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Chemical Guided Missile Could Be the Answer to Wiping out Cancer

Deakin University medical scientists have created the world's first cancer stem cell-targeting chemical missile, placing them a step closer to creating a medical 'smart bomb' that would seek out and eradicate the root of cancer cells.

The Deakin researchers have worked with scientists in India and Australia to create the world's first RNA aptamer, a chemical antibody that acts like a guided missile to seek out and bind only to cancer stem cells. The aptamer has the potential to deliver drugs directly to the stem cells (the root of cancer cells) and also to be used to develop a more effective cancer imaging system for early detection of the disease. Their discoveries have been published recently in an international cancer research journal, *Cancer Science*.

The Director of Deakin Medical School's Nanomedicine Program, Professor Wei Duan, said the development of the aptamer had huge implications for the way cancer is detected and treated.

"Despite technological and medical advances, the survival rates for many cancers remain poor, due partly to the inability to detect cancer early and then provide targeted treatment," Professor Duan said.

"Current cancer treatments destroy the cells that form the bulk of the tumour, but are largely ineffective against the root of the cancer, the cancer stem cells. This suggests that in order to provide a cure for cancer we must accurately detect and eliminate the cancer stem cells."

The aptamer is the first part of the 'medical smart bomb' the researchers have been developing.

"What we have created is the 'guided missile' part of the 'smart bomb,'" Professor Duan explained.

"The aptamer acts like a guided missile, targeting the tumour and binding to the root of the cancer.

"The aim now is to combine the aptamer with the 'bomb' (a microscopic fat particle) that can carry anti-cancer drugs or diagnostic imaging agents directly to the cancer stem cells, creating the ultimate medical smart bomb."

Professor Duan said the medical smart bomb opened up exciting possibilities for detection and treatment of cancer.

"The cancer stem cell-targeting missile and the smart bomb could revolutionise the way cancer is diagnosed," he explained.

"The minute size of the aptamer means it could locate cancer cells in their very early stages. Attaching radioactive compounds to the aptamer could lead to the development of sensitive diagnostic scans for earlier detection, more accurate pinpointing of the location of cancer, better prediction of the chance of cure and improved monitoring of the response to treatment.

"More accurate identification of the type of cancer present would lead to more personalised treatment that is more successful and cost-effective.

"This could ultimately lead to better cancer survival rates and greatly improved quality of life for patients."

More About the Project

The project is a collaboration between Deakin University's School of Medicine and Institute for Technology Research and Innovation and the Indian Institute of Science in Bangalore, Institute of Life Science along with Barwon Health's Andrew Love Cancer Centre and ChemGenex

Pharmaceuticals. It has received \$700,000 funding from the Federal Government's Australia-India Strategic Research Fund, with reciprocal support from the Indian Government.

Cancer cells are made up of many cells that have different characteristics. They are, for example, like a tree with some cells being the root system and the others the branches and leaves; if you cut off the branches and leaves, the root of the tree is still alive. Current cancer treatments are ineffective in eradicating the whole cancer cell because they only kill the branches and leaves. The root cells are particularly tough and resistant to drugs and radiotherapy. They possess drug pumps that pumps out the anti-cancer drugs. This means that, while most of the cancer cell is killed, the cancer root remains and can regenerate. This makes the root cells (cancer stem cells) an important target for new cancer treatments.

There are two parts to the project being undertaken by the Deakin and Indian scientists.

The first is building the guided missile, or aptamer. The aptamer is a chemical antibody, much smaller and cheaper and easier to make than conventional antibodies, designed to bind specifically to cancer cells. It has been designed to effectively penetrate a tumour and specifically target

cancer stem cells. This missile will carry the 'bomb'; the second part of the drug delivery system.

The 'bomb' will be a very smart lipid, or fat particle that will remain stable in the body, i.e. it will not break down. This particle will carry the anti-cancer drug as well as anti-cancer genes.

When combined, the 'smart bomb' will be injected into the body and find the cancer cell. It will then enter the cell through an endosome route -- a small road within the cell. Once inside the cell, it will very quickly release its contents and kill the whole cancer cell.

A unique part of the system being developed is that the bomb is very stable outside of the cancer cell, but once inside it will very quickly release its contents and kill the cancer cell from within. This system is made by materials that are very human compatible and human degradable -- it is not toxic to other cells in the body and would cause very limited side-effects.

Source: Sarah Shigdar, Jia Lin, Yan Yu, Mile Pastuovic, Ming Wei, Wei Duan. An RNA aptamer against a cancer stem cell marker epithelial cell adhesion molecule (EpCAM). *Cancer Science*, 2011; DOI: 10.1111/j.1349-7006.2011.01897.x