NTU INNOVATIONS LOOK SET TO REVOLUTIONIZE BIOMEDICAL TREATMENT

Two recent innovations by the School of Materials Engineering, Nanyang Technological University (NTU), look set to revolutionize biomedical treatment.

The first innovation is probably the world’s first multiple drug-eluting biodegradable stent for use in any part of the body where fluid flow, including blood, is disrupted.

The second, also believed to be a world-first, is a frictionless micro-pump that combines patented technologies of the School of Materials Engineering at NTU and the Dept of Bioengineering at the California Institute of Technology (Caltech). Both NTU and Caltech are forming a company in California to exploit the commercial value of this device, which boosts blood flow.

Two separate teams of researchers and students at NTU worked on these projects.

Says Prof Freddy Boey, Acting Dean of NTU’s School of Materials Engineering, “We at NTU are grateful for the exciting and fulfilling experience of developing innovations that we know will not only help prolong human life but enhance it. This fact alone has been the greatest motivation for the NTU project teams.”

“Of course, we are also very happy to have an excellent working relationship with leading universities like Caltech. Other universities that our school collaborates with include MIT, UCLA and UT Austin in the USA, Fudan in China and Montpellier in France.”
“It has been a privilege leading dedicated NTU staff members and students in the two projects and we are happy that the work we have done will place NTU prominently on the global biomedical map.”

**Multiple drug-eluting biodegradable stent**

Stents are devices that address blockages. They are used in various parts of the body such as coronary arteries, the ureter and bronchial tubes.

Present day stents, including the recently announced metal-coated stents, are permanently implanted into the patient, making them a liability as they can interfere with medical diagnostic tests, such as an MRI test.

The permanent presence of metal stents can also cause a re-closure of the blood vessel. This is because the stent itself causes injury to wall tissues, resulting in the profuse growth of cells at the site and inadvertently resulting in the fatal re-closure of the vessel.

The bio-incompatibility of metal stents can also cause blood clotting, again resulting in a fatal outcome. To treat this, a daily dose of several drugs is required. However, current coated metal stents can only deliver a small amount of a single anti-proliferative drug. They cannot deliver the other required anti-clotting drugs.

To address the above problems, NTU has developed a new generation multiple drug-eluting biodegradable stent. Research has shown that a stent is only required to be implanted in a patient for up to six months.

The new generation NTU stent is biodegradable and capable of multiple drug release over a sustained period from a few days to several months. The stent can also release drugs at whatever rates and profiles a doctor may prescribe for optimal treatment. In fact, the stent can even be designed to release different drugs at different stages.

The NTU stent can thus simultaneously and effectively prevent both blockage and clotting.

Key to the development of this new generation stent is a technology developed by Prof Boey and Assoc Prof Subbu to produce a stent made up of multiple layers of drugs containing biodegradable polymer films.

The professors took about two and a half years, starting from 2001, to develop the stent, together with about five other staff members and eight undergraduate and graduate students.
The team is now working extensively with both local organizations and major biomedical companies in the United States to commercialize the device.

The stent can be used for coronary applications, cranial applications, urological applications and bronchial applications.

The team from NTU is in the process of forming a company to realize the commercial value of this new generation stent. Already, they have and are signing commercial agreements with major biomedical companies for these four categories of applications.

One of the world’s biggest multinational biomedical companies has signed a commercial agreement with the NTU team to use the stents for coronary applications.

Prof Boey and Assoc Prof Subbu are also working with Dr Chia Sing Joo, Head of the Department of General Surgery and Urology at the Tan Tock Seng Hospital on the application of stents for urological applications.

A local company funded by the EDB has signed a commercial agreement with NTU for a specific application, and a US biomedical company is negotiating with the NTU team for the fourth application.

Says Prof Boey, “We are proud that this new generation multiple drug-eluting biodegradable stent is developed entirely at NTU. I am thankful to our NTU students and staff members who provided the passion and drive to create an innovation that I believe will enhance the quality of many people’s lives.”

**Frictionless micro-pump**

In an exciting development, the School of Materials Engineering at NTU and Caltech’s Dept of Bioengineering have married their respective technologies to produce what is believed to be the world’s first frictionless micro-pump for biomedical applications.

The device combines a Caltech-patented design for a pump that requires no diaphragms, impeller or any friction-causing moving parts, with NTU’s patented technology for a highly efficient and lightweight PZT micro-pump.

The result is a device that is not only light in weight but also made up totally of biocompatible materials which will elute drugs to significantly reduce bio rejection and blood-clotting problems.
This biocompatible device is small enough to be inserted into small capillaries. It acts simultaneously as both a stent and a pump, helping to boost blood supply to parts of the bodies suffering from blood depravation.

Like the multiple drug-eluting biodegradable stent, the micro-pump has many applications. They include its use as a micro-pump for kidney perfusion, a blood oxygenator device for dialysis machines and a device for the delivery of implanted drugs for pain management.

The pump may be used in any patient suffering from localized blood starvation e.g. diabetics with peripheral artery disease who face the risk of blood starvation leading to gangrene and amputation.

The pump is also expected to be instrumental in the treatment of Hydrocephalus in which there is excess fluid in the brain. Hydrocephalus occurs in patients with head injuries and is also associated with new born babies.

The professors behind this innovation are Prof Boey and Assoc Prof Ma Jan from the School of Materials Engineering at NTU, and Prof Mory Gharib, Head of the Bioengineering Department at Caltech.

The professors got together to work on the frictionless micro-pump in January 2003. A team of about five staff members led by Prof Gharib worked on the project in Caltech while a team of seven staff members and about five undergraduate and graduate students worked on the project at NTU. Of the five NTU students, one worked in Caltech with Prof Gharib for several months.

Professors Boey, Ma and Gharib are now in the process of starting a company to fully exploit the commercial value of their innovation. This company will be based in California in the United States. Already, the start-up has received major commercial support from a Californian biomedical company.

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