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CHAPTER 5

Health Science

Peter C. Doherty
Laureate Professor, Department of Microbiology and Immunology, University of Melbourne, and St Jude Children's Research Hospital in Memphis

Fiona Stanley
Distinguished Research Professor at the University of Western Australia and Vice Chancellor's Fellow at the University of Melbourne

Michael Good
NHMRC Australia Fellow and Professor at Griffith University

The evidence is clear that programs that improve the health and wellbeing of pregnant women and the healthy development of their offspring create future wealth and prosperity for the society.

A healthy future? Let's put medical science under the microscope

Peter C. Doherty
University of Melbourne

Contributors: Fiona Stanley[1] and Michael Good[2]
[1]*University of Western Australia*
[2]*Griffith University*

The past is prologue, or so we should hope for biomedical research.

Australia has a proud history with four Nobel Prizes for Physiology or Medicine given for work done here. In particular, the 2005 award to Perth gastroenterologist Barry Marshall and pathologist Robin Warren for establishing that *Helicobacter pylori* bacteria cause the dyspepsia and ulcers that predispose to stomach cancer, recognised a discovery that had an immediate effect on human wellbeing.

Apart from decreasing suffering and improving health outcomes, that single finding massively diminished medical costs worldwide by substituting a short course of antibiotics for life-long pill popping.

Otherwise, a major problem with new treatments, particularly those involving the repeat administration of proteins such as monoclonal antibodies (for cancer, rheumatoid arthritis and so on) is the massive expense involved.

Dealing with the question of 'who pays?' in the public arena over the next ten to 15 years is likely to involve both considerable angst and a need for strong and consistent national leadership that is informed by the best possible evidence.

In this context, it's important to bear in mind that the cost of biomedical research, whether it is laboratory-based or in the sociology/behavioural sphere, is minuscule compared to the dollar amounts required for health care delivery.

In general, government funding for research is under ever-increasing pressure. If we want to derive economic benefit from science, we can't expect others to 'roll over' and allow us to exploit their science. We must cut our own track.

Our own devices

Historically, Australia has had big hits in the medical devices area. In general, the regulatory costs for bringing gadgets to the market are considerably less than those required to license a new drug or vaccine.

Whether or not Australian innovators win the race to build a bionic eye — early prototypes are currently implanted in three individuals — there are many other possibilities for cross-fertilisation between physical scientists, engineers and biomedical/clinical researchers.

Most will be aware that:

- research led by Prime Minister's Prize Winner, Brisbane's Ian Frazer, led to the Gardasil vaccine that prevents the majority of cervical cancers — an effort which, with initial help from our vaccine and blood products company CSL, has led to substantial royalty income flowing back here
- Australia's leading science award also went to the Melbourne and Canberra based developers of Relenza, one of the world's first 'designer' drugs and the first specific treatment for influenza
- the same goes for the Walter and Eliza Hall Institute (WEHI) team that discovered the cancer regulatory

> protein Bcl2, the target for a very promising anti-leukaemia drug that is currently in trial here and may well have emerged as a major therapeutic by 2025. The basic role of Bcl2 was defined more than 20 years ago, highlighting the long lead-time between discovery and practical application that characterises biomedical innovation.

On the vaccine front, there are a number of federally funded initiatives — National Health and Medicine Research Council (NHMRC) and the Australian Research Council (ARC) — aimed at developing novel vaccines and therapeutics combining, for example, the insights of researchers focused on influenza or HIV/AIDS with the expertise of physical scientist working in areas such as nanotechnology.

By 2025, the advances that emerge from such broad screening programs such as the Australian-initiated and led Human Variome Project will have likely led to greatly improved diagnostics and will hopefully be enabling the transition to more precisely targeted therapies for, say, particular subsets of cancers. Here we are talking optimally about small molecules, or drugs.

That's one of the many reasons why medical research needs the analytical possibilities provided by the synchrotron and the Australian Nuclear Science and Technology Organisation (ANSTO) nuclear reactor.

New threats and challenges

Although we don't currently have malaria in this country, Australian researchers are at the cutting edge of the global effort to develop a vaccine. This has attracted major funding from the US National Institutes of Health (NIH; equivalent to our NHMRC) and from the Bill and Melinda Gates Foundation.

As we move more people into our north, and the vector mosquitoes migrate south with global warming, the viral encephalitis and malaria, which currently kill about 500,000 children a year, may become a much greater problem for us.

With the enormous advances in both medicine and surgery that have so diminished the toll of coronary heart disease, Australians are, like people across the planet who have the good fortune to be born into advanced societies, living longer and better lives.

The downside is, though, the increased incidence of degenerative neurological disease. Extrapolating Alzheimer's disease incidence figures to 2025 and beyond shows that, unless there is some breakthrough in prevention and/or therapy, the costs in terms of both health dollars and human suffering will be appalling. Research done in Melbourne and Perth has refined the use of positron emission tomography (PET) scanning for preclinical diagnosis.

This is by far the biggest medical problem facing us and, if novel therapeutics do not provide a solution (likely by delaying onset), we must find the moral and political integrity to face very difficult and contentious issues related to quality of life and end of life.

Regrettably, though we may think of ourselves as a great sporting nation, Australia ranks at the high end in the global obesity pandemic. Australian research on possible causes (and treatments for) the associated type II diabetes problem is recognised as world-class, but we also need better mechanisms for tackling the underlying dietary and psychological issues.

The quality of Australian research and clinical practice in the infectious disease area, combined with successive governments that were willing to take a pragmatic approach, led to Australia being enormously effective in stemming the toll of the horrific HIV/AIDS pandemic.

Now with the success of HIV drug treatment, there is a disturbing increase in the incidence of this, and other sexually transmitted diseases. How do we get everyone to focus on the idea that each of us is responsible for our own basic health? How do we persuade all parents to vaccinate their children?

Badging biomedical R&D

While science aimed at discovery and illuminating basic mechanisms may, at times, seem 'blue sky', it is a fact that the current era of molecular medicine is particularly suited to the rapid translation of new findings for human benefit.

Important problems in medicine are increasingly solved by teams that go beyond the expertise of physician-scientists, biomedicine PhDs, research nurses and other allied medical professionals, to draw on the talents of engineers, mathematicians, chemists, physicists and social scientists.

From the aspect of funding and policy, the NHMRC, the ARC, the Cooperative Research Centres (CRCs), ANSTO and the CSIRO should be thought of as intimately entwined in the national enterprise we badge as biomedical R&D.

Australia's research universities and affiliated institutes bring all these skill sets together and, apart from their primary role in our international education 'industry', are major drivers of innovation.

When it comes to promoting a high technology society, maintaining the health of our education system is paramount, at every level.

Commentary by Fiona Stanley

The sciences of epidemiology, neurosciences and child development come together to explain how genes and environments, interacting from conception onwards, influence the health, wellbeing and capacity of humans throughout their whole life course.

The evidence is now clear that human capability (defined as the competencies to participate effectively in civil society) is enhanced if the pathways from conception and particularly in early childhood are positive, nurturing, include good nutrition and avoid excessive, damaging stress and toxic exposures such as alcohol, lead or mercury.

As well, the pathways to many non-communicable diseases such as diabetes, obesity, cardiovascular disease, mental health problems and maybe some cancers, also commence in-utero and are strongly influenced by childhood risk factors.

The knowledge from this collaborative group of sciences could be applied to:

1. positively enhance the capacity of Australia's workforce and economic success
2. reduce the considerable amounts of the health, mental health, prison and welfare budgets that are increasingly being spent on preventable conditions and problems.

The evidence is clear that programs that improve the health and wellbeing of pregnant women and the healthy development of their offspring create future wealth and prosperity for the society.

Commentary by Michael Good

No major problem in medicine is specific to Australia. An issue in disadvantaged peoples everywhere, the high incidence of rheumatic heart disease in some indigenous communities, is of major concern.

Infection with group A streptococci can lead to simple infections, which if untreated can give rise to far more serious conditions. Rheumatic heart disease is one such condition which is an autoimmune disease affecting a number of tissues, but which exerts its major and lifelong pathology in the heart, leading to valve scarring and heart failure.

Our Aboriginal and Torres Strait Islander populations suffer the highest reported rates worldwide leading to hundreds of young lives lost. Worldwide, near 500,000 lives are lost each year due to streptococcal pathology.

The autoimmune nature of rheumatic heart disease has made vaccine development extremely challenging — we don't want a vaccine to actually cause disease — so our approach has been to define an absolutely minimal streptococcal sequence (only 12 amino acids) which is the target of protective antibodies and which is found on all strains.

Vaccination with this peptide, referred to as J8, can protect mice from all the strains that we have examined (including strains recovered from Australian patients). We are now completing a Phase I pilot vaccine study in volunteers in Brisbane. The preliminary data are very encouraging, and we are currently planning larger follow-up trials in Australia and overseas.