient and the surgeon in Stockholm.

## Pioneering

I visited the London end of this international collaboration, at the labs at the Royal Free Hospital in Hampstead, where the trachea was made.

One of the keys to the synthetic windpipe is its structure which contained millions of tiny holes. This was important during the two days that the windpipe spent in a revolving bio-reactor.

## Nanocomposite

The bio-reactor contained adult stem cells taken from the patient's bone marrow. The nanocomposite material of the windpipe had a huge surface area and its porous nature allowed it to be seeded by the patient's tissue.

In effect, a synthetic windpipe became the patient's own.

The surgery was carried out on 9th June and the patient is being discharged on Friday. Clearly, it is still early days, but if he makes a good recovery then it marks another successful pioneering step in the history of transplantation.

Professor Macchiarini summed up the importance of this new technique.

"The material can be made quickly and you have no need of a donor," he said.

"This avoids waiting. Also there is no requirement for anti-suppressant drugs."

There have been transplants before without donors. Several patients have received replacement bladders grown from their own stem cells. There have been artificial mechanical hearts which have assisted failing organs.

Three years ago Professor Macchiarini gave a woman in Spain a new windpipe which was seeded by her own stem cells. But that involved a donor windpipe which was stripped down to cartilage.

This technique does away with the need for donors and the tissue can be created rapidly in the lab.

Alex Seifalian, Professor of Nanotechnology and Regenerative Medicine at UCL, whose research is funded by the Wellcome Trust, has big plans for his synthetic tissue. He showed me a machine which, in just 20 minutes, can create a metre long synthetic tube.

"The material pulses like an artery and we can make it different diameters" he said. "We plan to use it for arteries, larger structures like aorta and it could even be used to create an ear, nose or replacement skin."

The next collaboration between Professor Seifalian and the surgeon, Professor Paolo Macchiarini, involves creating a windpipe for an 11-month-old girl from South Korea, who was born with a rare abnormality which prevented her trachea from growing.

The surgery is likely to take place in the US later this year.

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## Surgeons carry out first synthetic windpipe transplant

By **Michelle Roberts** Health reporter, BBC News, in Stockholm



The replacement windpipe was grown in the lab

Surgeons in Sweden have carried out the world's first synthetic organ transplant.

Scientists in London created an artificial windpipe which was then coated in stem cells from the patient.

Crucially, the technique does not need a donor, and there is no risk of the organ being rejected. The surgeons stress a windpipe can also be made within days.

The 36-year-old cancer patient is doing well a month after the operation.

Professor Paolo Macchiarini from Italy led the pioneering surgery, which took place at the Karolinska University Hospital.

In an interview with the BBC, he said he now hopes to use the technique to treat a nine-month-old child in Korea who was born with a malformed windpipe or trachea.

Professor Macchiarini already has 10 other windpipe transplants under his belt - most notably the world's first tissue-engineered tracheal transplant in 2008 on 30-year-old Spanish woman Claudia Costillo - but all required a donor.

## Indistinguishable

**The key to the latest technique is modelling a structure or scaffold that is an exact replica of the patient's own windpipe, removing the need for a donor organ.**

To do this he enlisted the help of UK experts who were given 3D scans of the 36-year-old African patient, Andemariam Teklesenbet Beyene. The geology student currently lives in Iceland where he is studying for a PhD.

Using these images, the scientists at University College London were able to craft a perfect copy of Mr Beyene's trachea and two main bronchi out of glass.

This was then flown to Sweden and soaked in a solution of stem cells taken from the patient's bone marrow.

**After two days, the millions of holes in the porous windpipe had been seeded with the patient's own tissue.**

Dr Alex Seifalian and his team used this fragile structure to create a replacement for the patient, whose own windpipe was ravaged by an inoperable tumour.

Despite aggressive chemotherapy and radiotherapy, the cancer had grown to the size of a golf ball and was blocking his breathing. Without a transplant he would have died.

During a 12-hour operation Professor Macchiarini removed all of the tumour and the diseased windpipe and replaced it with the tailor-made replica.

The bone marrow cells and lining cells taken from his nose, which were also implanted during the operation, were able to divide and grow, turning the inert windpipe scaffold into an organ indistinguishable from a normal healthy one.

And, importantly, Mr Beyene's body will accept it as its own, meaning he will not need to take the strong anti-rejection drugs that other transplant patients have to.

Professor Macchiarini said this was the real breakthrough.

"Thanks to nanotechnology, this new branch of regenerative medicine, we are now able to produce a custom-made windpipe within two days or one week.

"This is a synthetic windpipe. The beauty of this is you can have it immediately. There is no delay. This technique does not rely on a human donation."

He said many other organs could be repaired or replaced in the same way.

A month on from his operation, Mr Beyene is still looking weak, but well.

Sitting up in his hospital bed, he said: "I was very scared, very scared about the operation. But it was live or die."

He says he is looking forward to getting back to Iceland to finish his studies and then returning to his home in Eritrea where he will be reunited with his wife and young family, and meet his new three-month-old child.

He says he is eternally grateful to the medical team that has saved his life.