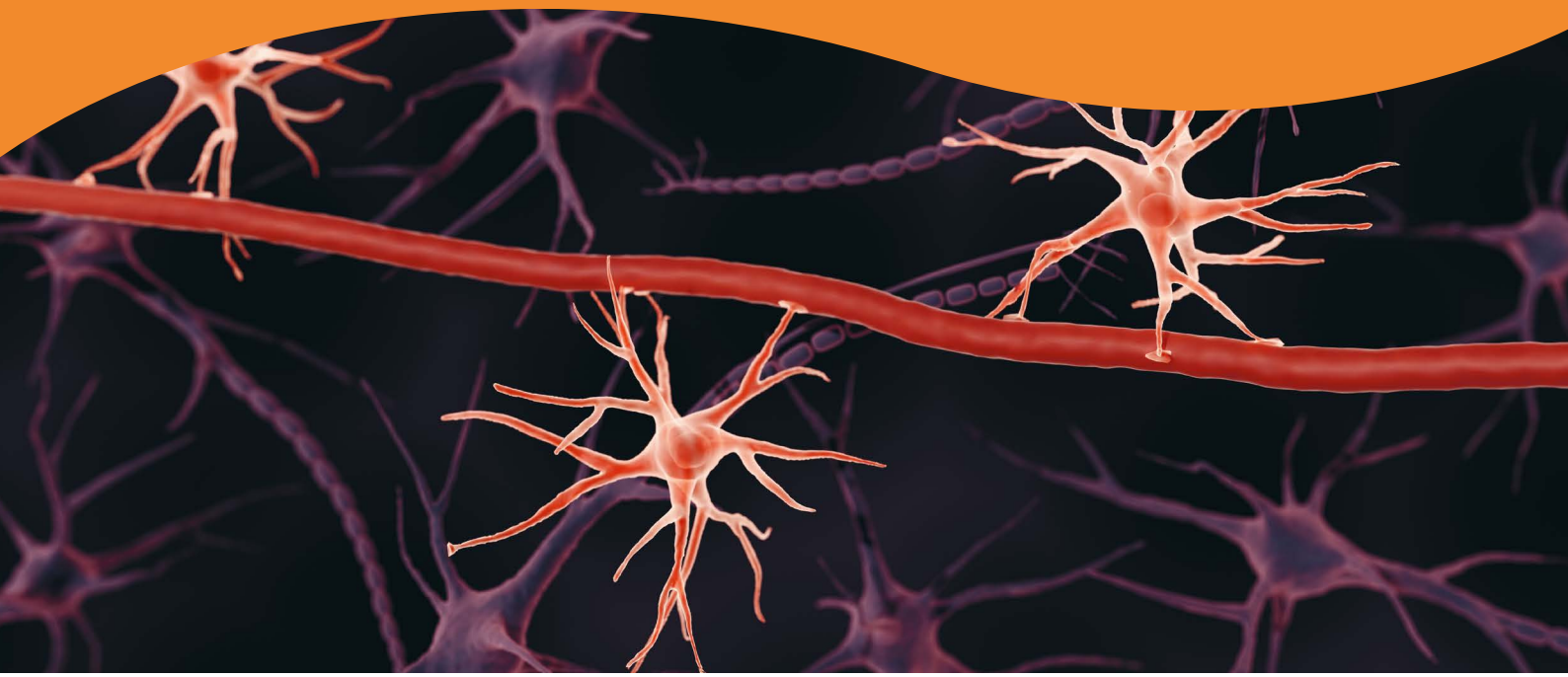
Research Milestone
By Professor Perminder Sachdev AM

Dementia Australia™ Research Foundation



Nanotechnology delivers Alzheimer's disease treatments across the blood-brain barrier

What was the focus of the research?

Bringing together clinical neuroscience and nanoscience to transform the diagnostics and therapeutics of Alzheimer's disease.

Why was it important?

Alzheimer's disease is a devastating neurodegenerative disease. The brain degeneration that occurs affects memory, thinking, emotions, behaviour and mood. A person's ability to carry out daily activities becomes impaired, as does their language, attention and judgement. As the disease progresses, symptoms worsen, and their abilities decline further.

Memory of recent events is often the first to be affected, but as the disease progresses, long-term memory is also lost. This causes untold heartache for family and friends. Even more devastating is that there is currently no treatment to prevent or modify the course of Alzheimer's disease.

What is the blood-brain barrier?

A specialised part of the vascular system that stops bacteria, toxins and other harmful substances from entering the brain. The barrier lies between the brain's blood vessels and other tissue. It acts as a roadblock for any nasty substances floating around in the blood that want to enter the brain. While it's a fantastic security system, unfortunately, in the case of neurodegenerative diseases, it prevents drugs and other substances from reaching the parts of the brain where they are needed.

There are numerous obstacles in the effort to find effective treatments or a cure. Professor Sachdev believed that two of those obstacles – early diagnosis and drug delivery – can potentially be overcome with the latest developments in nanoscience.

The use of nanotechnology in neuro-medicine offers exciting possibilities and Professor Sachdev's research may revolutionise the way Alzheimer's disease is detected and treated in the brain. Delivering drugs across the blood-brain barrier has been a major challenge in many neurodegenerative conditions. However, nanotechnology, which is a science based on manipulating matter at the nanoscale, may offer a solution.

The nanoscale is a very tiny scale that measures only one-billionth of a metre. At this level, unique phenomena are possible, because this is the scale of molecules. By manipulating molecules, Professor Sachdev's vision was to piggyback treatments and magnetic imaging properties onto nanoparticles, which can cross the blood-brain barrier and bind to diseased sites in the brain. He hopes to uncover new pathways for diagnosis via magnetic resonance imaging (MRI) and the development of effective treatments for Alzheimer's disease.

How did this happen?

Stage 1: developed nanoparticles with special magnetic properties as imaging agents to allow early diagnosis of Alzheimer's disease through imaging scans like MRI and magnetic particle imaging (MPI). Magnetic nanoparticles were specially manufactured at the University of New South Wales and shown to give a good signal on MRI and MPI.

Stage 2: tagged the nanoparticles with monoclonal antibodies (lab-created immune system proteins) that have been shown to target dementia-specific plaques. Injected the nanoparticles into the brains of mice with these plaques. They moved across the blood-brain barrier without causing toxicity.

What were the results?

- Successfully attached monoclonal antibodies to magnetic nanoparticles, which crossed the blood-brain barrier in mice.
- Those antibodies were shown to detect and bind to Alzheimer's disease plaques in mice brains.
- MRI of the mice brains was able to detect these magnetic nanoparticles and the plaques.

What does this mean for dementia research?

- The chance of faster and more accurate diagnosis of Alzheimer's disease using MRI. This can potentially be extended to other dementias.
- New avenues to develop treatments that cross the blood-brain barrier.
- Professor Sachdev's next step is to demonstrate the feasibility of this technique in humans.

Who undertook the research?

Professor Perminder Sachdev AM, University of New South Wales

Perminder Sachdev AM is Scientia Professor of Neuropsychiatry at the University of New South Wales, co-director of the Centre for Healthy Brain Ageing and clinical director of the Neuropsychiatric Institute, Prince of Wales Hospital, Sydney. Professor Sachdev was NSW Scientist of the Year for Biomedical Sciences in 2010, and appointed Member of the Order of Australia in 2011 for his service to medical research in the field of neuropsychiatry. He was awarded the prestigious Ryman Prize in 2022 for *the world's best discovery, development, advance or achievement that enhances quality of life for older people*.

The title of Professor Sachdev's project is *Nanotechnology for the diagnosis and treatment of neurodegenerative disorders.*

Professor Sachdev and Dementia Australia Research Foundation would like to acknowledge the support of the Yulgilbar Alzheimer's Research Program in making this research possible.