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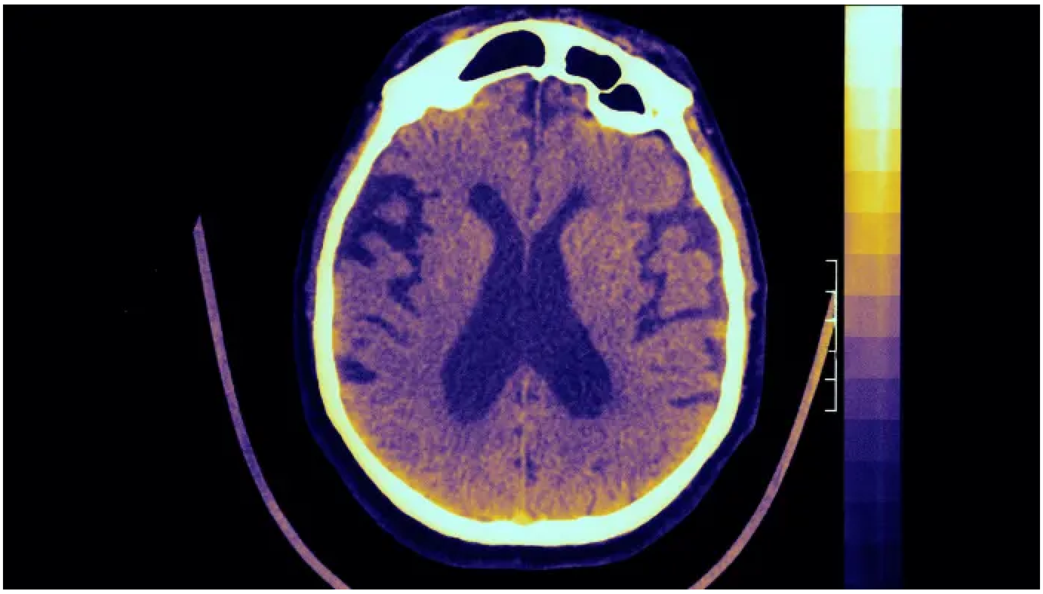
Neurotechnology holds the key to a healthy ageing population in 2050

Advances in brain science and technology needed to tackle diseases of the elderly

CLIVE COOKSON



As the world's population ages there will be more patients with currently incurable neurodegenerative diseases © Universal Images Group via Getty

Clive Cookson, Science Editor SEPTEMBER 12 2019

If we use history as a guide, it is unlikely that we will see a glorious transformation of all medicine over the next 30 years. The generalisation coined by the American futurist Roy Amara — that we tend to overestimate the effect of a technology in the short run and underestimate its effect in the long run — certainly applies to healthcare and the life sciences.

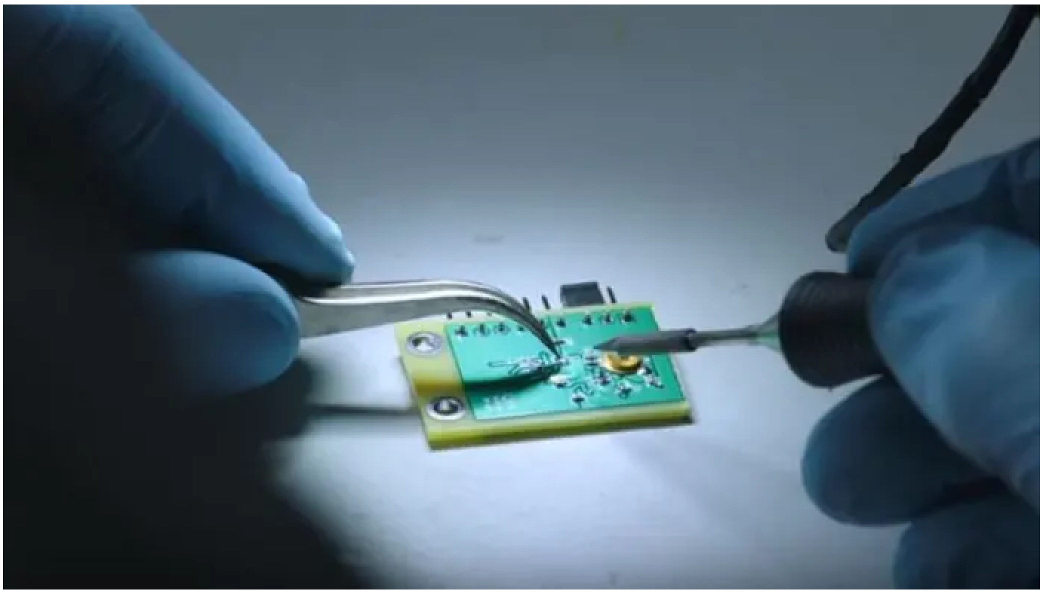
The field in which big advances are most urgently needed is brain science and technology. This is because the world's rapidly ageing population will increase the number of patients with currently incurable neurodegenerative diseases. The UN predicts that by 2050, 16 per cent of us will be over the age of 65, up from 9 per cent of this year's population.

Two broad avenues of brain research are converging to give hope for the future, though bearing in mind Amara's law, it is hard to predict what will come to fruition when. One is based on electronics, physics and information technology, the other on biology and neuroscience.

The first route uses brain-computer interfaces (BCIs) to link neurons to the outside world. The crude devices available today are one-way information carriers. They record neural activity to drive an external device, such as robotic arms or even the patient's own limbs to bypass a spinal cord injury. Or they emit electrical signals to stimulate activity within the brain, for example to treat Parkinson's symptoms.

Far more delicate devices, now under development, will have enough bandwidth to provide rapid, two-way communications between the brain and outside world. With such a powerful interface, it may be possible to revitalise failing brains by exchanging information and strengthening memory via a computer or AI machine.

One example of technology already under development is "mesh electronics" from Charles Lieber's lab at Harvard University. This injects a dense network of electrodes that mimics the cellular structure of neurons and their associated cells into the brain. Another is Elon Musk's Neuralink company whose microsurgical robot inserts electrodes through small holes in the skull and then weaves them through the brain in flexible threads, each thinner than a human hair.



Tech tonic: Neuralink is one company working on brain-computer interfaces © Neuralink

But this technology would not stop the underlying neurodegeneration, which requires biological intervention. Regenerative medicine uses a variety of methods, such as cell and gene therapy, to stimulate regrowth of human tissues and organs which are failing through injury, disease or old age.

For the brain this could involve inserting new neurons or even a "mini-brain", grown in the lab from the patient's own cells and genetically edited to have the best chance of thriving and taking over from the diseased cells.

If advanced neurotechnology of this sort — electronic, biological or a hybrid of the two — is in use by 2050, it is hard to imagine a bigger change in medical practice. But much healthcare in 2050 will probably remain familiar to those who remember 2020.

Indeed, looking back 30 years, much healthcare remains unaltered from 1990, in spite of quick and notable progress in select areas.

While family doctors refer to a computer rather than paper record, the format of most visits to general practitioners today — including the instruments and techniques used to examine patients — is rooted in the late 20th century. People have talked about using gene-based tests and artificial intelligence (AI) to diagnose conditions for years, but they have not yet reached GP surgeries.

Likewise, hospital wards may look much the same but the specialist equipment available to doctors has come a long way with physicians able to see inside patients with the likes of magnetic resonance imaging (MRI) .

By 2050 genetic testing will be pervasive, allowing physicians to personalise treatment for each individual

Specialists can also call upon a new generation of drugs based on antibodies and knowledge of the immune system, transforming the treatment of some cancers and autoimmune conditions.

But even within specialist care, some areas have been slow to develop. There has been little progress in developing new antibiotics to replace old ones as microbes develop resistance to them.

Nor has there been much progress in treating degenerative brain disorders, from motor neurone disease to Alzheimer's.

The promise of the human genome project, which delivered a first readout of our DNA almost 20 years ago, has arrived slowly because understanding the genetic code has proved to be more of a challenge than optimists expected. Now however, we are just getting to the point where genomes can be analysed cheaply and quickly enough to be useful for diagnosing cancers and rare genetic diseases.

Work on this will continue and by 2050 genetic testing will be pervasive, allowing physicians to personalise treatment for each individual. Doctors will be able to modulate patients' immune systems selectively so that wanted additions, such as transplanted tissues, are not rejected, while autoimmune disease is controlled and unwanted tumours are destroyed.

If looking back to 1990 is a good starting point for considering how medicine and healthcare might change over the next 30 years, it suggests that answer will be patchily.

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