NSW Research: a Prescription for Health

Report of a review commissioned by the Minister for Science and Medical Research, the Hon Frank Sartor MP

March 2004

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Executive summary

Medical and health research: the global commitment

Australia invests less in science and innovation than many other OECD countries, relative to GDP. In particular, R&D investment by Australian business lags behind the international norm.

Of the relatively few areas of strength in Australian science and innovation, the main one, by many measures, is medical and health research. It accounts for approximately one third of Australia's total scientific publications.

The benefits of medical and health research are multifaceted. Medical and health research has been a major contributing factor to the twenty-year increase in life expectancy over the last century. It is difficult to put a price on good health or longer life, but the benefits of improved wellbeing and greater individual productivity are immense.

In addition, the rapid development of new biomedical and biotechnology industries presents a unique opportunity. The economic benefits of these sectors are directly derived from top-quality medical research. Massive international investment is being made by competitor countries, including many that have started well behind Australia in their scientific and research capacity. Their intent is to develop critical mass in biomedical research and biotechnology, reaping not only the direct health benefits but also the commercial benefits. Australia must not miss the opportunity. It is in our interests to foster and augment our strength in medical and health research. As Australia's largest state, the contribution that NSW makes will be critical.

Medical research is a global activity. If developed countries like Australia wish to gain access to the outcomes of medical research, they should rightly contribute to the research effort. Australia benefits from it. A substantial research capacity ensures that Australia has ready access to discoveries made abroad, and can assess them and rapidly incorporate them into practice. Australia needs a research capacity to address health problems that occur frequently in our own environment. If we have the leading edge in solving these problems, we not only benefit the Australian population, but also make a contribution to international knowledge.

Fundamental to NSW is the role of clinical research within the hospital system. Research has broad benefits for hospitals and health systems. It infuses health-care institutions with a philosophy and ethic of critical inquiry, which in turn attracts and helps to retain the best clinicians, thereby fostering best practice. Public-health research and health-services research are directed to the priorities of the health system: improving the health of the population and the organisation of health services for the efficient delivery of high-quality, safe and effective health care. Yet the estimated level of funding for Area Health Service-based research, including clinical research, has halved over the last eight years as a proportion of the NSW Department of Health Teaching and Research Program budget.

The economic potential of Australian medical and health research is often untapped

Most research outcomes are still treated as a public good, to be shared globally. This is changing. Worldwide, researchers are becoming more inclined to claim intellectual property (IP) as private property. Whether that is a desirable trend for humanity is not really the issue.

Australian researchers have tended to be less focused on the intellectual property potential of their discoveries, perhaps for altruistic reasons. We secure only one-fifth of the average number of patents for a given number of publications. Nationally we can expect to incur increasing costs for providing high-technology medical care, on which the Australian people place high expectations. We have to do more to capture the economic potential of our own creativity and generate the means with which to afford the creativity of others.

This is as true of research undertaken within the public sector, including NSW Government funded research, as of private sector research. NSW is finalising a policy for the management of IP arising from R&D in public-sector entities. In our view, it is important to formulate and adopt a policy that actively encourages researchers to secure IP rights, and rewards them for doing so.

Research is generally aligned with State and national health priorities

NSW has a very substantial medical and health research capacity, and its efforts are generally aligned well with State and national health priorities. There is evidence of increasing research collaboration within and across institutions – within the State, nationally, and internationally. NSW has strong research groups in biomedical research (e.g. vascular biology, atherosclerosis, experimental neurology, immune responses, and breast and prostate cancer); substantial strengths in clinical research (e.g. mental health, kidney disease, liver disease, and clinical trials); public health research (e.g. screening, and decision making processes); and health services research (e.g. health economics and policy evaluation).

State and Territory Government funding accounts for around one tenth of Australia's investment in medical research, yet has a profoundly significant influence on the location, level, and ultimate success of medical research.

The medical and health research effort is geographically dispersed, but collaboration is growing

Research in NSW tends to be located in numerous physically-separate clusters, rather than in a few areas of concentration. Most Sydney medical and health researchers, and certainly most of their interstate colleagues, see this as a disadvantage. It is not easily corrected. In NSW, for

practical and cost-related reasons, it is more difficult to build the sort of facility that Queensland has established with the Institute of Molecular Bioscience. Costly research equipment needs to be shared efficiently, subject to open access protocols. This form of sharing, involving widely-separated research campuses, is just beginning to happen in NSW.

One unique feature of NSW research is embodied in the recently-established Institute for Health Research, which provides an inclusive network of clinical, public health and health services research, strongly linked to the NSW Department of Health and its priorities. The circumstances of NSW make such a research broker role particularly appropriate.

NSW medical and health research is under pressure

Because of the limited availability of interstate comparative data, our analysis of State funding, which is based on survey data collected biennially by the Australian Bureau of Statistics, is confined to the period up to and including 2000-01. Like some other States, NSW has announced significant medical and health research funding enhancements since 2000-01, but no comparative assessment of the overall effects of these enhancements has been possible.

However, it is clear that NSW needs to bolster its strengths. Victoria has secured over $50 million more from Commonwealth funding schemes, as a result of its research performance, than its share of population would imply. A similar gap exists between the two States in the respective contributions that endowments and philanthropy make. That benefit also has many additional advantages. NSW is producing 30% fewer doctoral graduates in the medical and health research fields than is Victoria, once population differences are taken into account. NSW produces slightly more medical and health research papers than Victoria, but those from Victoria are more highly cited. NSW receives, on merit, around 24% of NHMRC peer-reviewed funding. Victoria receives about 40%, and Queensland's share is edging up. Victoria, on a per capita basis, is currently contributing at about twice the level of NSW to the funding of medical and health research.

In short, NSW medical and health research is feeling the pressure. Its ability to attract money from the major Commonwealth Government and international peer-reviewed funding streams is far from certain. Competition from Victoria and Queensland for funding may intensify. NSW is certainly not matching the pace set internationally and by other States.

NSW is home to much of Australia's pharmaceutical and biotechnology industry, and has had significant success in the field of medical devices. However, there is evidence that NSW is less effective than other States when it comes to commercialisation of research for diagnostics and therapeutics. Biomedical industries in NSW appear to be interacting less with medical researchers than, say, are their Queensland counterparts. Much of the philosophy that has prompted the Commonwealth Government to increase investment in medical research is summed up in the concept of 'the virtuous cycle', a self-reinforcing, symbiotic interaction between researchers, government and industry, leading to increased investment in both

research and industry. Despite the relatively small size of its R&D enterprise, Queensland has adopted that philosophy with apparent success.

The 'virtuous cycle' must be energised in NSW

It is critical for Australia that its biggest State, NSW, also fuels the 'virtuous cycle'. Hence the creation of the portfolio of the Minister for Science and Medical Research in the NSW Government, with the Hon Frank Sartor MP as Minister, is of great significance, and is a clear recognition of the importance of medical and health research for health outcomes and for the economy of the State. The Premier has publicly pledged his strong support for the research sector.

Enhancing NSW medical and health research capacity is not part of a 'zero sum game', an internal Australian competition with no net national gain. A competitive advantage in an area of science and innovation should be built across the nation. With clear support and purpose, NSW should commit itself to increase its standing in Australian and international research rankings. The benefits flow through in many areas and many ways. NSW can be at the international forefront of medical and health research and attract international funding. There is great potential for constructive interaction if the NSW business and research sectors could engage with each other more actively and productively.

NSW could capture more of the global R&D carried out by international biomedical industries. Investing in first-rate basic science and in postgraduate education is the core requirement. Attracting R&D nodes of international companies is also important.

There is a need to concentrate on maximising the value of intellectual property for the State. The later the stage of commercialisation, the greater the potential gains. Manufacturing is often far less economically significant than the location of the R&D itself. Thus R&D itself is a 'product'.

We propose a 'prescription' for health in NSW

Our 'prescription' advocates a quantum increase in support for medical and health research in NSW, with an unqualified commitment to excellence. The funding arrangements that we recommend are designed to attract and retain stellar researchers, and to reinforce the role of the exceptionally successful institutions, giving them the means to get on with ground-breaking research. We argue that it is crucial to put research back into the teaching hospital environment. Clinical research is a vital part of the continuum of research, essential for translational research. It is also an important means of influencing the ethos and promoting the highest standards of clinical practice.

The pressures on research in NSW will not abate. If the State's capacity is not strongly supported, it could wilt, with the potential loss of some of the best of the State's scientific leaders, and a critical loss to the State's intellectual infrastructure. Apart from interstate competition, there is a global market for top international medical research talent.

Research institutions and clusters of research in NSW are more dispersed than in other States. It is not desirable for funding policy per se to be the trigger generating 'offspring' institutes. Amalgamations would be beneficial if they were to occur spontaneously. In our 'prescription', we advocate steps to avoid further fragmentation of research institutions, and to encourage amalgamations and help to sustain them if they occur. For example, we recommend adjusting the eligibility threshold for peer-review grants in the award of infrastructure grants. We also recommend practical and legal assistance if individual research groups, of their own inclination, see advantages in amalgamation.

It is crucial that the decision-making processes reinforce the goal of pursuing absolute excellence. Once specific programs have been designed by Government, the involvement of peer review and specialised expertise in the subsequent case-by-case, scheme-by-scheme allocations and decisions is paramount. So too are processes that are explicit, clear, universally applied, and open to scrutiny. Legislation could be one way (but not the only way) of achieving these ends. This would involve passage of a Medical Research Act, with the employment (as done at Commonwealth Government level) of a statutory authority to oversee the administration of the programs.

Our 'prescription' for health and recommendations appear in Chapter 9.

1 Introduction

1.1 Objectives and Terms of Reference of the Review

In August 2003, the Minister for Science and Medical Research, the Hon Frank Sartor MP, commissioned an independent panel to carry out a review of medical and health research in New South Wales. The aim, as stated by the Minister, was to recommend:

1) *priorities for NSW Government expenditure;*
2) *how to better utilise the strengths and overcome any weaknesses inherent in the NSW research environment;*
3) *how to optimise funding in NSW; and,*
4) *future directions for its development.*

The Terms of Reference of the Review are reproduced in full in Appendix A. In summary, the Review Panel was asked to:

1) Review all existing NSW Government-funded medical and health research programs, including the BioFirst program, the NSW Medical and Health Infrastructure Grants Program, and Department of Health research programs, to:

   a) identify current NSW strengths in biomedical, clinical, public-health, health-services, and health-policy research;
   b) identify other strengths and advantages of medical and health research in NSW;
   c) assess whether the balance between basic, translational and clinical research is optimal;
   d) examine opportunities to achieve critical mass and/or optimal size of research entities, and to avoid duplication; and
   e) identify how NSW can exert leverage and contribute to interstate and international research efforts.

2) Review and recommend strategic priorities for NSW Government expenditure on medical and health research in the context of:

   a) health priorities for NSW, with reference to the health of the State's population and the operation of the health system;
   b) the specification of research goals;
   c) maximising benefits from research findings; and
   d) determinants of research excellence.

3) Review investment in medical and health research in NSW as a whole (including the private sector) and recommend how to optimise its value by:

   a) identifying the benefits likely to accrue from additional investment;
   b) developing a funding framework that supports NSW priorities, including recommendations for an appropriate level of infrastructure funding and an allocation formula;
   c) investigating how NSW Government funding could exert leverage in bringing contributions from the Australian Government, the private sector, and industry; and
   d) identifying how to engage research entities in the State that do not receive NSW Government funding.

4) Identify future directions for the development of medical and health research in NSW.

1.2 Background to the Review

1.2.1 General context

The current global context of medical and health research is discussed in Chapter 2. In summary, great changes have occurred in medical and health research throughout the world over the last decade. Two developments have been particularly important.

The first is the progress made in establishing the structure of the human genome. This has profoundly affected the methods, pace and expectations of biomedical discovery, and has highlighted the potential for profitable commercialisation of research. Both considerations have led governments throughout the world to increase their support for medical and health research.

The second key consideration is that, with the ageing of populations, health systems everywhere are wrestling with an increasing burden of complex, chronic disease and disability. At the same time, society has the expectation that high-technology health care will be available at an affordable cost to the individual. Health systems in all developed countries need to reconcile these pressures, and see advantage in strengthening their research and development (R&D) capacity to underpin health policy, public-health practice, the organisation and management of health services, and clinical practice.

1.2.2 New South Wales context

Following its re-election in March 2003, Premier Carr's Government gave a clear signal of its recognition of the importance of science and medical research by establishing the portfolio of Minister for Science and Medical Research within the Cabinet, with the Hon Frank Sartor MP as

Minister. No such portfolio had previously existed in NSW. The decision represents an unambiguous commitment to science and medical research and sends a strong signal to that effect.

While the overall directions and standards of Australian medical and health research are largely determined at the national level, State and Territory Governments have a crucial role, not only in setting local research priorities, but also in developing and sustaining local research capacity and in promoting a research-oriented culture. State Government investment can exert leverage by giving State-based research entities a competitive edge, nationally and internationally. This may involve providing resources and creating an environment that encourages investment in R&D from other sectors, and by supporting the conditions that attract top researchers who in turn attract external funding. It may also involve contributing to the cost of facilities, equipment and priority research programs that are co-funded from other sectors. In addition, the States can promote research by helping to remove research impediments - for example, by developing favourable intellectual-property policies and by streamlining ethical clearance of multi-centre research. The State Government influences research policy in national forums, such as the National Health and Medical Research Council (NHMRC) and the Australian Health Ministers' Council.

Above all, a State Government's commitment to research is enormously important in ensuring that the health system is primed to adopt new knowledge derived from high-quality research conducted anywhere in the world, and to apply research-based knowledge in improving health and the quality, effectiveness and efficiency of health services.

1.2.3 The context of the Review

Current NSW Government policies and funding arrangements for medical and health research were developed in the mid-1990s and implemented from 1997 onwards. The history of medical and health research policy and funding in NSW is described in Chapter 3. Briefly, over the last decade, the NSW Government's attention has focused on five aspects of medical and health research funding:

- infrastructure funding for medical and health research entities linked with NSW public-sector health services;
- funding for the development of capacity for health-policy, public-health and health-services research in the State;
- funding for the development of the State's capacity in biotechnology and the BioFirst strategy;
- research commissioned by various Branches within the Department of Health; and
- initiatives to promote and account for the use of funds allocated for research to the State's Area Health Services.

The present Review was inaugurated soon after the announcement of the third round of triennial funding in the NSW Health Research Infrastructure Grants Program (IGP) and the first round of triennial funding in the Capacity Building Infrastructure Grants (CBIG) program, both taking effect in the 2003-04 financial year. The IGP was first implemented in 1997, and has been emulated by other Australian States. In this latest triennium, the processes for selecting research entities for IGP awards, and for determining feasible levels of funding, stimulated considerable debate, both within the NSW Government and across the research community. In part the debate occurred because funding constraints meant NSW support did not keep pace with the substantial increase in peer-reviewed (Federal) grant allocations, to which payments under the NSW scheme are linked.

The rapidly evolving global research context, plus the debate over program administration, led the Minister to call for a fundamental re-assessment of the role of the NSW Government in medical and health research, opportunities to improve the State's research performance, the identification of the State's strengths in medical and health research, and likely gains that could flow from an increased or redirected NSW Government investment. These questions were timely.

1.2.4 Related initiatives

The decision to establish this Review has been one of several steps taken by the Minister in the policy-development process. Others include his support for:

- a review of science and its commercialisation in NSW undertaken by the Legislative Council's Standing Committee on State Development chaired by the Hon Tony Burke MLC;
- the commissioning of a review of 'biocentres' undertaken by Professor Andrew Coats, Dean of the Faculty of Medicine in The University of Sydney, and Professor Denis Wade; and
- the convening of a Ministerial Advisory Council on Medical and Health Research.

For its part, the Commonwealth Government has been undertaking policy reviews in a number of related areas. These included a Commonwealth Government's Report, factual in nature and now just published entitled *Mapping Australian Science and Innovation.* The Commonwealth Government has also been conducting reviews of *Backing Australia's Ability*, the relatively recent set of decisions boosting Commonwealth funding of R&D generally; and of the implementation of the recommendations of the Health and Medical Strategic Research Review (the Wills Review). The report of the Wills Review, entitled *The Virtuous Cycle*, was published in 1999. It has been the point of reference for Commonwealth Government policy on medical and health research, and, amongst other things, led to a decision to double Commonwealth funding of research funded through the NHMRC over a five year period (2001-06).

1.3 Modus Operandi

1.3.1 Scope of the Review Panel's inquiries

The Panel was working to a tight deadline. It relied on and was fortunate to have the assistance and cooperation of those listed in the acknowledgements. As a committee it met recurrently over the four-month period of the Review and on five occasions with Minister Sartor.

The Panel's modus operandi was to:

- meet with a large number of experts in medical and health research, research policy and commercialisation in NSW, Victoria, Queensland and Canberra. Those interviewed, and their affiliations, are listed in Appendix B;
- meet in group discussions with successful and unsuccessful applicants for the 2004-06 round of IGP and CIBG funding, and with the Ministerial Advisory Committee on Medical Research;
- meet with the NSW Legislative Council Committee reviewing Science and Research Commercialisation;
- consider some 90 written submissions. These were solicited by public advertisement or by direct written request. The Review Panel's call for submissions is reproduced in Appendix C, and a list of submissions received is given in Appendix D. Most submissions were from NSW-based research organisations and health services. The Panel also received constructive comment from a range of NSW Government Departments, Health Departments in other States, and Commonwealth Government agencies, and from the US National Institutes of Health;
- seek and analyse a very large amount of empirical data, described in more detail in section 1.3.2; and
- commission a number of studies, which are listed below.

1.3.2 Collection and compilation of empirical data

The Panel Secretariat, located in the NSW Department of Health, and Professor Frommer's Sydney Health Projects Group at The University of Sydney, sought data from a wide variety of sources including:

- the Australian Bureau of Statistics (ABS): data on research expenditure;
- the databases of the Institute for Scientific Information (ISI) in the USA, and the Science Citation Index (SCI) and the Social Science Citation Index (SSCI): bibliometric data, covering publications, citations, and impact factors;
- the Australian Patents Office: data on Australian patents by state of residence of registrant, and by sector;

- the NHMRC: data on numbers of applications for grants, scholarships and fellowships, numbers of successful applications, and amounts of funding awarded;
- the Australian Research Council (ARC): data on funding awarded for medical and health research under the ARC Large Grant and Discovery–Projects scheme, and the ARC SPIRT and Linkage–Projects scheme;
- the US National Institutes of Health: data on grants awarded to NSW researchers; and
- the Commonwealth Department of Industry, Tourism and Resources: information on the funding received by the NSW biomedical industry under various Government programs designed to promote research and development.

Information on NHMRC grants, Australian and overseas funding of science and innovation, US patents, and NIH funding was also obtained from the websites of the NHMRC, ABS, US Patents and Trademarks Office, and NIH respectively.

The NSW Department of Health provided data on grants awarded under the IGP, the CBIG program, the operation of the Department's Program 6.1 (which covers Teaching and Research in the Area Health Services), and the BioFirst program. It also advised the Panel on the characteristics of research entities awarded grants in 1997, 2000 and 2003.

At the Panel's request the NSW Department of Health commissioned the following reports:

- Bibliometric data – from Mr Walter Giusti and Mr Jeromy Anglim, Department of Psychology, The University of Melbourne, and from Associate Professor Connie Wilson, School of Information Systems, Technology and Management, University of NSW.

- The status of medical and health research in Canada and the United Kingdom – from Dr Harvey Sims and Dr James Mitchell, Sussex Circle Inc, Ottawa, and Dr Anthony Harrison, The King's Fund Institute, London.

The Department also commissioned studies on R&D tax concessions, industry grants, and philanthropic funding of research from Dr Kate Grenot, BCP Investment Pty Limited, Sydney.

1.3.3 Data analysis and reporting

Details of the analysis of research funding and bibliometric data, including the classifications used, are given in Chapters 5 and 6.

Analysis of quantitative data relied on simple descriptive methods. No formal statistical tests were applied, and no estimates of precision were made. Modelling of financial data used basic accounting methods.

1.4 Structure of this report

The logic of this report is as follows.

At the outset, we examine the rationale for a strong, internationally-significant capacity for medical and health research (Chapter 2, 'Science and a vibrant economy'). Our conclusions and recommendations are built on an understanding of the State's current research capacity, the characteristics of its research community, its institutions, and their relationships.

In Chapter 3 ('Priorities and capacity for medical and health research') we summarise these characteristics, emphasising those that are unique. We also identify research priorities for NSW, both as declared by the NSW Government and as shown in published data on the major causes of death and disability. We refer to impediments and opportunities to facilitate medical and health research and related commercial development: ethical assessment of multi-centre research projects; and intellectual-property (IP) policy.

Research capacity and research performance depend on the size and nature of the research investment and researchers' access to the funds. In Chapter 4 ('The investment in medical and health research') we set out the figures and examine the components of the investment, showing where the money comes from and how it is spent. This analysis highlights some important differences between NSW and other jurisdictions.

One of the characteristics of the research sector is that a large proportion of the input funding is in the form of competitive grants and career awards, which are subjected to extensive peer review. This means that: (a) research is judged for its quality and value, and researchers are judged for their ability, *before* the research can be undertaken; (b) attracting peer-reviewed investment for research is itself a marker of performance and peer esteem; and (c) data on peer-reviewed grants, scholarships and fellowships not only tell us about research funding, but are also used as indicators of research performance. In Chapter 5 ('Peer-reviewed investment track record') we evaluate the State's progress according to those indicators.

In Chapter 6 ('Publications and patents') we present a comparative analysis of bibliometric data and the data on the registration, in Australia and the USA, of patents originating in NSW. Both represent short- and medium-term research outcomes.

In Chapter 7 ('Health, health service, and economic outcomes') we explore the contribution of the State's medical and health research to health and health services, and we assess the State's performance in the commercial development of research findings. We also examine the growth of biotechnology in NSW, and the performance of medical and health research in supporting the growth of biotechnology.

In Chapter 8 ('Conclusion') we draw together our findings, linking research priorities, investment, capacity, and performance, and we set out our main conclusions.

Finally, in Chapter 9 ('NSW research: a prescription for health'), we set out our recommendations.

2 Why is research crucial for medicine and health in NSW?

Main points:

- Successful medical and health research requires strength in all types of research - basic, clinical, translational, public-health, health-systems and health-services research - plus an intensive and constructive interaction between researchers and the biomedical and biotechnology industries.

- Life expectancy has increased by more than 20 years over the last century. Medical and health research has been a major contributor to this.

- Medical research is one area of science where Australia is genuinely competitive internationally and has established capacity. One-third of Australia's scientific publications are in the medical and health research area.

- Governments throughout the world are increasing their investment in medical and health research. Public-interest and public-good research reinforces emerging commercial potential in the biotechnology sector.

- Research is a global activity. If governments are to access its outcomes, they must expect to contribute.

- Australia cannot lead in medical and health research and biotechnology unless NSW, its largest State, is committed, and performs at the highest level.

- Investment in medical and health research has been estimated by Access Economics to pay off five-fold.

- In addition to direct health and economic benefits, an effective research commitment has a systemic benefit for the operation of hospitals and the health system more broadly, because it changes the philosophy and ethic that underpin them and becomes a key determinant in fostering best practice.

2.1 R&D investment and the strength of Australian science

Over recent months Australian Governments have been 'mapping' Australia's science and technology. The intent is to determine our national scientific strengths, assess our effectiveness in contributing to global science, and then judge how well we translate inventiveness into commercial possibility. An effective R&D capacity is becoming more

important by the day. Australia, like other developed countries, can no longer presume that the resources for its rising living standards will be found in agriculture, mineral resources, and our increasingly efficient but not very innovative manufacturing sector. For us, as for others, it is ideas, ingenuity, intellectual creativity and innovation, all of which are dependent on a highly educated workforce, that will determine future living standards, international competitiveness and community wellbeing.

The figures from the mapping study provide a mixed picture. As a percentage of gross domestic product (GDP), Australia spends a fraction of the amount that most other countries in the Organisation for Economic Cooperation and Development (OECD) spend on R&D. In particular, as a proportion of GDP, the R&D expenditure by the Australian business sector is about half the OECD average. Significantly, Government and industry in NSW invest less in R&D than does the country as a whole (1.29% compared to 1.53% of GDP). However, despite low national expenditure levels, Australian scientists are impressively productive. We rank eighth amongst OECD countries in scientific publications (standardised by population).

In a number of disciplines and research organisations, Australian science is demonstrably world class. The biomedical sciences stand out. Around one third of our total scientific output is in the medical and health sciences. Australian publications in medical and health fields account for 2.9% of world output in these fields. By way of comparison, our share of the combined GDP of OECD countries is roughly half of that figure. Correspondingly, some of the fastest rates of growth in Australian patenting are in biotechnology and pharmaceuticals. By international standards we have few areas of scientific strength: the biomedical sciences are one such.

2.2 The changing character of medical research

Even over the last decade, great change has occurred in the way in which medical and health research is conducted throughout the world. As mentioned in Chapter 1, two developments have been mainly responsible.

First, the outcomes of research on the structure of the human genome in the late 1990s have profoundly affected the methods, pace and expectations of biomedical discovery. New fields of post-genomic research have emerged rapidly to feed the growth of biotechnology. In addition, research in many existing biomedical fields has been reorganised and expanded, and new large-scale methods are being used.

Important features of this reorganisation are: (i) collaboration among research groups (so that researchers can share access to complex, expensive equipment, and the expertise needed to operate it), and (ii) new linkages between researchers from different disciplines. These advances are creating new opportunities in both basic research (e.g. in-silico biology) and translational research (e.g. applying discoveries to patient care). Thus, one distinguishing aspect of modern research is multidisciplinary collaboration. Breakthroughs are often made

along the 'fault-lines' that define different areas of science. Capacity in one scientific field both requires compatible and collaborative knowledge and enhances the scientific capacity of the country more generally.

An illustration is this year's Nobel Prize winners. One of the two recipients of the Nobel Prize for Medicine was a physicist. This year the Nobel Prize for Chemistry was awarded to two medical scientists whose studies have shown how salts (ions) and water are transported into and out of the cells of the body. The discoveries have afforded a fundamental molecular understanding of how the electrical signals in nerve cells are generated and propagated. They have also defined the structure of a molecule that will form the basis of improved drug development for many neurological diseases. But the work involved chemistry, and the prize was awarded for chemistry rather than physiology or medicine.

Second, with the ageing and growth of the population, health systems everywhere have recognised the need to cope with an increasing burden of complex, chronic disease and disability. At the same time, society is making increasing demands for high-cost, high-technology health care that has the potential to prolong life and delay morbidity, and for improvements in the safety and quality of health services. Health systems in all developed countries are working out how to provide high-quality, complex health care within feasible expenditure limits, and how to use health-care institutions (particularly acute hospitals) more effectively. This transformation of health care is creating an increasing demand for knowledge that is based on clinical, health-services and population-health research. There are numerous instances of research having led to improvements in the organisation and delivery of health services. For example, research-based developments in the coordination and delivery of ambulance and emergency-department care of patients with acute cardiac ischaemia (incipient heart attack) have resulted not only in great improvements in survival, but also in marked reductions in the length of hospital stay. Health systems have therefore become interested in strengthening R&D capacity to underpin health policy, public-health practice, the organisation and management of health services, and clinical practice.

2.3 Australia's contribution to medical and health research

Over many decades, Australians have made an exceptional contribution to global medical research. Australian researchers have made breakthroughs in disease prevention, fundamental science, and cost-reducing medical interventions. Four Australians have won the Nobel Prize for medicine. The most recent, Professor Peter Doherty, won the Prize for a shared discovery of how the immune system recognises cells infected with a virus. Other earlier recipients were Sir Howard Florey, Sir Macfarlane Burnet and Sir John Eccles. Notably, when Professor Doherty spoke at the Nobel award ceremony, he traced his intellectual lineage back to Burnet, Professor Frank Fenner, and others who had not only influenced him personally but created the intellectual momentum on which he was to draw, a generation later. Scientific discovery is sustained, protracted, and unpredictable, and its benefits potentially enormous. It is also for

the tenacious. As Premier Carr recently commented, “Medical researchers are miracle workers”.

Examples of important Australian research include:

- Dr John Cade’s discovery that lithium compounds could relieve the symptoms of bipolar disease (a discovery estimated to save up to $10 billion a year worldwide on hospital costs);
- confirmation, by Professor Fiona Stanley and others, of a link between low levels of folate intake by pregnant women and the risk of spina bifida in babies;
- demonstration by Professors Barry Marshall and Robin Warren that stomach ulcers were caused by a bacterium, defying conventional wisdom;
- molecular genetics discoveries by Professor John Shine, now Director of the Garvan Institute in Sydney, that pioneered the biotechnology revolution; and
- confirmation of the link between a baby’s sleeping position and sudden infant death syndrome, in research by a team led by Professor Terry Dwyer at the University of Tasmania.

The gains are ongoing. Recent NSW-based medical and health advances include:

- research by Professor David Henderson-Smart (of the Centre for Perinatal Health Services Research) on optimal levels of supplementary oxygen for pre-term babies, reducing the need for intensive care and improving outcomes, widely implemented in Australian neonatal intensive care nurseries;
- research by Professor Colin Chesterman (of the Centre for Vascular Research) on anti-clotting drugs and their use to avoid or reduce the need for hospital care of patients with blood clots;
- research and subsequent implementation of research findings by Associate Professor Lyn Fragar (of the Australian Centre for Agricultural Health and Safety) to reduce farm-related injuries and illness; and
- the development and evaluation of a potentially effective male hormonal contraceptive by Professor David Handelsman (of the ANZAC Research Institute), in collaboration with Melbourne colleagues (in the Prince Henry’s Institute of Medical Research, Melbourne).

2.4 Rationales for medical and health research

Medical research has multifaceted benefits. Those of paramount importance are the direct contribution to improved health, reduced morbidity, and increased life expectancy, both for the individual and the population generally. Another dimension is the economic potential of research; countries are attaching ever-increasing importance to this aspect. Biotechnology, of which the biomedical sector is one major component, offers unprecedented scientific and economic possibilities. The economic potential of biotechnology is enormous, possibly on a par with that of information technology, and the international competition to develop critical mass in biotechnology is intense.

The gains from improved personal health are hard to quantify in a way that allow meaningful comparison as to worth. As a society we want to define everything in dollar terms. Over the last century, life expectancy in Australia has risen by over twenty years. Over the last generation, with little discussion as to how or why, the life expectancy of Australians has increased by eight years. Medical research has been a major contributing factor. We take such gains for granted just as we presume that better medical treatments will constantly occur and hope that they are in the areas that most concern us personally. In fact they require steady investment and ongoing development of the core skills required by research.

One attempt to compare costs and benefits of improved health has recently been made by Access Economics in a study entitled *Exceptional Returns: the value of investing in Health R&D in Australia*, commissioned by the Australian Society for Medical Research. It analysed the contribution that medical research has made to our longer and healthier life, then took the further step of attempting to put a dollar figure on those benefits. The numbers are astronomical. More qualitatively the conclusion was that '…investment in health R&D surpasses every other source of rising living standards in our time.' The additional years added to the life expectancy of Australians was worth many trillion dollars to Australians. The gains associated with the prevention and treatment of cardiovascular disease alone totalled $1.7 trillion.

Notwithstanding the extra years, public expectations are such that Australians generally are concerned about 'the health system'. Health care is already the largest single global and national 'industry'. Australia's expenditure on health care is more than four times that on defence. State Governments fund about one quarter of health expenditure. The NSW Government currently spends about $9 billion a year, primarily on the State's hospital services.

The share of the total national budget devoted to health will rise. As mentioned, the main influencing factors are the ageing of the population, consumer expectations that more effective treatments will be quickly made available (and at modest cost to the individual), and the cost of high-technology medicine (particularly diagnostic technology) and the frequency with which it is employed. Again consumer expectations of the quality, accessibility and affordability of health are constantly rising. A cost-effective, efficient health system is a

political necessity to meet societal expectations. It is a tough equation: the public takes the steady health improvements for granted, and responds with agitation to anything less than perfect and immediate health care. Beside fundamental research directed at specific diseases, improvements in the cost and efficiency of health care also require careful research, albeit at a different stage of the research continuum.

In short, it would be difficult to find another area of endeavour offering the potential gains of medical research. Particularly at the present time, medical research brings into conjunction the prospect of improved health and longer life (with the huge societal gain that it represents) and the potent economic possibilities of biotechnology, an area in which Australia has established aptitude.

2.5 International comparisons

Many countries are boosting their investment in medical research. In Canada, always a point of comparison for Australia, the Government has rapidly escalated its commitment to science funding and to medical research funding in particular. In 2000, the Canadian Government in Ottawa established the Canadian Institute of Health Research, with a budget increasing from C$477 million in its first year of operation, to $727 million in the current year, to a projected $1billion in 2007. This health-specific initiative is supported by the Canadian Foundation for Innovation with funding of C$1.7 billion, currently directed to 2,800 research projects across Canada, many of them health-related. Another C$900 million program established in 2000, the Canadian Research Chairs Program, is designed to enable universities and their affiliated research centres and hospital institutions to attract and retain outstanding researchers in Canada. The program will support the creation of a total of 2,000 professorial-level posts.

For comparative purposes, the Australian economy is roughly two thirds the size of its Canadian counterpart. There is an international market for top talent. Coming on top of the almost-irresistible attraction that the USA and the United Kingdom exercise over Australian scientists, the Canadian determination to attract the best represents another serious challenge in an environment where intellectual capital is key. Canada's purposes are hard-headed, and are directed to how Canadians see their national advantage.

In the UK and the USA, funding levels for medical research have increased considerably, and are expected to continue to do so, but in both of these countries it is the private not-for-profit sector that has the central role.

2.6 The rationale for medical and health research in Australia and NSW

Why should Australia, and NSW specifically, be concerned to invest in medical research? What is wrong with simply 'consuming' the benefits of research undertaken by others?

There are several reasons.

Australia is an international leader in medical and health research.
First, medical and health research is one area of science (and there are not many) where Australia is genuinely at the cutting edge internationally. There is real benefit in building on that capacity, especially now. If Australia is to build on its capacity in medical and health research, NSW (as the State with the largest population) must take a leading position.

Enormous health benefits accrue.
International funding increases for medical research appear to have economic considerations as their primary motivation. However, as the Access Economics figures imply, it is the actual health benefits that remain paramount and offer the strongest rationale for health research. For example, Australian age-standardised death rates for males fell by 19%, and for females by 16%, between 1991 and 2000. This a spectacular improvement in the health of the Australian population, and reflects the combined effect of numerous medical and public-health advances based on research findings.

No state can sustain being a passenger in the medical and health research enterprise.
Arguably all countries stand to benefit from advances in medical and health research. No one society, no matter how large or wealthy, is in a position, nor should be expected, to pick up a disproportionate burden of the cost of medical and health research when the benefits are universally shared. If States want their citizens to benefit in the ways identified by the Access Economics study, they should expect to invest in research that advances global welfare. One country might try to take a 'free ride' on the research undertaken by others, but that approach would quickly break down if a number of major countries were to do so. Australia, for all its strengths in medical research, will still be 'importing' the bulk of the research-based advances that are incorporated into medical practice. One has to make a contribution if one expects to draw on the contribution of others - otherwise the 'deal' will quickly break down.

NSW also needs a research capacity so that it can make effective use of research results from elsewhere.
Perhaps equally importantly, while basic biomedical research undertaken in the USA or the UK may be directly applicable in Australia, there are many research questions that are important to Australia's health, and need to be investigated locally to define their applicability and even their importance. If we lose the capacity to undertake basic research and to investigate how to improve the delivery of health services, we will also lose our capacity to decide what advances to incorporate into health care and how to apportion our limited resources. A high-level

research capacity is essential to enable us quickly and independently to interpret research undertaken elsewhere (abroad or interstate), and to implement the results of such research. Thus, for example, Australia's research expertise in epidemiology, virology and infectious-disease control enabled us to assimilate overseas information on HIV rapidly, respond quickly to the emerging worldwide AIDS epidemic in the 1980s, implement and evaluate highly-effective prevention, and keep the disease in check in our country. Much of this research expertise is based in NSW.

NSW needs a research capacity to deal with local health problems.

Some disease and health problems are uniquely Australian in their occurrence and consequences, and some occur more frequently in one State than another. AIDS, again, is an example. NSW has the largest concentration of AIDS cases in Australia (49% of all cases, compared with 27% in Victoria). Another example is the variation in the incidence of melanoma among Australian States: when age differences are taken into account, the average incidence of melanoma in Queensland males is almost double that in Victoria, with NSW ranking in between. Melanoma is a cancer of particular importance in Australia. It is the fourth-most frequent cancer in Australian males, and the third-most frequent in Australian females. The incidence of melanoma in Australia is about five times that of most European countries and more than four times that of Canada. The need for a local capacity to study health problems such as these is self evident, as they particularly affect the population of NSW. Moreover, the investigation of health problems of local concern can open other productive lines of research. If we lack the resources and the capability to study local health problems, no one else will carry out the necessary research on our behalf. These problems not only represent priorities for research, but also point to areas of comparative advantage for Australian research.

A research orientation improves the quality of clinical practice.

People who work in a health-care service that is committed to research recognise that practice and the organisation of care can always be improved, and they are ready and willing to make changes for the better. Moreover, those involved in delivering care in a research-oriented environment are constantly exposed to the most recent evidence, and are constantly challenged to incorporate it into their practice. Direct benefits follow for patients. Thus, for example, a Swedish study has shown that patients undergoing surgery for rectal cancer in university hospitals have a significantly lower rate of recurrence of cancer in the pelvis than patients undergoing similar surgery in non-university hospitals. Also, health-care institutions that are committed to research usually carry out clinical trials, and there is evidence that patients who participate in properly-conducted clinical trials have better outcomes than non-participants with equivalent characteristics. Health-care institutions that carry out research usually have a high specific caseload and an emphasis on quality improvement. Research, quality and caseload form an inseparable triad that leads to better patient care, and lifts the capability and performance of the health system generally.

The direct and indirect contribution of research to health services was underlined by Professor Tony Cunningham in his submission to the Review Panel. Professor Cunningham listed the

ways in which a strong biomedical research base can ensure quality and excellence in clinical care. They include the capacity to:

- attract the best doctors and other staff to teaching hospitals;
- create a culture of evidence-based medicine, with evidence drawn from research;
- ensure a flow of the latest knowledge from around the world to inform clinical care;
- provide early access for the people of NSW to new effective drugs though clinical trials and collation of protocols;
- enable direct translation of biomedical research into clinical care, and conversely, seek answers in the laboratory to questions raised in the clinic;
- provide the cutting-edge scientific skill and technology base for the introduction of new prevention methods, diagnostics, and treatment methods;
- provide a critical base of expertise for development of health policy and health care (for both prevention and treatment) within the State;
- contribute to the overall national research effort;
- carry out key research on diseases of regional significance; and
- serve as the essential engine for the development of biotechnology industry in NSW, with all the promise that this holds for significant health and economic benefits.

While technological development can increase the price of health services as well as their effectiveness, research can also lead to lower costs. For instance, research leading to the production of safe and effective vaccines has led to the virtual disappearance of many vaccine-preventable diseases. An historical example is poliomyelitis, which filled hospital wards in the 1950s; not a single new case was notified in NSW between 1991 and 2002. Apart from prevention of morbidity, the cost savings are obvious.

Research that focuses primarily on the enhancement of health-system and health-service delivery effectiveness can also lead to cost savings. Improvements in health-care quality and safety mean improvements in cost effectiveness, and in many cases produce cost savings. For example, research in the USA and the UK as well as Australia has shown that improvements in the coordination of care for patients with chronic heart failure – especially the transition between hospital care and care in the community after discharge – can lead to longer survival and better quality of life, fewer readmissions to hospital, and lower costs overall. Cost-effectiveness of care is an especially important consideration in planning services for chronic heart failure patients because heart failure is the largest single cause of hospital admission for people aged 65-plus in Australia, and its prevalence is increasing.

The Economic Potential

In the main, much health-related intellectual property continues to be shared as a public good. However, the trend increasingly is to patent, and capture as private property, medical-sector discoveries. Trends in patenting are described in section 6.3 of this report while commercialisation is discussed in Chapter 7..

The 'free ride', even if we wanted it, is becoming less and less accessible. If we want to balance the ledger, offset the rising costs of health care, and harvest the economic potential of our considerable and internationally respected research capacity we need to secure our own medical advances and the economic gains of marketing them globally. There evidence is that having a significant research capacity strongly influences the location of biomedical and biotechnology industry and employment.

This is in a context where securing the economic potential of research is a particular challenge for Australia. Our national deficiency is in translating scientific potential into commercial outcomes. In 2001, for all areas of science, Australians secured one-third of the OECD average for the number of patents, after differences in population were taken into account. In the medical field, Australia's disposition to commercialise research, as measured very crudely by the ratio of patents secured to research papers published, appears to be about one fifth of the world average. This is an issue that needs to be addressed urgently and actively, both nationally and at the State level.

Part of the explanation for this is the relatively low percentage of R&D that occurs in the business sector in Australia, coupled with the fact that the number of patents applied for by academic institutions is very low. The reluctance to patent is likely to be a significant impediment to the commercialisation of Australia's research. The low priority given to commercialisation by academic institutions and researchers until recently is an important factor.

2.7 Research as an integrated activity

2.7.1 The continuum of research

An effective medical and health research sector requires strength across an entire spectrum from fundamental sciences like mathematics and chemistry, through basic biomedical research and clinical research, to public-health and health-services research. The reasons are twofold. First, contemporary research is multi-disciplinary. For example, biomedical research typically involves chemistry and mathematics as well as molecular biology, and clinical research often involves the application of biomedical research results. Second, the investigation of states of health and disease increasingly relies on combining evidence from different types of research. Thus research on the prevention of falls in the elderly (a public health problem, studied using epidemiological methods) has relied on research on vision and balance (clinical neurosciences and ophthalmology) which in turn has relied on studies of the degeneration of brain tissue (neuropathology) at a cellular level. An understanding of degenerative abnormalities at the cellular level thus provides an understanding of the clinical problem, and helps to design interventions that can lead to a prevention of falling – an outcome that can be monitored using epidemiological research techniques.

Fundamental or basic research addresses fundamental biological processes. It can be hypothesis driven or based on collection of data and then interpretation. Recent advances in 'big science' have led to a greater emphasis on massive data collection and mathematical algorithms to interpret and turn the data into useable information. By its nature, advances in basic research are unpredictable, and often open up new fields. There are many examples of the power of basic research. One example is research into retroviruses in the 1960s that led to an understanding of oncogenes and AIDS in the 1980s.

The creation of a successful environment for basic research is critical. The focus is on supporting excellence by identifying the best people and providing them with long-term resources. Sometimes the term *strategic basic research* is discussed. This implies putting in place teams and resources in a particularly important area. However, decisions about what should be studied, and how, are most productively left to those carrying out research. Success comes from supporting the best people, and not from trying to manage what they work on. If groups are not productive, they will attract neither peer-reviewed funding nor students and post-doctoral fellows; and they will not survive.

Clinical research is essential for gaining new insights into disease processes, and for assessing the efficacy and effectiveness of new approaches to disease detection, diagnosis and management. Clinical research involves identifying and quantifying prognostic factors and the testing of new diagnostic and treatment methods in humans. It can also involve population-based or epidemiological studies. The conduct of clinical research is highly regulated to ensure it is conducted ethically and in a way that results in valid information. As Professor Cunningham's list (given in section 2.6 above) indicates, the benefits of clinical research are themselves complex and multifaceted.

2.7.2 Research transfer and translational research

The term 'research transfer' describes the uptake of research results, either in policy or practice, or in stimulating further research. 'Research transfer' and 'research translation' are often used synonymously. 'Research transfer' can be used in connection with any type of research (e.g. the fundamental sciences, biomedical research, clinical research, or epidemiological research).

'Development' (as in 'research and development') is analogous to 'research transfer', but it is often used specifically to mean the processes by which a discovery or an invention is prepared for commercialisation. Commercialisation can be viewed as a type of research uptake, and as a route to the implementation of research findings in practice.

The term 'translational research' is used specifically to describe the research activities that progress a biomedical discovery to the point at which it can be tested for clinical application (e.g. the development of a new substance to the point at which it is ready for the first stages of evaluation of its clinical efficacy).

Translational research has traditionally been the focus of the pharmaceutical and biotechnology industry, and is an essential component of successful commercialisation. Its success comes from setting clear objectives, defining a timeline, bringing appropriate resources to bear, asking the critical questions early in the program, and abandoning unsuccessful programs so that resources can be deployed on more productive projects if progress is proving elusive.

In general, public institutions are not as successful in translational research as industry. This reflects the amount of money needed, given the high attrition rates (particularly when developing new therapeutics) and the requirement for teamwork rather than individual contributions and rewards. The global investment in R&D by the pharmaceutical and biotechnology industry is of the order of US$30-40 billion per annum. Applications in the areas of diagnostics, therapeutics, devices, and technologies used for research, involve major scientific and commercial development. Successful commercial development occurs when there is effective interaction and collaboration between the business and the academic community, and when the latter is able to participate in some aspects of development. Successful commercial development often requires a partnership between private enterprise and institutions with responsibility for patient care.

Research with more immediate policy application includes epidemiology, health-services evaluation, behavioural research, and economic evaluation of alternative approaches. Often such research is directly commissioned by the relevant health department. Effective management of these fields of research requires selecting the important questions to investigate, designing meaningful studies, providing timely results, and ensuring the results are communicated and incorporated into health-care delivery. The major challenge faced by all the health departments from which we obtained information was how to sequester funding for research in these fields and not have it subsumed by the acute funding needs of the health system. Clinical trials represent an area of particular research strength in NSW. They involve industry, hospital, and researcher cooperation, and in their own right can have beneficial effects on the quality of the health system.

The major conclusion is that the State needs to maintain a broad portfolio of medical and health R&D activities. Capacity is needed all along this interactive spectrum if the full potential of the benefits of research are to be captured.

2.8 What motivates researchers?

A successful and productive research environment needs to take account of what motivates the individual researcher. Research Australia recently conducted a poll of Health and Medical Researcher opinion. The key motivator of health and medical researchers was found to be the excitement of discovery: 86% of researchers rated this as extremely or very important. Career path, salary, and community recognition all mattered, but far less than the actual scientific

discovery. Significantly (and a cause for concern in the Australian context), the potential for personal wealth from commercialisation was given a very low ranking by respondents.

Asked how they ranked the importance of potential research outcomes, researchers gave top priority to 'improving health outcomes'. Second in importance was publications, closely followed by 'seeing outcomes of research used in practice'. Securing patents and creating new business were accorded lower importance.

Researchers will move to where they can pursue the most interesting science and address the intellectual challenges that matter to them, to where the internationally-respected mentors are conducting research, and to where the most stimulating and productive colleagues are found. More than anything, they want to make discoveries.

2.9 Implications for research policy in NSW

Reflecting similar trends abroad and motivated by similar considerations, Commonwealth Government spending on research funded through the NHMRC will double over a five-year period subsequent to the recommendations of the Wills Review.

The rapidly-changing scientific and societal context has also seen the NSW Government – in parallel with other State and Territory Governments and the Commonwealth Government – re-examine policies for the support of research. Hence this Review.

Along with other funders, governments have tended to reassess the value of research in relation to its potential to yield both health gains and economic gains. They have moved away from the view that money should be *spent* on research to a recognition that money should be *invested* in research.

This shift has had two important consequences.

- First, governments generally have become much more active in developing policy for medical and health research, evaluating options for the funding of research, and deciding how research performance should be measured and reported.
- Second, there has been a stepped increase in government investment in research, both nationally and in the States and Territories. The specific objectives and magnitude of these increases have varied, but in all instances funding increases have been tied to certain expectations, including promotion of medical biotechnology, achievement of a competitive edge, promotion of collaboration and inter-sectoral partnerships, leverage of external resources, and the translation of research into policy, practice, and improved health, as well as commercial products.

These considerations provide the context in which NSW needs to decide its future policy design and resource commitment to medical research in the State.

3 Capacity and priorities for medical and health research in NSW

Main points

- The organisation of medical and health research in NSW is characterised by a strong university and hospital sector, and a number of mostly medium-sized research centres and institutes. These institutes have differing constitutions; and vary significantly in their degree of independence.

- Medical and health research in NSW is physically located in a relatively large number of groupings, geographically and structurally clustered around teaching hospitals and related clinical schools. Some of these clusters are evolving into research hubs, in partnership with private industry.

- The different research sectors differ in their ability to place sole emphasis on research productivity, as distinct from teaching or clinical responsibilities. Pressure on teaching hospital budgets has constrained research activity in that context.

- Access to various funding streams differs among the different types of institutions. Significantly, institutions that can demonstrate a structural affiliation with a university, and put their grants through a university, may be eligible to receive Commonwealth funding for research infrastructure.

- Many research entities opportunistically blend university and hospital identities, and routinely switch between university and health-service administrative services to maximise their financial advantage.

- In NSW, the specialised institute-based research capacity is relatively young: most of the institutes in the State were established in the last 20 years.

- The NSW Infrastructure Grants Program has been a crucial contributor in sustaining the State's medical and health research capacity over the last eight years.

- The NSW Government has made a substantial commitment to biotechnology R&D through the Bio*First* program.

- Alongside infrastructure and biotechnology funding, the NSW Department of Health has maintained a financial program known as the Teaching and Research Program, mainly to offset the extra costs associated with providing clinical care in hospitals in which teaching and research takes place. Area Health Services' expenditure on research is accounted for under the Program.

- Burden-of-disease analysis, national priorities, and identified State priorities point to the following as broad research priorities: cardiovascular disease, cancer, mental disorders, nervous-system disorders, chronic respiratory diseases, unintentional injuries, musculo-skeletal diseases, diabetes mellitus, childhood developmental disorders, infectious diseases, diseases potentially amenable to gene therapy, prevention of risk factors, and health-system research that leads to equity of access and outcomes and helps to optimise care for people with chronic and complex diseases.

- Practical research to optimise care delivery and disease prevention is critical. Overseas experience indicates that independent 'research brokers' can help to bridge the divides among research groups and health decision makers. The Institute for Health Research is beginning to fulfil this role in NSW.

3.1 Overall structure of medical and health research in Australia

3.1.1 Preamble

Medical and health research is conducted in various institutions, including: (i) universities; (ii) hospitals and other health-service agencies; (iii) independent institutes; (iv) private industry; (v) State health departments and associated laboratories; and (vi) Commonwealth Government entities, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Our review concentrated on the first four categories.

In most States and Territories, strong structural and functional linkages often exist among university and hospital research groups and independent institutes. Research institutions of different types are frequently located on the same campus (usually a teaching hospital). Research staff may hold academic titles and have cross-institutional roles, contributing to clinical services and teaching programs as well as research training.

Linkages among the different types of institutions can have a very long history, and they are part of the ethos and tradition of Australian medical and health research. Understandably, the linkages have helped to promote collaborative, multi-disciplinary research among groups working in close proximity to one another, but have inhibited collaboration among research groups at different sites. The group identity is often vested in a university; research groups appear to be more likely to collaborate with other research groups that are affiliated with the same university. Until very recently research has, in this sense, tended to be a tribal activity.

Growth in the scale of biomedical research (described in Chapter 2), increasing reliance on expensive technology, and the need for new combinations of research expertise have led to the formation of new relationships among researchers, often spanning two or more universities and Area Health Services. Concurrently, new partnerships have formed between research groups and industry, stimulated by perceptions of mutual benefit and the opportunity to obtain special partnership grants from national research-funding agencies, including the NHMRC and the ARC.

All of these phenomena can be seen in NSW, Victoria, and Queensland, and to a lesser extent in other States. As regards the organisation of research, the main features that distinguish one State from another are a result of:

- differences in the distribution of research activity among universities, hospitals, and independent institutes;
- the relative strengths of these sectors;
- differences in the characteristics of industry-based medical and health research; and
- differing reliance on the various sources of funding.

3.1.2 Institutional emphasis on research productivity

Different types of institutions have differing capacities to place emphasis on research productivity, depending on the extent of their other academic and clinical responsibilities. Much medical and health research and research-related activity (such as the training of postgraduate research students) is carried out in institutions that have functions other than research. For instance, university staff also have teaching and service commitments; and in hospitals and other health-service institutions, clinical care is always the top priority, and research often ranks after administration and teaching as a priority.

By contrast, research is the unchallenged priority for staff of research institutes, especially institutes that do not have a reporting relationship with a university or a hospital. Other activities, such as teaching and clinical service, are secondary, and independent institutes usually have sufficient organisational flexibility to free research staff from administrative duties. On a collective basis, publications from institutes tend to have higher citation rates than publications from other sectors. At the same time (as mentioned in Chapter 2), one great advantage of research within a hospital environment is its beneficial effect on the approach and ethic that is adopted in that particular environment.

3.1.3 Access to funding

Researchers in universities, health-service agencies and independent institutes are free to compete for a wide range of research grants, notably national peer-reviewed grants. In addition, university departments are often eligible for internal university grants, while researchers in health-service agencies are often eligible for special targeted grants, such as hospital endowment grants.

However, with regard to funding, the key difference among researchers in these settings is their access to infrastructure funds. Commonwealth Government funding for research infrastructure from the Department of Education, Science and Training (DEST) is available only for higher-education institutions – independent institutes and researchers in health-service agencies are not eligible. Consequently in many (but not all) States and Territories, infrastructure grants have been provided for independent institutes and research groups in health-service agencies, but not for university departments. An analysis of DEST funding is given in Chapter 4.

3.2 Distribution of research activity in NSW

3.2.1 Overview of distinguishing structural features

The most notable structural features of medical and health research in NSW are:

- relatively large university and hospital sectors;
- the existence of a number of research groups that are identified as centres or institutes, but have a wide variety of governance arrangements and relationships with universities and health services – few are completely independent research institutes; and
- a relatively large R&D base in private industry, particularly directed to development (examined in Chapters 4 and 7).

3.2.2 Medical and health research in universities and Area Health Services

Health care in NSW is organised on a geographical and population basis into 17 semi-autonomous Area Health Services. Research activity tends to be concentrated in the Areas that have larger populations and teaching hospitals. The teaching hospitals are mostly also the headquarters of the universities' clinical schools. Thus in NSW, medical and health research is geographically and organisationally concentrated around the teaching hospitals and clinical schools of the three universities that have medical faculties – the Universities of Sydney, NSW and Newcastle.

Other universities across the State also have substantial interests in specific medical and health research fields, and attract competitive peer-reviewed grants for this research, although on a much smaller scale than the Universities of Sydney, NSW and Newcastle. The Centre for Health Economics Research and Evaluation at the University of Technology, Sydney (UTS) was awarded a $6.3 million NHMRC Program Grant in 2003. Macquarie University and the University of Wollongong have secured NHMRC Project Grants, and the University of Wollongong has been awarded a grant by the US National Institutes of Health. Macquarie, Wollongong, UTS, Charles Sturt University, the University of Western Sydney, the University of New England and Southern Cross University (Lismore) all hold ARC Linkage-Project and Discovery-Project grants for research in a variety of biomedical fields, as well as public-health and health-services research.

Given the extent of the urban sprawl on the east coast of NSW and the time and effort needed to travel between two metropolitan sites, it is not surprising that relatively self-sufficient clusters of medical and health research have developed around teaching hospitals and associated clinical schools. The research entities in these clusters often contain both university and hospital elements within a single research organisation. Some of their staff may be university employees, while others are employees of the Area Health Service. Some of

their research-grant applications are processed through university research offices, and some are processed through Area Health Service systems.

Research groups have become adept at identifying the 'best deal' for the employment of staff and the management of grants, and legitimately and routinely switch between Area Health Service and university administrative services to maximise their advantage. The structural and functional blending of university and health-service elements in individual organisations cements collaboration. However, it complicates the analysis and interpretation of data on how much is really spent on research in the different sectors, on what research is done where, and on the performance of the respective sectors.

Geographic concentration of research is less marked in NSW than in other States. A large part of Victoria's research capacity is concentrated in the 'Parkville strip', the area around Royal Melbourne Hospital. Senior researchers in all three States emphasise the value of geographical proximity for enhancing collaboration. Indeed, in developing new building plans, one of Victoria's foremost biomedical researchers opposed a development that would have required staff to cross a main road between research buildings in order to see each other, arguing that this would militate against collaboration.

The feature of NSW is the large number of research clusters. Examples include:

- St Vincent's Hospital;
- Prince of Wales Hospital and the central campus of the University of NSW;
- Royal Prince Alfred Hospital (RPAH) and the central campus of the University of Sydney;
- Westmead Hospital and The Children's Hospital at Westmead;
- Royal North Shore Hospital;
- John Hunter Hospital and the campus of the University of Newcastle;
- Liverpool Hospital;
- Repatriation General Hospital, Concord (strongly linked to RPAH);
- St George Hospital;
- Sydney Hospital.

Clinical research is also done at other metropolitan hospitals, such as Nepean (linked with the University of Sydney), Gosford (linked with the University of Newcastle), and Manly (linked with Royal North Shore Hospital).

Outside the metropolitan areas, research foci exist in Lismore (Northern Rivers Health Service, in conjunction with Southern Cross University and the University of Sydney), Broken Hill (Far West Health Service and the University of Sydney), and Moree (the University of Sydney). These foci are all notable for their work in public health and health-services research.

Beyond question the geographic scatter of NSW research is not ideal, and may be wasteful. In reality, the State could address it only at great expense, although some modification may be possible.

3.2.3 Medical and health research in independent institutes

In some of the clusters described above, research groups within specific fields have formed centres or institutes. The number of these has increased over the last decade. The centres and institutes often contain both university and Area Health Service elements in addition to an institutional governance and/or advisory structure. Most of the centres and institutes are constituted within a university or an Area Health Service, which provides space for the research work (or land for a purpose-built building) as well as some infrastructure support (ranging from payroll and other administrative services to electricity supply and information-technology support). The directors of the centres and institutes are usually employed by and report to either a university or an Area Health Service. They often hold conjoint appointments in both, or a salaried appointment in one and an adjunct appointment in the other.

Only a few of these centres and institutes can be described as truly independent. Hallmarks of independence include:

- incorporation under the Corporations Law, or constitution under statute, with a board of governors that is independent of a university or Area Health Service;
- an institute having the capacity to apply its own conditions of employment, and to employ staff using its own payroll and human-resources services, without reference to the payroll and human-resources services of a university or Area Health Service;
- the absence of infrastructure support from a university or Area Health Service;
- compliance with NHMRC Policy on Accreditation of Health and Medical Research Institutes, (July 2003), and eligibility for accreditation by the NHMRC as an independent institute.

Alternatively, an institute may be considered to be independent only to the degree that it submits its research-grant applications, and receives grant funds, through its own administrative system, without reference to a university or an Area Health Service.

Two medical research institutes in NSW are constituted under statute: the Garvan Institute of Medical Research, and the Centenary Institute of Cancer Medicine and Cell Biology. Several others have a legitimate claim to being identified as 'independent'. Others are named as institutes, and have strong track records of performance, but do not claim to fulfil criteria of independence.

All of these entities have a relatively short history. An exception is the Kolling Institute of Medical Research, which began research in 1920, having been established under the Royal North Shore Hospital of Sydney Act 1910. The Children's Medical Research Institute was established in 1958. The Garvan Institute was established in 1963 as the clinical research unit of St Vincent's Hospital. Many of the others were established in the 1990s from a coalescence of pre-existing university- and hospital-based research groups. The Centenary Institute was established by an Act of the NSW Parliament in 1985, to commemorate the centenaries of the

University of Sydney's medical school and Royal Prince Alfred Hospital. It became a functioning entity in 1989.

While NSW has a small number of truly-independent institutes and a larger number of what might be described as semi-independent research centres, Victorian research strength is concentrated in a relatively small number of outstanding institutes. The leading example is the Walter and Eliza Hall Institute. The Hall Institute began operations in 1919, drawing on a large charitable trust that had been established with the proceeds of gold-mining in the Victorian gold rush, the pastoral industry, and the Cobb & Co horse-drawn coach line. Through its 84 years, the Hall Institute has been home to some of Australia's most important biomedical research figures, including one Nobel laureate (Sir Macfarlane Burnet, who was Director from 1944 to 1965). None of the NSW institutes has such a solid foundation, or such a long and rich history of achievement.

Queensland's research strength is also concentrated in a small number of institutes, of which two stand out – the Queensland Institute of Medical Research (QIMR), and the Institute for Molecular Bioscience (IMB). The QIMR was established by an Act of the Queensland Parliament in 1945. The IMB was established in 2002 from a coalescence of pre-existing research groups at the University of Queensland, and remains an entity of the University. Both are on the scale of the larger Victorian institutes or the Garvan Institute, and both receive very substantial support from the Queensland Government. Given the very small number of independent institutes and the fact that the IMB is a university entity, a large proportion of medical and health research in Queensland is attributed to the university and health-service sectors.

As noted in sections 3.1.1 to 3.1.3, an understanding of the extent of development of independent institutes is important in making sense of the distribution of funding for research (see Chapter 4), and assessing Statewide research performance and interpreting data on peer-reviewed grants, publications, and other indicators (see Chapters 5-7).

Many independent institutes have explored their eligibility for Commonwealth DEST funding under the Higher Education Funding Act 1988. Since the mid-1990s a number of independent institutes in different parts of Australia have found ways of obtaining infrastructure funds from DEST, by forging strong links with universities. The current Commonwealth Government inquiry into infrastructure funding of research is likely to examine these practices. It will also examine the option of supplementing peer-reviewed grants with infrastructure payments, as is done for grants from the US National Institutes of Health.

3.3 NSW Government funding of medical and health research

3.3.1 History

Until the 1996-97 financial year, State Government funding of medical and health research in NSW was very limited. Most of the funding was derived from two budget programs of the Department of Health – the External Research Program and the Teaching and Research Program.

Funds in the External Research Program, totalling $4.68 million in 1995/96, were allocated to several research institutes. There was no discernible policy objective for the Program as a whole, for the allocation of funds to particular institutes, or for the quantum of funds that each received. No formal selection or allocation process had ever been conducted. Institutes essentially obtained funding by lobbying health ministers and senior government officials. About 90% of the funds went to institutes which were predominantly involved in biomedical and clinical research, and the remainder to groups with a primary interest in population health research, health services research, and health economics.

The Teaching and Research Program was allocated to Area Health Services (then Area and District Health Services) in accordance with the distribution of high-cost complex casemix. In practice, the Teaching and Research Program was not intended explicitly to support education and research per se, but rather to fund the extra costs associated with providing clinical care in hospitals in which teaching and research took place. An analysis of the Teaching and Research Program is given in Chapter 4.

In addition to these two Programs, the Department of Health has funded research to support its own needs in decision making, monitoring the health of the State's population, and evaluating health services. It has included research activities conducted within the Department; commissioned research to support policy and program development; funding of the State's Central Cancer Registry and analysis of epidemiological data on cancer; funding to establish the NSW Breast Cancer Institute and to bid for establishment of the National Breast Cancer Institute in NSW; and various scholarships. Internal Departmental research, and its commissioning of external research, are also discussed in Chapter 4.

At least two reviews of the Department's funding of medical and health research were commissioned in the early 1990s. The first was led by Professor Matthew Vadas, from Adelaide, and the second was led by Professor Paul Korner, who had recently retired as the Director of the Baker Institute in Melbourne. Information on the origins and outcomes of the first review is no longer available. The second review seems to have been stimulated by a Departmental impetus to improve the performance of medical and health research institutes, recognising that NSW consistently attracted less NHMRC funding than Victoria. Also, directors of institutes – both those funded and those not funded under the External Research Program – were unhappy about the allocation of funding, and continued to lobby ministers. The medical

and health research community in NSW was united in arguing for more funding and for some basis for funding allocations other than historical precedent and political favour.

The Korner review was never released. Rather, under Mr Wyn Owen's leadership as Director General, the NSW Department of Health moved to place a strong emphasis on research and the implementation of research-based knowledge in policy and practice. The Department formed a Centre for Research and Development which, inter alia, had responsibility for research funding policy and the design and implementation of new mechanisms for the funding of independent institutes and other health-system-based research organisations.

As part of the process for the development of a policy framework for research funding, a discussion paper entitled *Research and Development in the NSW Health System* was widely circulated in August 1995. The concepts outlined in this discussion paper, subsequently modified after public consideration, led to the establishment of the NSW Health Infrastructure Grants Program, described below. Funding in the new Program commenced in 1996/97, superseding the External Research Program.

3.3.2 Infrastructure Grants Program and Capacity-Building Grants Program, 1997-2006

Overall intent and structure of the IGP

The overall goal of the Infrastructure Grants Program, as determined in 1995, was to stimulate health and medical R&D in NSW. The most important barrier to health and medical R&D was perceived as being a lack of funding for the components of research that were not covered by Australian competitive peer-reviewed grants. Peer-reviewed grants were perceived as covering only the marginal costs of research, and not the underlying costs of the enterprise that enabled researchers to compete for grants and carry out the research that the grants funded.

When the IGP was established, policy decisions were made:

- to define infrastructure as 'anything needed for research but not covered by a grant', other than capital works;
- to confine eligibility to research organisations based in the health system, not the higher-education system;
- to allocate infrastructure grants in proportion to peer-reviewed grant funding, with reference to funding programs on the Australian Competitive Grants Register;
- to expect that grant recipients would use the funds for purposes such as the salaries of senior scientists and administrative staff, as well as information and communication technology, libraries, data access, laboratory equipment, furniture, electricity and other services, and other such requirements for the running of a research enterprise; and
- to require general accountability, but not detailed item-by-item accountability.

The IGP, as established, comprised three streams. Stream 1 was intended for large biomedical and clinical research organisations that were accredited as independent institutes by the NHMRC. Stream 2 was intended for medium-sized biomedical and clinical research organisations (as described in sections 3.2.2 and 3.2.3). Stream 3 was intended for public health and health-services research organisations. Streaming was not intended to be a measure of quality.

Outcomes of the 2002 review

The IGP was reviewed by an independent panel in 2002, with extensive consultation. This review led to five changes that were implemented in the third round (2003-04 to 2005-06):

- Streams 1 and 2 were opened to all medical and health research organisations that met eligibility criteria, rather than being restricted to those undertaking biomedical or clinical research.
- New eligibility criteria were introduced, whereby the distinction between Streams 1 and 2 was based on level of peer-reviewed income and number of research staff, rather than on degree of 'independence'.
- A weighted formula was introduced for the allocation of IGP funds. Allocations were calculated based on peer-reviewed grant income for the preceding three years, with greater weight given to the more recent years. This rewarded organisations that were growing, and meant that funding was better aligned with current infrastructure needs.
- Where research entities put all or some of their research grants through a university and attracted DEST RIBG funds, a proportion of these funds was subtracted from the IGP allocation.
- Stream 3 was replaced by the Capacity Building Infrastructure Grants Program.

The third round (2003-04 to 2005-06)

To be eligible for Stream 1 IGP funding in the third round, candidate institutes had to be based in the NSW health system, had to have received at least $2.5 million in peer-reviewed grants per annum over the preceding three years, had to have 40 or more full-time equivalent (FTE) research staff employed through research funds, and had to meet the following criteria for independence:

- have an independent governance structure;
- be able to determine and implement research directions and policies;
- have an identifiable budget for infrastructure;
- not rely substantially on a university or Area Health Service for general infrastructure; and
- have the capacity to account for funds.

To be eligible for Stream 2, applicants had to have received at least $1 million in peer-reviewed grants per annum over the preceding three years, have 20 or more FTE research staff employed through research funds, and meet the same criteria for independence as Stream 1.

Infrastructure was defined as: "The facilities and functions of a research organisation which are not specific to research projects e.g. animal facilities, maintenance of laboratory equipment and service contracts, scientific equipment not specific to projects, purchase of generic consumables, subscription to gene databases, general maintenance costs, telephone/communication systems, office and computer equipment, and the salaries of administrative and senior scientific staff. It excludes funds for staff and materials deployed on specific projects."

Eligibility criteria for all three rounds of funding under Streams 1 and 2 of the IGP are summarised in Table 3A1 (essential eligibility criteria) and Table 3A2 (additional eligibility criteria). These Tables have been placed in an addendum at the end of this Chapter.

A separate expert selection panel reviewed the 22 applications for the third round, and this led to a total of 14 research organisations receiving IGP funding: six in Stream 1, and eight in Stream 2. In addition, one applicant received special funding. The successful applicants, and the funding awarded to them over three years 2003-04 to 2005-06, are listed in Box 3.1.

Box 3.1: Successful applicants in the third round of the NSW Medical and Health R&D Infrastructure Grants Program, Streams 1 and 2, and their total three-year funding, 2003-04 to 2005-06

Stream 1

Garvan Institute of Medical Research - $10.73 million.
Westmead Millennium Institute - $6.95 million.
Prince of Wales Medical Research Institute - $4.44 million.
Centenary Institute of Cancer Medicine and Cell Biology - $3.78 million.
Kolling Institute of Medical Research - $3.37 million.
Victor Chang Cardiac Research Institute - $3.33 million.

Stream 2

Woolcock Institute of Medical Research - $2.30 million.
Children's Medical Research Institute - $2.23 million.
Centre for Immunology - $2.11 million.
Centre for Vascular Research - $1.94 million.
The Heart Research Institute - $1.60 million.
National Centre in HIV Epidemiology and Clinical Research - $1.39 million.
ANZAC Research Institute - $1.30 million.

In addition, the Hunter Medical Research Institute, which did not satisfy the specified criteria, received a special grant of $3.86 million.

Capacity Building Infrastructure Grants program, 2003-04 to 2005-06

The intent of the CBIG program is to build the capacity and competitiveness of NSW research organisations in the fields of public health research, primary health care research, and health-services research, particularly encouraging research in these fields that addresses the priorities of the NSW Health system.

Another expert selection panel reviewed the 19 applications, and this led to eight organisations receiving CBIG program awards, totalling $9.6 million. Six received grants of $1.5 million over the three years, and two received special grants of $300,000. The successful applicants, and the funding awarded to them over three years 2003-04 to 2005-06, are listed in Box 3.2.

Box 3.2: Successful applicants in the NSW Health R&D Capacity-Building Infrastructure Grants program, and their total three-year funding, 2003-04 to 2005-06

Six organisations awarded $1.5 million each

Australian Rural Health Research Collaboration (Moree, Lismore, Broken Hill)
Centre for Health Service Development, University of Wollongong
Newcastle Institute for Public Health (Hunter Medical Research Institute*)
Centre for Infectious Diseases and Microbiology, Westmead
Centre for Health Informatics, University of NSW
Consortium for Social and Policy Research on HIV, Hepatitis C and Related Diseases, University of NSW

*in addition to the special grant awarded to the Hunter Medical Research Institute under the IGP.

Two special grants of $300,000 each

Centres for Primary Health Care and Equity
Primary Health Institute

3.3.3 Biotechnology funding

Alongside the support for medical and health research provided through the IGP and the CBIG program, the NSW Government established the Bio*First* Strategy to promote biotechnology in the State, with an August 2001 announcement from Premier Carr of a commitment of $68 million to the Strategy over a five-year period. The Strategy is a 'whole-of-government' initiative involving the NSW Departments of Health, Agriculture, and State and Regional Development, as well as other agencies. Until the establishment of the Ministry for Science and Medical Research in December 2003, the implementation of the Bio*First* Strategy was coordinated through the BioUnit of the Cabinet Office.

The Strategy has three components in addition to the coordinating activity of the Ministry (or, previously, the BioUnit):

- BioPlatform, which aims to build on the State's existing biotechnology research capacity, and to support scientists. The NSW Department of Health is a lead agency for BioPlatform.

- BioBusiness, which aims to promote and assist the translation of research into commercial products, enhance opportunities for small biotechnology businesses to grow and expand into international markets, and attract new biotechnology investment into NSW.

- BioEthics, which aims to promote informed community discussion of ethical and regulatory issues, conduct community consultation, ensure that the State has a fair and responsible regulatory system for biotechnology, and develop and maintain biotechnology risk-management plans.

The Bio*First* Strategy will be the subject of a formal mid-term review in 2004.

Under BioPlatform, capital development funds totalling $28 million have been allocated to the development of the St Vincent's Research and Biotechnology Precinct ($20 million over five years) to bring together the Garvan and Victor Chang Institutes and research groups in St Vincent's Hospital; and the development of the Westmead Millennium Institute Stage 2 in the context of support for the Westmead Research Hub ($8 million over five years). These allocations are important for promoting the concept of biocentres. Numerous submissions received by the Panel expressed a view that the processes for allocating this money did not allow for full consideration of competing claims.

Also under BioPlatform are the Converging Technologies initiative and the BioFirst Awards program.

- The Converging Technologies initiative will provide much-needed high-bandwidth communication capacity for biotechnology research institutions in the not-for-profit and public sectors.

- The BioFirst Awards program, which provides 'top-up' funding to attract biotechnology researchers to NSW, has been well received. Five researchers have received awards – fewer than desired – but further awards are in the pipeline. It is too early to assess the effectiveness of the BioFirst Awards in building a critical mass of biotechnology researchers in the State.

Bio-Link, a new business alliance created to expedite the commercialisation of life-science research in NSW, was announced by the Premier in December 2002, with funding of $650,000 per annum for four years. Foundation participants include the Garvan Institute, the Westmead Research Hub, and the Hunter Medical Research Institute. The need to improve patenting and

commercialisation is apparent but it remains to be seen whether the proposed model will prove effective.

A full discussion of the State's directions in medical biotechnology is given in Chapter 7 of this report.

3.4 Biocentres

In recent years the NSW Government has expressed interest in the formation of 'biocentres' for medical and health research. Biocentres are large aggregations of research and biotechnology groups in geographically-defined precincts, linking universities, teaching hospitals, independent institutes, and private industry. The Government has provided various incentives for the development of biocentres at specific sites, notably Westmead and the St Vincent's Hospital precinct (see section 3.3.3). It has also stimulated mechanisms for the establishment of linkages among hubs, both through the provision of funding for high-bandwidth communication networks and through initiatives such as Bio-Link.

Biocentres will generate a major cultural shift from the traditional tribalism of research, described in section 3.1.1, and a move to expand the horizons of the small self-sufficient clusters that have formed in the past (section 3.2.2). The process of biocentre development is likely to take several years. Early signs of success are evident in that, within nascent biocentres such as that at Westmead, institutions which previously operated separately have reported a new collegiality, new shared approaches to the management of intellectual property, and processes for the sharing of high-cost research technology. But the developments are piecemeal, and are likely to take many years to consolidate.

There are limited data on the advantages and disadvantages of such aggregations on which to develop policy. It is more likely that clusters will be effective if they occur naturally, and are appropriately supported and developed, than if they created artificially. Conversely, artificial creation of research clusters is unlikely to be effective. It is clear that there are very effective research clusters, such as the 'Parkville Strip'. For many, the possibility of chance encounters between researchers working in close proximity is itself a catalyst for productivity. For example, the collaboration that led to the 1996 Nobel Prize arose when there was insufficient space at the John Curtin School of Medical Research (JCSMR) for a Swiss PhD Student, Rolf Zinkernagel, who moved along the corridor to the laboratory of Peter Doherty.

As mentioned in Chapter 1, the Minister for Science and Medical Research has commissioned a separate review of biocentres.

3.5 Medical and health research priorities in NSW

3.5.1 Preamble

In this section, we outline the approaches that have been taken, both within the NSW health system and throughout Australia, in the determination of priorities for research. The identification of these priorities can help in decisions about strategic investment in research.

In addition to their support for investigator-driven basic research, governments throughout the world have often sought to align research funding to health-system priorities. For example, the CBIG program was deliberately established in order to promote research on NSW health system priorities. The NSW Department of Health has also established an expert group (the Getting Research into Policy and Practice Committee) to foster integration of research with policy and practice, and is working with the Institute for Health Research (described in section 4.2.3) to conduct a research priority-setting process based on that used by the Canadian Institutes of Health Research.

In most health systems, health priorities and research are aligned partly through directed funding, partly through researchers' own recognition that priority areas are important and fruitful areas for research, and partly by the pressure of peer review. In general, good researchers are acutely aware of the priority areas in their fields of expertise. They have an unequalled depth of knowledge about their fields, and they know what can be achieved with contemporary research methods. Major funding agencies, such as the NHMRC, exert considerable pressure in ensuring that grants are awarded for research on priority topics, as the peer-review process brings to bear the knowledge of many international experts.

Evidence from overseas suggests that ongoing dialogue between decision makers and researchers is needed to shape research programs that are policy-relevant, and to promote the uptake of research into policy. Independent 'research brokers', such as Academy Health in the USA and the Canadian Health Services Research Foundation, can help to bridge the divides among research groups and health decision-makers. The Institute for Health Research, established in 2002 with funding from the NSW Department of Health, is beginning to fulfil this role in NSW. Its activities include streamlining the process for commissioning reviews of research evidence, and facilitating complex multi-centre bids for research grants and commissions.

3.5.2 The burden of disease

The overall burden of disease in a population, such as the population of NSW, can be calculated by combining the *number of years lost due to premature death* and the *number of years lived with a disability*. From this calculation, the number of *disability-adjusted life years* (DALYs) can be estimated. Because the data are difficult to compile, figures on burden are

published only occasionally, and the most recent Australian figures refer to the calendar year 1996. In that year the total burden of disease in NSW amounted to 864,652 DALYs. Eleven conditions accounted for more than 90% of the total burden (Table 3.1).

Table 3.1: Diseases or conditions accounting for more than 90% of the total burden of disease in NSW, 1996

Disease or condition	Burden due to the disease or condition (number of disability-adjusted life years), NSW, 1996	Proportion of total NSW burden (percent)
Cardiovascular disease	198,258	22.9
Malignant neoplasms	163,375	18.9
Mental disorders	116,558	13.5
Nervous system disorders	82,056	9.5
Chronic respiratory diseases	63,197	7.3
Unintentional injuries	41,509	4.8
Musculo-skeletal diseases	30,965	3.6
Digestive system diseases	22,647	2.6
Intentional injuries	21,900	2.5
Genito-urinary diseases	21,540	2.5
Diabetes mellitus	21,288	2.5

Source: The Health of the People of NSW. Report of the Chief Health Officer, 2002

Cardiovascular disease, cancer, and mental and nervous-system disorders predominate, accounting for about two-thirds of the total burden.

Certain conditions impose a particularly heavy burden in specific populations. For example, much of the excessive morbidity and mortality of Aboriginal and Torres Strait Islander peoples in NSW can be attributed to cardiovascular disease (ischaemic heart disease), type 2 diabetes, injuries, and chronic renal failure.

3.5.3 Morbidity and the ageing of the population

The Premier has drawn attention to the ageing of the population as one of the most critical policy challenges facing the State in the coming years. To deal with this challenge, it is important to identify gaps in knowledge relating to the major causes of morbidity that affect older people. Strategic research can then be supported or commissioned to fill these gaps.

With the exception of intentional injuries, the occurrence of almost all of the 11 conditions listed above increases with age. The following are of particular importance:

Cardiovascular disease: atherosclerosis, cardiac failure.
Cancer: many cancers, most notably colorectal, breast, lung and prostate cancer.

Mental disorders and nervous system disorders: depression, dementia, and disorders of balance, sight and hearing.
Chronic respiratory diseases: chronic obstructive pulmonary disease.
Musculo-skeletal diseases: arthritis, osteoporosis.
Genito-urinary diseases: urinary incontinence.
Diabetes mellitus: type 2 diabetes.

3.5.4 National and State health priorities

The following have been established as National Health Priority Areas, endorsed by the Australian Health Ministers' Council:

Heart disease, stroke, and vascular disease*
Cancer*
Asthma*
Diabetes*
Injury*
Mental health*
Arthritis and musculo-skeletal disease

The National Health Priority Areas selected by the NSW Department of Health as priorities for research are marked with an asterisk (*). The Department has also identified the following conditions as priorities for research:

- Developmental disorders in children
- Chronic neurodegenerative diseases (e.g. Alzheimer's disease)
- Blood-borne infections (e.g. HIV/AIDS and hepatitis C)
- Nosocomial infections (i.e. infections acquired by patients in hospital)
- Vaccine-preventable diseases
- Diseases potentially amenable to gene therapy.

In addition, the Department has highlighted the following topics and issues as research priorities:

- *Health-related biotechnology* – functional and structural genomics, proteomics, bioinformatics, the convergence between biotechnology and other technologies.
- *Health risks* – smoking, obesity, inadequate physical activity, alcohol use, use of licit and illicit drugs.
- *Health of specific populations* – Aboriginal and Torres Strait Islander peoples, rural and remote populations, older people, and children.
- *Health inequalities* – addressing the impact of socioeconomic inequalities on health.

- *Health system issue*s – the organisation, financing and delivery of health services to promote equity of access and equity of outcomes, and optimise continuity of care for people with chronic and complex health conditions.
- *Health informatics* – surveillance systems for epidemiologic trends and clinical quality assurance, current awareness tools to facilitate the implementation of new and existing knowledge, electronic information dissemination systems.
- *Research transfer* – barriers and enablers to implementation of research findings, effective methods for synthesising research evidence, encouraging commercial development of the products of research.

3.5.5 Selection of priorities

Based on the data in sections 3.5.2 to 3.5.4, the following emerge as broad research priorities for NSW:

- Cardiovascular disease
- Cancer
- Mental disorders
- Nervous system disorders
- Chronic respiratory diseases
- Unintentional injuries
- Musculo-skeletal diseases
- Diabetes mellitus
- Childhood development disorders
- Infectious diseases
- Diseases potentially amenable to gene therapy
- Public health: prevention through management of disease risk factors, e.g. inadequate physical activity
- Health-service and health-system issues: the organisation, financing and delivery of health services to promote equity of access and outcomes, and optimise continuity of care for people with chronic and complex diseases.

A matrix addressing these priorities in relation to the State's capacity is given in Chapter 8.

3.6 Ethical clearance of research

Problems associated with the ethical clearance of research were raised with the Panel in a number of submissions, including one from the NSW Department of Health. The submissions drew attention especially to the difficulties associated with ethical clearance of multi-centre research, and the cumbersome processes of ethical review generally.

All research involving humans must be approved by a Human Research Ethics Committee (HREC). There are 226 HRECs throughout Australia. Some 55 are based in NSW Government, academic, non-government and private-sector institutions, and 25 of these are within the NSW public-sector health system, covering the NSW Department of Health and every Area Health Service. HRECs comprise mainly volunteer or invited members who receive no financial support and little training.

Ethical clearance of research is the subject of national protocols. The NHMRC is responsible for formulating guidelines and policy for HRECs on a national basis, and HRECs operate in accordance with the NHMRC *National Statement on Ethical Conduct in Research Involving Humans* (1999). NHMRC and other national peer-reviewed funding may be withdrawn from any research involving humans that is carried out without HREC approval. Legal and financial levers, taken in combination, give the Commonwealth the whip hand in deciding the nature of ethical clearance processes.

HRECs are reportedly experiencing a substantial increase in workload. While year-to-year variations are evident, national data suggest an increase of the order of 10% in the number of ethics applications considered by HRECs over the three years to 30 June 2003. HRECs also report some increase in the complexity of the applications that they examine, and additional pressures due to the requirement to monitor compliance of researchers with ethical undertakings. There have been no appreciable changes in the resources available to support HRECs, and the number of HRECs has remained constant.

With regard to multi-centre studies, individual HRECs have proved reluctant to rely on the research and reviews undertaken by counterpart committees to alleviate workloads or lack of expertise. Behind this is an uncertainty as to capacity of other HRECs for scientific assessment of applications, particularly in specialist fields, and legal liability and legal indemnity issues.

Particular complications arise in multi-centre research where there is likely to be duplication of effort and delay. The legal design and the individual sense of responsibility and accountability that attach to the ethical clearance process lead to multi-centre clinical trials being separately reviewed and monitored by the HREC responsible for each separate institution. One consequence, possibly a benefit and possibly a complication, is inconsistent feedback regarding the technical and scientific aspects of the trial. Duplication of effort is common. However, individual HRECs have a duty of care to their local populations, which may differ in ways that create particular sensitivities. HRECs have to take these sensitivities into account in ethical assessments of research.

If research activity is expanded, HREC processes are a potential constraint unless their members are trained, and they are given resources and expanded or streamlined to carry out their work. In the main it is the Commonwealth Government that is best placed to achieve this. Recent surveys that the NHMRC itself commissioned indicated a range of practical issues where that organisation could assist HRECs to operate, e.g. with more ready access to scientific assessment and by providing more precise and definitive practical advice. The

absence of definitive advice from central agencies is a constant concern of HRECs. In addition there are no clear guidelines as to, say, the level of monitoring that HRECs should undertake in different research situations.

The Panel has no single solution. Streamlining of processes, simpler documentation, shared scientific assessment and clarification of legal responsibility have all been under consideration at a national level. The more NSW can itself improve the training, data and advice available to its HRECs, the quicker and the better their performance. Pushing for the finalisation of the proposed standard national application form for clinical research, so that researchers submit a standardised set of information to each HREC, is a long sought objective. NSW should continue to push the NHMRC for agreement on its terms.

The NSW pilot of a shared scientific assessment scheme for multi-centre clinical drug trials, currently being evaluated, seems to be a step in the right direction. Under this arrangement methodological and safety issues are resolved prior to submission to local HRECs. The NSW Department of Health is also examining the feasibility of piloting central HREC review in certain areas of NSW Health. The Australian Health Ethics Committee has notified the NSW Department of Health of its intention to pilot a central review committee throughout Australia for epidemiological and public health research.

Because of the national legal and funding requirements, and the need therefore for individual Area Health Services to satisfy themselves that the legal as well as the ethical considerations are acceptable to them, centralised decision making is not likely to work. Queensland reputedly tried to introduce centralised multi-centre research clearance but the system faltered.

Other useful things NSW Health can do are to encourage institutes to recognise the importance of the HREC approval process in their research programs, and encourage them to resource their HRECs appropriately. Funding should be available for programs for the training, education and support of HRECs. Techniques for improving communication between HRECs would be beneficial. The approach to promoting shared scientific assessment is also potentially beneficial. Responsibilities of HRECs to monitor approved research should be articulated and standardised.

Elsewhere in this report, the Panel recommends the appointment of a Chief Scientist (Medical and Health Research) for the State, together with Directors of Research in each of the Area Health Services. The Panel believes that the Chief Scientist and Directors of Research will be able to help in the streamlining of ethical clearance processes. Both will give authority and clearer responsibility from which HRECs will benefit. Additional resources to carry out the ethical assessment of research are desirable.

Addendum

As noted in section 3.3.2, Tables 3A1 and 3A2 compare essential and additional eligibility criteria respectively across Streams 1 and 2 and across all three rounds of the Infrastructure Grants Program.

Table 3A1: NSW Infrastructure Grants Program essential eligibility criteria for Streams 1 and 2 in Rounds 1, 2 and 3

	Round 1		Round 2		Round 3	
	Stream 1	Stream 2	Stream 1	Stream 2	Stream 1	Stream 2
Health & medical R&D as primary function of the organisation	yes	yes	yes	yes	yes	yes
Location within NSW and funds used principally within NSW	yes	yes	yes	yes	yes	yes
Affiliation with a Health Service and/or public hospital in NSW	yes	yes	yes	yes	yes	yes
Identifiable entity with independence of operation: a) Capapcity to determine and implement its own research directions b) Identifiable budget for infrastructure, and control over this budget c) Capacity to account for grant funds	yes	yes	yes	yes	yes	yes
Interaction with one or more universities in NSW	yes	yes	yes	yes	yes	yes
Appropriately qualified and experienced director	yes	yes	yes	yes	yes	yes
Demonstrate good scientific practice	yes	yes	yes	yes	yes	yes
Mechanism for the management of intellectual property	no	no	yes	yes	yes	yes

Table 3A2: NSW Infrastructure Grants Program additional eligibility criteria for Streams 1 and 2 in Rounds 1, 2 and 3

	Round 1		Round 2		Round 3	
	Stream 1	Stream 2	Stream 1	Stream 2	Stream 1	Stream 2
Independence						
a) Autonomous entity – Act of NSW Parliament or incorporated under legislation for companies or associations	yes	no	yes	no	no	no
b) Independent Board of Management – on which no affiliated University, Health Service or hospital has a majority representation	yes	no	yes	no	yes	yes
c) Independent responsibility for infrastructure and research staff – must not rely on University or Health Service for general infrastructure, no more than 20% staff salaries from University or Health Service budgets	yes	no	yes	no	no	no
Track record of funding from competitive mechanisms	At least $1 million pa peer-reviewed grant income 1994-96	At least $350,000 pa peer-reviewed grant income 1992-96*	At least $1 million pa peer-reviewed grant income 1997-99	At least $350,000 pa peer-reviewed grant income 1997-99	At least $2.5 million pa peer-reviewed grant income 2000-02	At least $1 million pa peer-reviewed grant income 2000-02
Research staff	Not specified	Employ 20-plus research staff*	Not specified	Employ 20-plus research staff	Employ 40-plus FTE research staff through funds attracted for research	Employ 20-plus FTE research staff through funds attracted for research
NHMRC accreditation as an independent medical research institute	yes	no	yes	no	no	no

*Eligibility requires $350,000 peer reviewed grant income pa and/or 20 research staff

4 The funding of medical and health research in NSW

Main points

- On a per-capita basis, NSW receives a smaller proportion of overall national funding from all public and private sources for medical and health research than Victoria. Based on the most recent figures (2000-01), $84 per head of population goes to NSW, $116 to Victoria, and $61 to Queensland.

- State Governments provide just under one-tenth of the nation's funding for medical and health research, while the Commonwealth Government provides just under half, and the business sector one-quarter.

- However, the contribution of State Governments is crucial for setting directions, ensuring that research done around the world is implemented locally, and promoting a commitment to inquiry, evaluation and service improvement.

- Victoria and Queensland have given much stronger support to medical and health research than the NSW Government. On a population basis in 2000-01, Victoria provided about double, and the Queensland Government about one-and-a-half times, the amount provided by NSW.

- The NSW Government contributed 6% of the total investment in medical and health research in NSW – appreciably less than the 9% contributed by all State and Territory Governments combined to the total national figure.

- The business sector is a strong contributor to overall funding of medical and health R&D in NSW, most of the expenditure remains within the sector, and NSW business is not currently funding significant academic research.

- Philanthropy is an important source of funding for medical and health research. Indeed, philanthropy is a substantially larger source of funding than State Governments. Victorian researchers have been particularly successful in attracting philanthropic funds.

- NSW has performed well in attracting overseas funding for medical and health research, although a large part of this is funding from international business to the Australian business sector.

- The total funding accessible by researchers in NSW, in comparison with their interstate competitions, suggests that they are less well resourced.

- Departmental estimates suggest that the proportion of funding attributable to research under the Department's Teaching and Research Program halved in the eight years 1993-

94 to 2001-02 from 46% to 22%. The Department is developing methods to account more precisely for teaching and research expenditure under the Program.

- The NSW Department of Health expends a significant amount of money on externally-commissioned research, especially in the health services area. The processes for commissioning the research are often under time pressure, and run the risk of not giving sufficient consideration to valid conceptual design. Similar difficulties have been identified in the UK National Health Service, and appear to exist within other State health departments. The Chief Scientist (Medical and Health Research), a post suggested later in this report, could have responsibility for promoting the quality and applicability of commissioned research.

- Based on the amounts of money spent, medical and health research in NSW is heavily concentrated in the higher-education sector and the business sector. Independent medical research institutes (which are included in the private not-for-profit sector) are much more prominent in Victoria, reflecting the number and strength of such institutes in Melbourne.

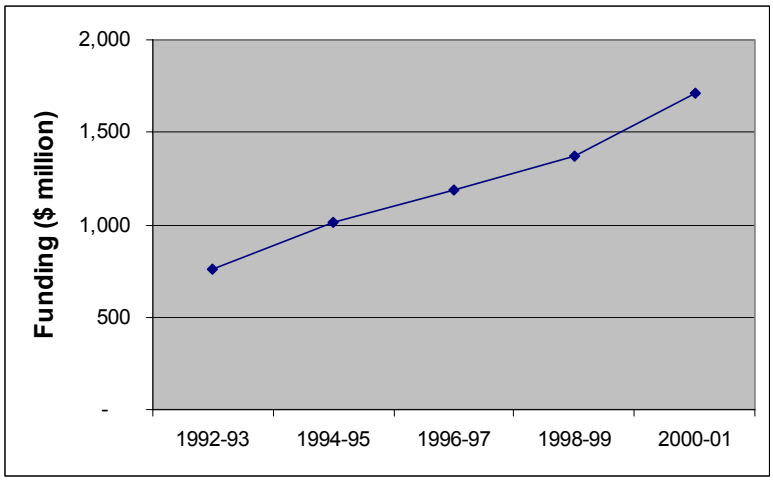
- The higher-education sector in NSW attracts large amounts of Commonwealth money through research and research-training subsidies paid to universities under the provisions of the Commonwealth Higher Education Funding Act 1988.

4.1 Overall investment in medical and health research

4.1.1 National funding facts

Total national funding of medical and health R&D in 2000-01 was $1.72 billion, or about 17% of gross expenditure on R&D across all fields. Total national funding of medical and health research has increased consistently over the last decade - in 2000-01 the level of funding was more than double the 1992-93 figure of $763 million (Figure 4.1).

Figure 4.1: Total national funding of medical and health research by year (biennially, 1992-93 to 2000-01)



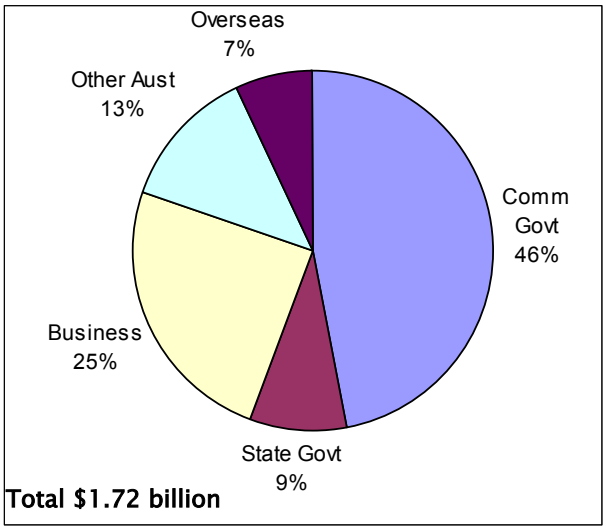
Source: ABS

Broadly, the funding comes from five sources, as follows:

a) the Commonwealth Government;
b) State and Territory Governments;
c) the business sector;
d) other Australian sources; and
e) overseas sources.

Figure 4.2 shows how much each of these sources contributed to the national total in 2002.

Figure 4.2: Where the money came from for medical and health research, Australia, 2000-01



Source: ABS

The sources of funding are examined in the national context below, and in the NSW context in section 4.2.

The pattern of funding for medical and health research has differed from that of R&D in other fields of science and innovation. Business investment in medical and health research has been much lower than its R&D investment in other fields of science and innovation, while Commonwealth Government investment has been significantly higher. Overseas investment in medical and health research has been relatively strong, and funding for medical and health research from other Australian sources (philanthropy and universities) has been much higher than funding for R&D in other fields of science and innovation.

(a) Commonwealth Government funding

The Commonwealth Government is the largest source of funds for medical and health R&D in Australia, providing almost half. The funds are distributed through several Commonwealth agencies and diverse programs, as follows.

i. National agencies that award peer-reviewed grants on a competitive basis, principally the National Health and Medical Research Council (NHMRC) and the Australian Research Council (ARC).

ii. Subsidies for university-based research and research training provided by the Department of Education, Science and Training (DEST).

iii. Direct funding of Commonwealth research agencies, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Nuclear Science and Technology Organisation (ANSTO).

iv. Specific programs administered by DEST and the Department of Industry, Tourism and Resources (DITR) to assist science and innovation in specific ways; two important ones are the Cooperative Research Centre (CRC) program and the Major National Research Facilities (MNRF) program.

v. Industry grants to promote the commercial development of Australian research in Australia, tax incentives for companies involved in the commercial development of research, and tax concessions for philanthropy.

i. National agencies that award peer-reviewed grants on a competitive basis

Public and not-for-profit medical and health research institutions rely heavily on grants from the NHMRC and, to a lesser extent, the ARC. These grants, which are awarded for research, research-training scholarships, and fellowships, are described in detail in Chapter 5. The level of Commonwealth Government grant monies for medical and health research funding has doubled over the last five years. In 1999, the NHMRC budget was $160.7 million, and in 2003 total NHMRC funding was $301.9 million. The increases followed the Commonwealth Government's consideration of the recommendations of the Wills Review (1999). ARC funding of medical and health research has increased from $19.6 million in 2000 to $39.1 million in 2003. In addition to NHMRC and ARC research-training scholarships, DEST conducts the Australian Postgraduate Awards scheme, which provides research-training scholarships in all fields of science, including medical and health research.

ii. DEST subsidies for university-based research and research training

A Schedule to the Commonwealth Higher Education Funding Act 1988 lists higher-education institutions throughout Australia that are eligible to receive subsidies for research and research-training activities. The subsidies are calculated using formulae that take account of specified performance measures and indicators. Four Commonwealth schemes are relevant: the Institutional Grants Scheme, the Research Training Scheme, the Research Infrastructure Block Grants Scheme, and the Systematic Infrastructure Initiative.

- The Institutional Grants Scheme (IGS), implemented in 2002. This absorbed funding that was previously allocated under the Research Quantum and the Small Grants Scheme. IGS funds are allocated via a formula that takes into account the university's success in attracting research students (30% of funding), attracting research income (60%), and research publications (10%). The IGS applies to all research income, not just grants listed

in the Australian Competitive Grants Register. At present, for every dollar of an eligible research grant, the IGS subsidy is of the order of 34 cents.

- The Research Training Scheme (RTS), also implemented in 2002. It provides block grants that enable higher-education institutions to support research training for higher-degree (i.e. masters-degree and doctoral) research students. Funding under the RTS is calculated by a formula that takes account of both enrolments and degree completions, as well as the university's total research grant income and research publications.

- The Research Infrastructure Block Grants (RIBG) Scheme. This provides block grants to higher-education institutions that attract grants from programs listed on the Australian Competitive Grants Register. The RIBG Scheme is designed to meet project-related infrastructure costs associated with these grants. RIBG funding is calculated by a formula that takes account of the university's total income from such grants. At present, for every dollar of an eligible research grant, the RIBG subsidy is of the order of 27 cents.

- The Systematic Infrastructure Initiative (SII), introduced in 2001 under the national strategy *Backing Australia's Ability*. The SII is intended to provide 'innovative approaches that link or expand access to shared facilities or high-priority investments that will bring sector-wide strategic benefits, e.g. libraries, ICT, specialised equipment, technical and administrative assistance…' Funding under the SII totals $246 million over five years, starting in the 2002 calendar year.

The threshold eligibility criterion for DEST subsidies is an organisational one – eligible entities must be part of a university, and put their grant applications through a university research office. In general, research institutions that are eligible for State Government infrastructure funding (as described in section 3.3.2) are ineligible for DEST subsidies, and vice versa. Many institutions have chosen structures that enable them to pursue one or other funding stream. Other institutions have found mechanisms whereby they endeavour to be eligible, at least in part, for both.

The Commonwealth Government spends large sums on the DEST higher-education-sector research assistance. In the calendar year 2002, total Australia-wide expenditures on the DEST schemes were: IGS, $271.3 million; RIBG program, $113.7 million; and RTS, $515.6 million. A total of $246 million was committed to the SII over five years, an annual average of $49.2 million. Together the four schemes thus provide about $950 million in one year.

The proportion of the DEST monies related to medical and health research is not known. However, if we assume that the figure is 17% (given that national expenditure on medical and health represents about 17% of gross expenditure on science and innovation across all fields), then DEST investment of the order of $160 million would go to medical and health research nationally. The IGS and RIBG are of particular interest to researchers, as they directly follow grant income and related research activity. Under the same assumption, Australia-wide

investment for medical and health research from these two schemes would total about $65 million.

iii. Direct funding of Commonwealth research agencies

The CSIRO and ANSTO carry out a significant amount of medical and health research, much of it in collaboration with other organisations.

The CSIRO spends about $20 million annually on medical and health research. Some $15 million from the CSIRO's 2002-03 budget was dedicated to 'promoting and maintaining good health'. This included funding for a major national partnership on Preventative Health ('P-Health'), under the National Research Flagships program. Developmental activities of the CSIRO have included innovations in cancer diagnosis, telemedicine and the 'Hospital without Walls' Initiative, improved heart valves, and extended-wear contact lenses.

ANSTO is extensively involved in the development and manufacture of novel radio-pharmaceuticals, using Australia's only nuclear reactor, located at Lucas Heights, NSW. It also operates the National Medical Cyclotron, an accelerator used to produce radio-isotopes for nuclear-medicine procedures, located in the grounds of Royal Prince Alfred Hospital, Sydney.

iv. Specific programs administered by DEST and DITR

The two most important programs relevant to medical and health research are the CRC and MNRF programs. To date, a total of 65 CRCs have been established throughout Australia in all fields of science and technology. Of these, ten are concerned with medical and health R&D. On average, each CRC receives $2.45 million per annum, so total national expenditure on CRCs in medical and health fields is about $22 million per annum. The Commonwealth Government's contribution to the acquisition and/or development of major research facilities and equipment through the MNRF program varies from year to year, as the MNRF is a co-investment program, investment partners being State and Territory Governments, universities and other public-sector and not-for-profit institutions, and private industry.

v. Industry grants and tax concessions

Commonwealth Government industry grants are intended to stimulate the commercial development of Australian research in Australia by supporting R&D, innovation, commercialisation and venture-capital programs. The most important of the industry grants for biomedical R&D are Biotechnology Innovation Fund (BIF) grants and R&D START Grants.

- The first BIF grants were awarded in 2001-02. BIF is a merit-based competitive grants program that provides assistance for the proof-of-concept stage of a biotechnology project. Nationally, the total value of grants awarded to biomedical companies in 2002-03 was $6.78 million.

- The R&D START Grants program, which was launched in 1996 and expanded in 1998 and 2001, is designed to increase the number of projects involving R&D activities with a high commercial potential that are undertaken by companies; to foster commercialisation; and to foster collaboration (including that between industry and research institutions). Nationally, the total value of START grants awarded to biomedical companies in 2002-03 was $3.76 million.

Further analysis of industry grants is given in Chapter 7.

As well as the industry grants, the Commonwealth Government offers a range of special tax incentives for companies involved in the commercial development of research. The tax concessions are only allowable where the intellectual property to which they relate is owned in Australia.

The Australian tax system also supports philanthropy by allowing donations to registered not-for-profit research entities to be tax deductible.

(b) State and Territory Government funding

State and Territory Governments contributed just under one-tenth of the nation's total funding for medical and health research in 2000-01 (about $155 million) (Figure 4.2).

The programmatic structure of the funding varies among the States and Territories. Broadly, State Government funding has been provided through the following.

- Direct funding for research infrastructure. The NSW Infrastructure Grants Program and Capacity Building Infrastructure Grants program, described further in section 4.2.3, are leading examples.

- Funding provided through regional health services or hospitals for research conducted locally. Most of this funding is provided through teaching hospitals. It includes 'in-kind' support (e.g. the provision of work space, or land for purpose-built buildings), staff time (e.g. a proportion of the time of salaried clinical staff specialists to conduct research), services (e.g. electricity supply and information and communication technology services and support), and limited funds for the purchase of research equipment and the conduct of research projects.

- Direct funding for medical biotechnology R&D. Major biotechnology R&D programs have been established in NSW, Victoria and Queensland.

- Special funding for research programs that are identified as State priorities, e.g. the recently-announced NSW program for research into spinal injuries and other neurological conditions.

- Funding for research projects carried out internally or commissioned externally by health departments to fulfil knowledge requirements for operational or strategic purposes.

(c) Business-sector funding

This refers specifically to Australian (as distinct from overseas) business funding.

Australia-wide, the business sector was the second-largest funder of medical and health research, accounting for 25% of total national funding in 2000-01 (about $430 million) (Figure 4.2). Most of this funding was related to the activities of pharmaceutical and biotechnology companies. Business-sector funding of medical and health research in Australia, and related performance issues, are described in section 4.3. Issues relating to commercialisation are discussed in Chapter 7.

(d) Other Australian sources

Other Australian sources of medical and health research funding made up 13% of the total in 2000-01 (about $224 million) (Figure 4.2). Reportedly, these sources mainly comprised current philanthropy (donations) and past philanthropy (income from endowments and trusts), and direct funding of research by universities.

We were unable to establish the precise proportions contributed by these sources. However, the Access Economics Report, *Exceptional Returns. The Value of Investing in Health R&D in Australia* identifies total funding from philanthropy as totalling about $216 million in 2000-01. The importance of philanthropy in supporting medical and health research must not be under-estimated. Virtually all research institutions are heavily dependent on public fund-raising and other forms of philanthropy. In total, the philanthropic support of medical and health research significantly exceeds that derived from State Governments.

Direct funding of research by universities comprises research and equipment grants and scholarships provided from university assets and revenues.

(e) Overseas funding

Overseas sources accounted for 7% of total national funding of medical and health research (Figure 4.2).

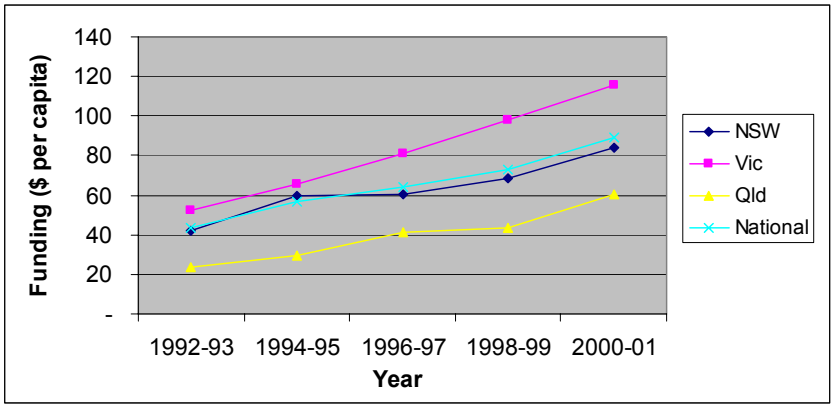
There are two main overseas sources: international business funding, and competitive grants. Business funding is by far the larger source, and as described below, most of the funding

from the business sector goes to R&D in that sector. The most important overseas grants awarded to Australian research were US National Institutes of Health (NIH) grants.

4.1.2 How the funds are divided among States and Territories

On a population basis, NSW has consistently received much less of the nation's funds for medical and health research than Victoria ($84.06 per capita, compared with $115.57) (Figure 4.3). The difference was even more marked when funding sourced from the business sector was excluded ($57.73 per capita in NSW, compared with $89.45 in Victoria). The gap between Victoria and NSW has widened progressively from 1994–95 (Figure 4.3).

Figure 4.3 Funding of medical and health research per capita of population, by State (NSW, Victoria and Queensland) and by year (1992–93 to 2000–01)



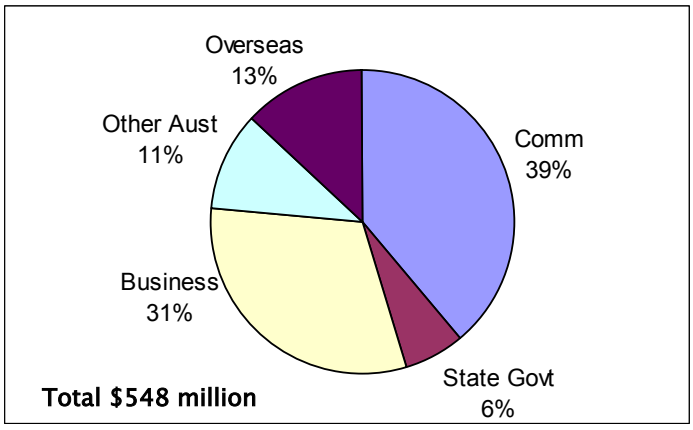
Source: ABS

4.2 Funding sources for medical and health research in NSW

4.2.1 Breakdown by sector

Analogous to the national picture (section 4.1.1), the Commonwealth Government was the largest single source of funding for medical and health research in NSW in 2000–01, with the business sector the second-largest (Figure 4.4).

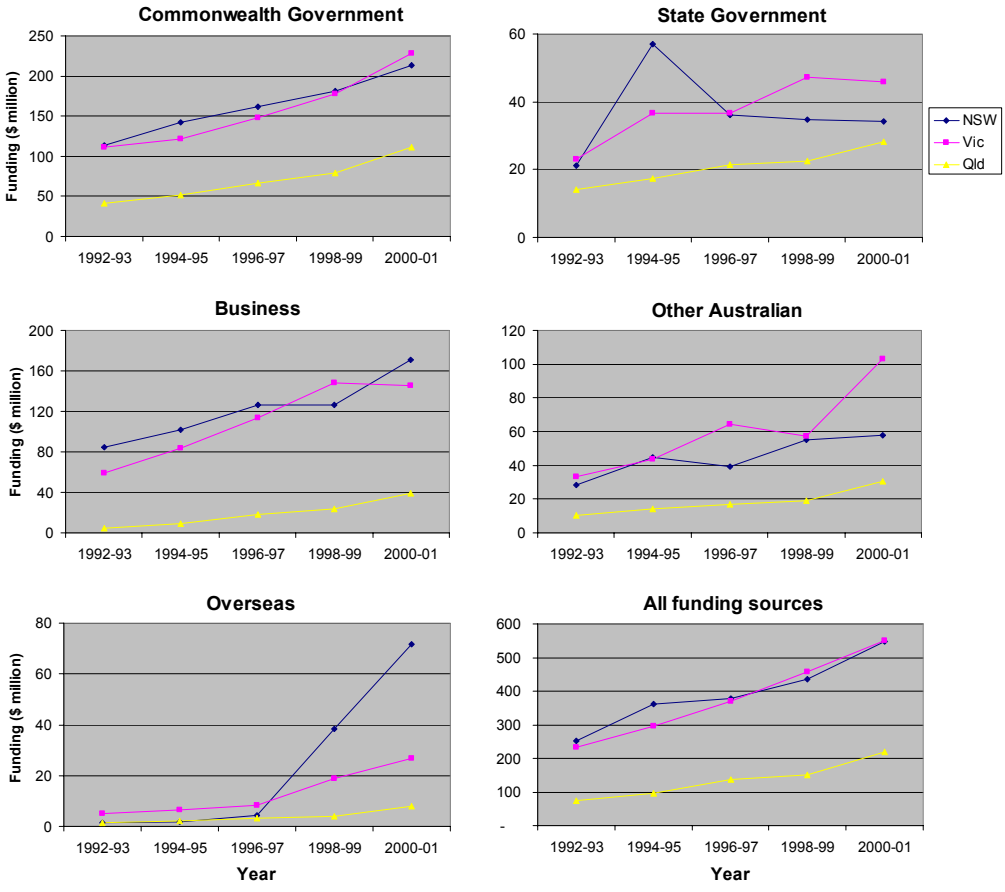
Figure 4.4: Sources of funding for medical and health research in NSW, 2000–01



Source: ABS

As described in sections 4.2.2 – 4.2.6 below, NSW has trailed Victoria in most sectors of research funding, except for overseas funding. The trends are shown in Figure 4.5.

Figure 4.5: Where money came from for medical and health research, by State (NSW, Victoria and Queensland), and by year (1992–93 to 2000–01)



Source: ABS

4.2.2 Funding by the Commonwealth Government

On a population basis, Commonwealth funding going to NSW has been less than that going to Victoria, with the gap between NSW and Victoria widening progressively since 1994-95. Queensland has been catching up - by 2000-01, Commonwealth funding going to Queensland was almost the same as that going to NSW on a per-capita basis.

As noted in section 4.1.1(a), Commonwealth Government funding for medical and health research is provided to the States through numerous agencies and programs. The most important of these are:

- national agencies that award peer-reviewed grants on a competitive basis;
- DEST funding for university-based research and research training;
- industry grants; and
- tax incentives and concessions.

National agencies that award peer-reviewed grants on a competitive basis

NHMRC and ARC funding attracted to NSW is examined in Chapter 5, both as sources of research monies and as markers of research performance.

NSW postgraduate scholars received $25.8 million in DEST-funded Australian Postgraduate Awards in 2002, across all fields of science and innovation. Victoria received $22.5 million.

DEST funding for university-based research and research training

In 2002, universities in NSW received DEST funding across all fields of academic endeavour as follows: IGS, $83.6 million; RIBG, $35.8 million; and RTS, $164.4 million.

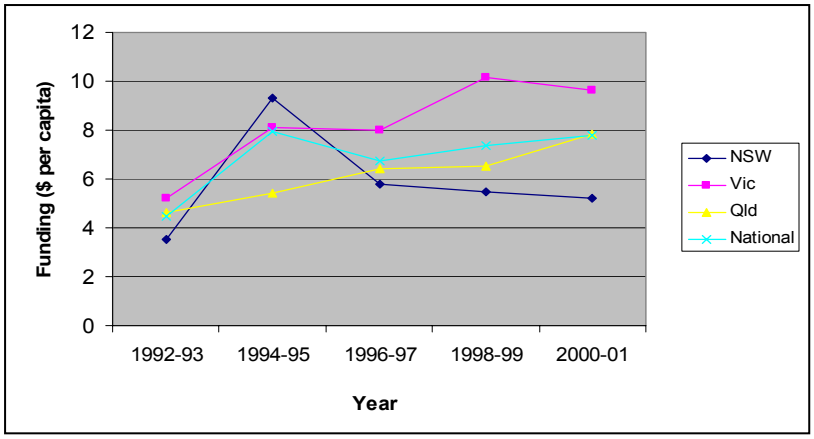
4.2.3 Funding by NSW and interstate comparisons

Our analysis of State funding, which is based on survey data collected biennially by the Australian Bureau of Statistics, is confined to the period up to 30 June 2001, because the available interstate comparative data from the ABS were limited to that period. Like some other States, NSW has announced some significant medical and health research funding enhancements since 2000-01. However, it has not been possible to assess the overall effect of these enhancements in interstate comparisons.

In 2000–01, the NSW Government contributed only 6% of the total investment in medical and health research in NSW – appreciably less than the 9% contributed by all State and Territory Governments combined to the total national figure (section 4.1.1, and Figure 4.2).

It is clear that NSW has provided much less funding for medical and health research than either the Victorian or the Queensland Governments (Figure 4.5). On a per-capita basis, the Victorian contribution was about double that of NSW, and the Queensland contribution about one-and-a-half times that of NSW (Figure 4.6). Even setting aside differences in the sizes of the States' respective populations, Victorian spending on medical and health research was much greater than that of the NSW Government. The ABS estimated that gross Victorian Government spending on medical and health research was $45.9 million in 2000–01 – about 34% more than the NSW Government figure of $34.2 million.

Figure 4.6: State Government spending on medical and health research, per capita of population, by State (NSW, Victoria and Queensland), and by year (1992–93 to 2000–01)



Source: ABS

As described in section 4.1.1, the main sources of State Government funding for medical and health research are:

- Direct funding for research infrastructure.
- Funding provided through Area Health Services for local research (such as that accounted for under the Teaching and Research Program).
- Direct funding for medical biotechnology R&D.
- Internal and external research carried out or commissioned by departments of health to fulfil knowledge requirements for operational or strategic purposes.

These are described below for NSW in comparison with other States.

(a) Direct medical and health research infrastructure funding

In Chapter 3 (sections 3.3.1 and 3.3.2) we describe the origins and conceptual basis of the NSW Medical and Health Research Infrastructure Grants Program (IGP) and the recently-added Capacity Building Infrastructure Grants (CBIG) program.

The first and second rounds of IGP funding

A total of $31 million over three years was made available for the first round of funding (1997-98 to 1999-2000). This represented more than a doubling of the funds previously available under the External Research Program (section 3.3.1). A total of $53 million was provided for the second round (2000-01 to 2002-03), a further 71% increase.

The third (current) round of IGP funding

In the third IGP round (2003-04 to 2005-06), the total funding awarded for Streams 1 and 2 was $50.6 million, compared with $47.7 million for these streams in the second round. The small size of this increase caused considerable disappointment among researchers, whose total peer-reviewed grant income had grown substantially as a result of (a) the overall growth in peer-reviewed grant funding in Australia (described in Chapter 5), and (b) the expansion of their research activity. As a consequence of the cap placed on total funding and the growth in national peer-reviewed grants, IGP allocations dropped from second-round levels of 65 cents in the dollar of peer-reviewed grant income for Stream 1 and 55 cents for Stream 2, to third-round levels of 43 cents in the dollar for Stream 1 and 33 cents for Stream 2.

The effective reduction in infrastructure support was an issue raised with the Panel by virtually all researchers whom we interviewed or who provided written submissions. In essence, they felt squeezed by their own success in obtaining peer-reviewed grants, without the necessary infrastructure support to sustain that research successfully. They were concerned at the uncertainty created, both for institutes and for their highly-qualified staff, when the basis of funding shifted without due forewarning and affected their ability to plan. Institutes need to be able to predict the State Government commitment to future research with reasonable certainty.

Capacity Building Infrastructure Grants program

As described in Chapter 3 (section 3.3.2), the CIBG program superseded Stream 3 in the third IGP round, with an allocation of $9.6 million over three years. The CIBG program appears to have been well received by public-health, health-services and primary-care researchers. Because the program has only begun in the current financial year, we cannot offer any comments on its effectiveness.

Assessment of the IGP

Researchers who contributed to our review were unanimous and unqualified in their support for infrastructure funding, as provided through the IGP and, latterly, the CIBG program. They considered that access to infrastructure funding on a transparent, equitable and competitive basis represented the most important contribution that the NSW Government could make to medical and health research. We were left in no doubt that the IGP had stimulated research activity in NSW. We also noted that the Victorian and Western Australian Governments had introduced analogous programs, basically copying the NSW design.

The main criticisms of the IGP were:

- the failure to maintain the pro-rata second-round level of funding in the third round;
- the compounding of this situation by basing grant eligibility on three-year grant funding (which further disadvantaged those institutes whose peer-reviewed income was rapidly growing – the faster the growth the rate the greater the disadvantage);
- specific criticisms from institutes that had just failed to meet the threshold (in one case by a few thousand dollars in one year); and
- difficult administrative arguments, mainly concerning individual institutes' degree of independence from universities.

In our recommendations, we propose a change in emphasis to focus on excellence and a clearer path to the determination of eligibility for and the allocation of infrastructure funds (Chapter 9).

Infrastructure funding in Victoria

The Victorian Department of Human Services has emulated the NSW IGP and created its own infrastructure funding program. This is known as the Victorian Operational Infrastructure Support Program, funded with an allocation of $113 million over five years. Under this Program, a total of $19.4 million is to be spent in 2003-04, with grants to individual institutes ranging from $31,000 to $6.69 million. The 2003-04 figure represents an 11% increase over 2002-03 funding.

(b) Funding provided through Area Health Services for local research

Funding provided through Area Health Services throughout NSW for hospital-based and other local research is intended to be reported through the Teaching and Research Program, as described in section 3.3.1. However, establishing what constitutes the research component of the Teaching and Research Program has proven elusive. While Area Health Services throughout NSW are required to report expenditure against the Program, funds are not specifically allocated to the Program; money is allocated to the Area as a whole. The amount

of money that an Area is expected to spend under the Teaching and Research Program depends primarily on the cost and complexity of the caseload managed in the Area.

Moreover, the reported expenditure is not necessarily an expenditure of money originating from the NSW Department of Health. For example, if a research group in a teaching hospital receives grant funds from the NHMRC, the expenditure of these funds is reported by the Area against the Teaching and Research Program as 'research expenditure'.

Undoubtedly some of the expenditure reported as 'research expenditure' goes directly on research activities. Some also goes towards the facilities that make research possible, such as Area Health Service contributions to the infrastructure of hospital-based research groups, the provision of libraries and journal subscriptions, and other such requirements.

This Panel is not the first to try to unravel the actual expenditure on research under this Program. Others have tried without much progress. A 1995-96 survey of teaching and research activities in Areas suggested that expenditure totalled $123 million in 1993-94, of which $57 million was estimated as having been spent on research activities (46%).

The application of cost escalation indices by the NSW Department of Health suggests that total expenditure in the Teaching and Research Program has risen to about $326 million, but the share attributable to research has shrunk to about 22% of this figure ($72 million). The 'teaching' component has expanded at a much greater rate than the 'research' component. This tallies with comments, made in submissions to the Panel, that the financial pressures to provide clinical services have squeezed the capacity of the teaching hospitals to undertake research.

There is another factor at play. Funding attributed to the Teaching and Research Program includes some $44 million from grants and contributions. This mainly comprises NHMRC grants and philanthropic donations, and is equivalent to about 60% of the estimated research expenditure under the Program. The available data suggest that the grants and contributions figure has been fairly stable. This implies that the actual level of State Government-funded research under the Teaching and Research Program has fallen by an even greater proportion than the 46% to 22% drop implies.

The Department is developing policies and processes for improved accounting of research expenditure in Area Health Services. Their implementation will enable the Department to determine how much of the reported expenditure is potentially available for the strategic development of research at Area Health Service level.

The Panel's attention was drawn to one particular area of difficulty in relation to the use of Area Health Service trust accounts. The Department has instructed that purchases by Area Health Service facilities of items of equipment costing more than $5,000 must be identified and notified at the start of the financial year. This includes purchases from trust-fund accounts (where research funds and donations are held) and private-practice cost centres

which have a legitimate and important role in research within the NSW health system. This limitation is likely to be inhibitory to research.

(c) Direct funding for medical biotechnology research

As described in Chapter 3 (section 3.3.3), the NSW Government has committed $68 million over five years for R&D in biotechnology, under the BioFirst program. This is examined further in Chapter 7.

Biotechnology and related funding in Victoria and Queensland

It is of interest here to compare NSW expenditure on biotechnology with that in Victoria and Queensland, although each State's expenditure program has a different scope and orientation.

In addition to the institutional infrastructure grants described above, the Victorian Department of Human Services allocates Science and Technology Innovation infrastructure grants

The Victorian Government has supported major capital scientific development projects which are at least partly used for medical research. A leading example is its contribution of $100 million ($16.4 million in 2002-2003) to the cost of the Australian Synchrotron facility, located at Monash University. The remaining funds are to come from industry, universities and other State Governments with an interest in sharing the use of the facility, which is due for completion in 2007.

The NSW Government's funding of biotechnology has certainly been eclipsed by the large amounts committed to medical biotechnology research through Queensland's 'Smart State' strategy. Under the Smart State Research Facilities Fund, some $68.5 million was allocated to medical biotechnology research over the two years 2001-2003, out of total program funding of $95.5 million for science and innovation in all fields.

(d) Internal and external research carried out or commissioned by the NSW Department of Health

The Department expends around $500,000 annually on research done internally, e.g. studies relating to the Health Survey Program, case-control studies of disease outbreaks, and the development of new statistical methods and software.

In addition, the many groups within the Department spend money outside the IGP and CIBG on commissioned research, and on one-off grants to provide start-up or infrastructure support to various research groups.

Total expenditure in recent years has been as follows:

1999-2000	$0.68 million
2000-01	$2.23 million
2001-02	$5.05 million.

Much of the contract research is commissioned on an ad-hoc basis to meet pressing policy needs. The processes for commissioning the research are often under time pressure, and run the risk of not giving sufficient consideration to valid conceptual design. Similar difficulties have been identified in the UK National Health Service, and appear to exist within other State health departments.

The Department is not systematically investing in research that focuses on its long-term strategic priorities. In some instances, policy areas have taken a longer-term view, and made a decision to set up and/or support an external research group. The Chief Scientist (Medical and Health Research), a post suggested later in this report, could have responsibility for promoting the quality and applicability of commissioned research.

All such expenditure is listed in the Department's Annual Report. Departmental grants are made according to standard Government procurement conditions, which require three quotes for work valued at $30,000 or more, and an open tender for work valued at more than $150,000. There is no centralised process for approving the grants or commissions - approval depends on the sum involved and the financial delegations of managerial and executive staff in the Department.

4.2.4 Funding from the business sector

While NSW appears to have been losing some of its share of Commonwealth medical and health research funding, the State has done fairly well with business-sector funds (Figure 4.5).

Business investment represents approximately 25% of total expenditure on medical and health R&D in Australia (Figure 4.2). NSW attracts a large share - around 40% of that total. The pharmaceutical and biotechnology industries are major sources of business-sector research investment, and it is notable that the headquarters of many of Australia's pharmaceutical and biotechnology companies are in Sydney. The investment figures may be distorted somewhat by the attribution of R&D expenditure to head offices in statistical returns; some of the research may be undertaken elsewhere.

Business investment in medical and health R&D has been boosted by the CRC Program and the numerous Commonwealth Government tax-based and grants schemes that have been put in place to encourage investment in biotechnology and R&D more generally, described elsewhere in this chapter.

4.2.5 Other Australian funding

Other Australian funding mainly comprises philanthropic funding and university funding of research (e.g. internal university grants and scholarships).

Our consultations reaffirmed our understanding that medical and health research often attracts philanthropy more readily than research in other fields. Particular topics in medical research are especially attractive to donors, research on childhood cancers being a prime example. Philanthropy is therefore a significant source of funds for medical research.

As shown in Figure 4.5, the growth in 'other Australian' funding in NSW has been much less than that in Victoria. This may reflect the substantial endowments of Victorian institutions.

4.2.6 Overseas funding

The performance of NSW in attracting overseas funding for research has strengthened greatly since 1996-97, and has outranked Victoria and Queensland since 1998-99 (Figure 4.5). Overseas funding is flowing almost exclusively into the business sector itself.

The State's success in attracting overseas funding for medical and health R&D may again be due to the fact that a large number of international pharmaceutical and biotechnology companies have their Australian headquarters in Sydney. The R&D funds that they receive from overseas parent companies may therefore be shown as NSW funding, although the research that the funds support may be conducted elsewhere.

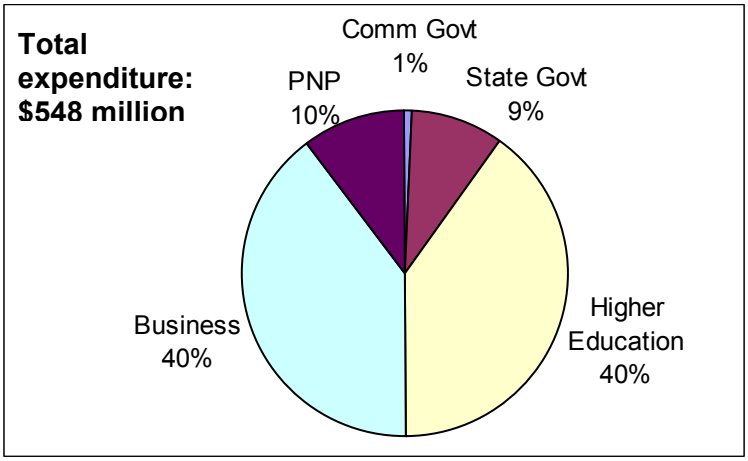
4.3 Where the money is spent

4.3.1 Expenditure in relation to activity

The distribution of expenditure reflects, at least in part, the organisational basis of medical and health research entities in each State.

In NSW, medical and health research is heavily concentrated in the higher-education and business sectors. In 2000-01, each received 40% of the State's medical and health research funding. The private not-for-profit sector, which includes most of the expenditure on independent medical research institutes, received 10%. The State Government sector – which includes most hospital-based research entities – received 9% (Figure 4.7).

Figure 4.7: Where money was spent on medical and health research, NSW, 2000–01



Source: ABS, PNP = private not-for-profit

Indeed, NSW expenditure in the business sector accounted for more than half of the national expenditure on medical and health research in that sector (Table 4.1 and Figure 4.8). This has persisted over the last decade, with only a slight drop in the NSW share of business-sector funding since 1992–93. The Queensland share of business-sector funding has increased from 2% in 1992–93 to 7% in 2000–01 at the expense of NSW and Victoria.

It should be noted that, where institutions which are affiliated with universities put grant applications through universities, the value of those grants contributes to expenditure in the higher-education sector. Thus some hospital- and institute-based research expenditure may be attributed to, and inflate, the higher-education-sector figure.

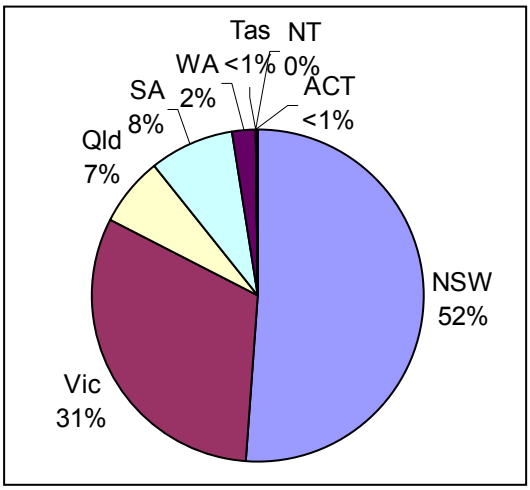
Despite the prominence of the higher-education sector in the State's medical and health research effort, NSW expenditure accounted for only 28% of national expenditure on medical and health research in that sector (Table 4.1).

Table 4.1: Sectors in which money is spent on medical and health research in NSW and nationally, 2000–01

Where money is spent	Expenditure in NSW	Expenditure Australia-wide	NSW proportion (percent)
Commonwealth sector	4,204,000	53,269,000	7.9
State Government sector	49,887,000	201,281,000	24.8
Higher education sector	218,353,000	771,207,000	28.3
Business sector	220,002,000	428,147,000	51.4
Private not-for-profit sector	55,607,000	258,105,000	21.5
Total	548,073,000	1,712,009,000	32.0

Source: ABS

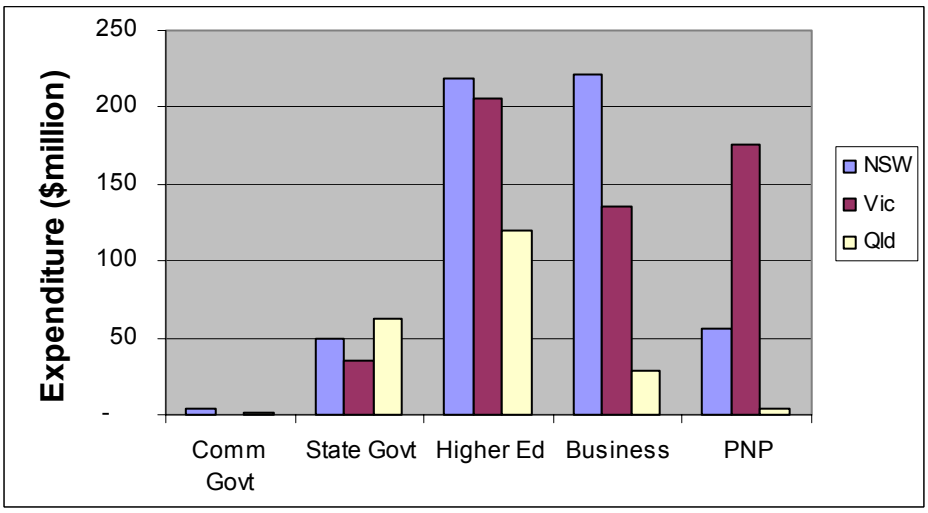
Figure 4.8: Money spent on medical and health research carried out in the business sector, by State and Territory, 2000–01



Source: ABS

Figure 4.9 compares the distribution of expenditure in each sector in NSW, Victoria and Queensland. It highlights the prominence of the higher-education and business sectors in NSW, and the prominence of the private not-for-profit sector in Victoria. It also draws attention to the relative prominence of the higher-education and State Government sectors in Queensland, which is due to the fact that two of Queensland's largest research institutes (the Queensland Institute of Medical Research and the Institute of Molecular Bioscience) are based in these sectors.

Figure 4.9: Where money is spent on medical and health research in NSW, Victoria and Queensland, 2000–01



Source: ABS, PNP = private not-for-profit

4.3.2 Expenditure in relation to source of funding

With reference to the financial year 2000-01, Figure 4.10 brings together the answers to two questions:

- Where does the money come from for medical and health research?
- Where is it spent?

Key observations are as follows:

- A very large proportion of Australian government funding of medical and health research in NSW (84%) went to the higher-education sector.

- An even larger proportion of business-sector funding (88%) in NSW went to research in the business sector. Thus business funding is not a major contributor to research in the higher education or the medical research institutes in NSW. A similar though less extreme pattern applies in Victoria (83% business to business). In contrast, in Queensland 40% of business R&D funding is destined for other sectors, most notably higher education and the State Government-run research establishments. This is a reflection of the close co-operation that is being engendered in Queensland between Government, industry and the research sector.

- A large proportion of the NSW Government funding (69%) went to State Government agencies, such as research in hospitals. This percentage would include the expenditure attributed to the Teaching and Research Program. Nine percent of NSW Government funding went to the higher-education sector, and 22% to the private not-for-profit sector. In contrast, far higher proportions of Victorian Government funding went to research in the university sector (18%) and the not-for-profit sector (30%). This observation reinforces the relative difference in funding commitment between Victoria and NSW.

- The strength of the Victorian private not-for-profit sector is reflected not only in its ability to attract State Government funding, but also its ability to attract Commonwealth funding.

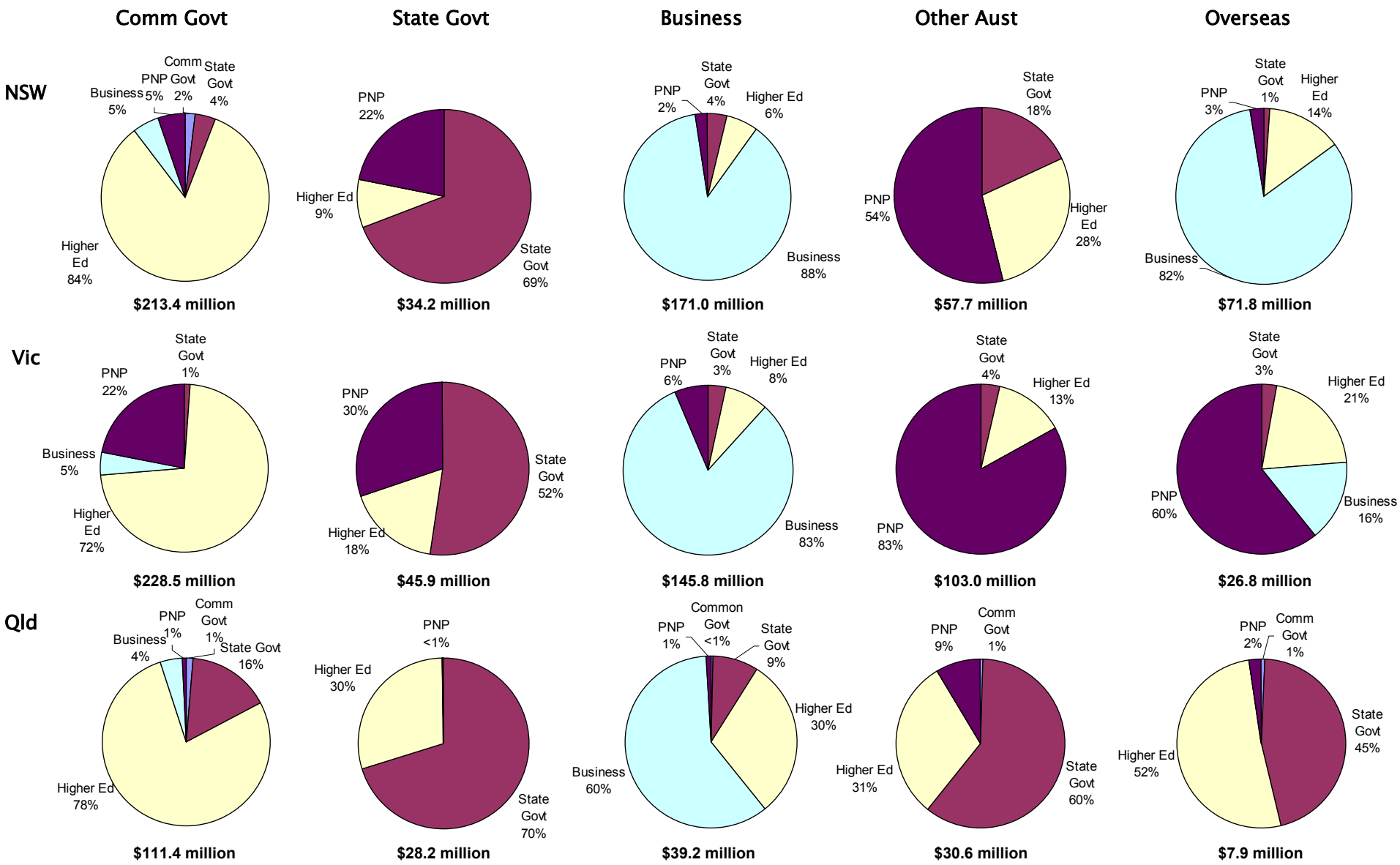
- The importance of philanthropy and endowments differs among the States. Most of the 'other Australian' category refers to philanthropy. In section 4.1.1(d) we drew attention to the importance of philanthropy as a source of funding for medical and health research. The data summarised in Figure 4.10 indicate that Victorian research institutions have been particularly successful in attracting philanthropic funding, drawing almost twice as much as NSW institutions. The total funding that Victorian research received from philanthropy in 2000-01 appeared to be more than three times the level of total NSW Government funding for medical and health research, and roughly equivalent to the funding of the NSW, Victorian and Queensland Governments combined. This underlines the competitive pressure that medical and health research in NSW encounters.

- In Queensland, very little Commonwealth, State and business-sourced funding went to research in the private not-for-profit sector, whereas a significant proportion (16%) of Commonwealth funding went to research in the State Government sector, and significant proportions of State Government and business-sourced funding (30% from each) went to research in the higher-education sector.

We infer from ABS data that up to 35% of business expenditure in NSW relates to R&D for the manufacture of pharmaceutical products, and a large proportion also relates to trials for the listing of new pharmaceuticals and certification for inclusion in the Pharmaceutical Benefits Scheme.

Arguably Queensland provides evidence that the Wills Report concept of trying to encourage a 'virtuous cycle' is being realised in practice, and fairly rapidly – primed by a very large State investment and commitment. That pattern could desirably be emulated in NSW. In the main, business funding of medical and health R&D is at half the level of other OECD countries as a share of GDP.

Figure 4.10: Where Commonwealth, State, business, other Australian and overseas funding for medical and health research was spent in NSW, Victoria and Queensland, 2000–01 (Source: ABS, PNP = private not-for-profit)



5 Peer-reviewed investment track record

Main points

- Grants obtained in competitive peer-reviewed funding schemes, notably those of the NHMRC, the ARC, and the US National Institutes of Health, are overall indicators of the quality and value of medical and health research in Australia.

- The performance of NSW researchers in obtaining grants from these agencies has consistently been lower than expected. Every year over the last decade, NSW has attracted less than 25% of the national total of NHMRC funding, and of the total value of NIH grants awarded in Australia. Victoria consistently attracts more than 40% in both schemes.

- Victoria secures an extra $50 million per annum for medical research than its share of national population or respective share of the Gross National Product would imply. This advantage has flow-on effects to the Victorian economy.

- Victoria's dominance of medical and health research is particularly marked in basic research. Victoria leads NSW in clinical research also, but by a small margin.

- NSW's performance has been particularly disappointing in securing NHMRC Program Grants and post-doctoral and career Fellowships. Doctoral completion rates in health fields have also been poor: although completion rates have increased greatly over the last decade, NSW produces 50% less doctoral graduates than Victoria in health fields, taking account of the population.

- NSW is likely to struggle increasingly to maintain its already-low share of national and international grant funding as it faces the dominance of Victoria and increasing competition from Queensland. Use of national discipline panels in peer-review processes, rather than regional grant interviewing committees, may also make it more difficult for NSW to compete.

- Encouraging signs in the data on NHMRC, ARC and NIH grants are as follows: (i) an improvement in NHMRC Project Grant performance for grants commencing in 2004 (however, under NHMRC funding rules, those receiving program grants are constrained from applying for project grants – it is the total NHMRC funding that is most important); (ii) consistently strong performance in the ARC Linkage-Projects grants scheme, and (iii) leadership in public health and health-services research.

- NHMRC Program Grant and NIH grant awards show that NSW does have strong research groups in the following fields:

    - cardiovascular disease,
    - cancer
    - mental health,
    - nervous system disorders,
    - neonatology,
    - infectious diseases (especially HIV) and immunology,
    - clinical trials,
    - health services, and
    - public health.

5.1 Competitive peer-reviewed grants, scholarships and fellowships: investment for excellence

Competitive peer-reviewed awards are the most consistent markers of research excellence. The awards are of two broad types: grants to cover the costs of doing the research; and people awards (scholarships and fellowships).

The award of competitive peer-reviewed grants reflects the quality and originality of the research, the potential of the research to generate useful new knowledge, and the esteem in which the researcher or research team is held by peers. Importantly, it represents a prospective judgment of the value of the research and the ability of the researchers. International grants provide an additional indication of the international competitiveness of Australian research.

Scholarships are awarded in recognition of the abilities and potential of individuals, and fellowships both recognise ability and reward achievement and track record. In addition, because scholarships and fellowships are awarded to individuals to work in particular institutions, they tell us how well institutions rate in the minds of peers. In general, excellent institutions attract the best researchers and thus host more scholarship holders and fellows.

The most important competitive peer-reviewed grants and awards for medical and health research in Australia are those offered by the NHMRC. ARC grants are also important, but the ARC funds much less medical and health research than the NHMRC. With respect to international grants, the largest and perhaps most prestigious source of funding is the US National Institutes of Health. NSW researchers have access to peer-reviewed funds from many other granting agencies. However, in our review we concentrated on the State's track record in obtaining funds from the NHMRC, the ARC and the NIH, because of the size and significance of these agencies and the value placed on their awards in the scientific community. We considered three types of grants – NHMRC Program Grants, Centres of Clinical Research Excellence awards, and NIH grants – to be the most prestigious. Researchers who procure these grants are arguably the best in Australia.

The peer-review process conducted by the NHMRC for Project Grants is typical of the peer-review processes of leading medical and health research funding agencies throughout the world. It involves several steps, including evaluation of a grant application by a Grant Review Panel with a knowledge of the topic of the research, evaluation by three independent expert assessors, consideration of the assessors' reports by the Grant Review Panel, an opportunity for the applicant to respond to issues raised by the Grant Review Panel (based on Panel members' own evaluation and that of the independent assessors), and a final ranking by the Grant Review Panel. Variants of this process are conducted for the award of Program Grants, other NHMRC research grants, and Research Fellowships.

Currently, project grants are assessed by national discipline panels. In the past, they were assessed by regional grant interviewing committees in each of the States. Given the requirement for different committees to fund at roughly comparable success rates, this means that States no longer have a presumption of a particular success rate. The new process is likely to play to the strengths of the already well-established groups.

5.2 NHMRC and ARC funding

5.2.1 Overall funding

Our inquiries concentrated on the extent to which NSW researchers were able to attract the expected share of NHMRC and ARC funding, with reference to the numbers and total value of the grants.

National funding available for research In Australia has increased since the mid 1990s, with Commonwealth Government policy initiatives leading to a particularly steep increase since 2000-01.

- In 1999, NHMRC funding totalled $160.7 million. Since 2000, it has been boosted through the implementation of the recommendations of the Wills Review (1999). The Australian Government has made a commitment to double the annual budget of the NHMRC over a six-year period. Allocated or committed total funding is as follows:

  2001 - $215.2 million;
  2002 - $265.7 million;
  2003 - $298.2 million;
  2004 - $323.8 million;
  2005 - $354.8 million.

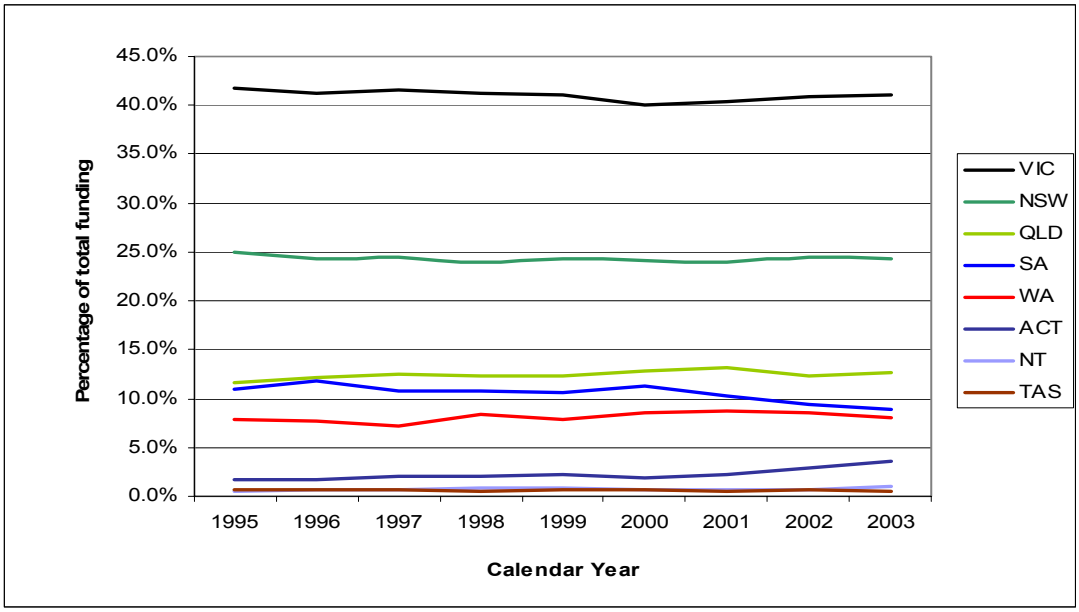
- *Backing Australia's Ability*, the national strategy to stimulate scientific and technological innovation, has led to large increases in ARC funding.

We anticipate that the rate of increase of NHMRC funding will reach a plateau from about 2006, although this is currently under review.

While the amount of NHMRC funding going to NSW has increased in accordance with the increased availability of funds, the State's share of NHMRC funds has been remarkably constant over the nine years 1995-2003. Other States' and Territories' shares have been similarly constant (Figure 5.1). Victoria has been the leader by a wide margin, taking approximately 40% each year, followed by NSW (25%) and Queensland (13%). The NSW share of NHMRC funding is considerably less than might be expected. If it were in proportion to population or Gross State Product, the NSW share would be of the order of 35%. The gap between Victoria and NSW is widening, and the difference is highlighted when the population

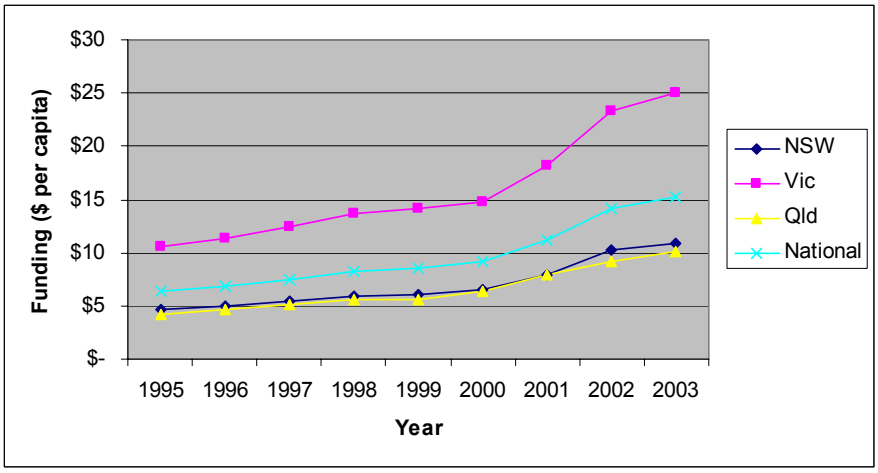
is taken into account (Figure 5.2). As discussed in earlier chapters of this report, Victoria's success is in part attributable to the strength of several major independent medical research institutes, such as the Walter and Eliza Hall Institute and the Ludwig Institute. Much NHMRC grant funding has also gone to (or at least through) the University of Melbourne and Monash University.

Figure 5.1: Proportion of overall total NHMRC funding awarded to each State and Territory by year (1995–2003)



Source: NHMRC

Figure 5.2: Total NHMRC funding per capita of population, by year (1995–2003) and by State (NSW, Victoria and Queensland)



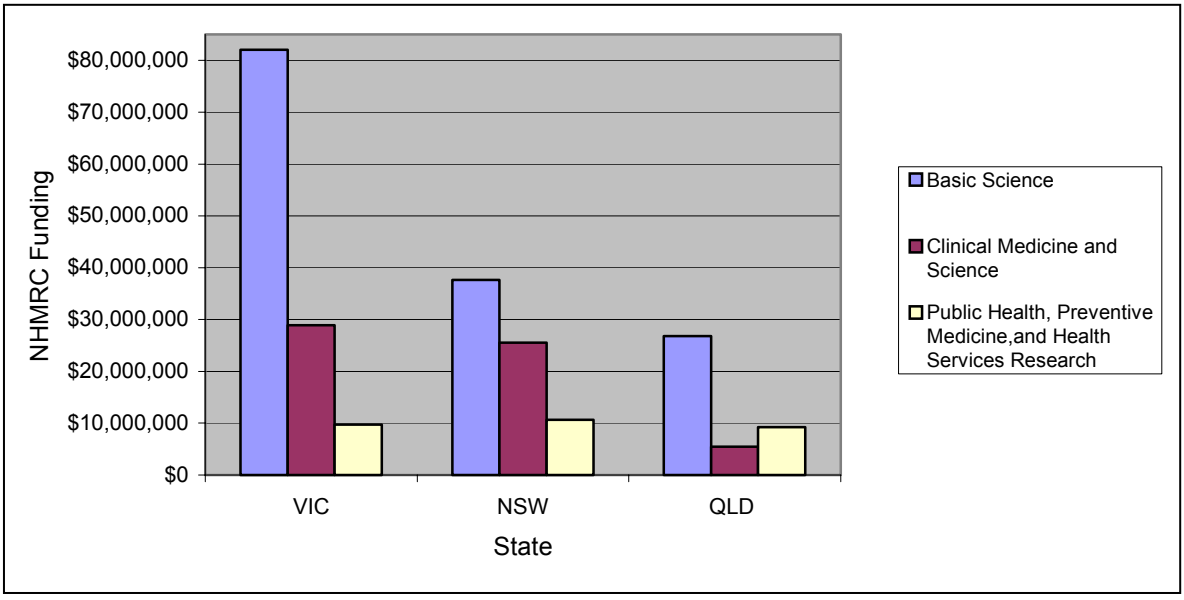
Source: NHMRC

Moreover, the already-low NSW share may be increasingly difficult to sustain. Victorian pre-eminence is one factor. Another is the increased competition that Queensland is exerting, with its major commitment to developing as a 'Smart State'. Changes in NHMRC funding arrangements that open each discipline to national competition, without preserving a balanced distribution among States and Territories, are likely to bring further disadvantage to NSW.

Victoria accounts for 25% of Australia's population, and the fact that Victoria attracted 40% of NHMRC funding in 2003 means that it secured almost $50 million more than expected on a population basis. It follows that taxpayers located in other States and Territories subsidised Victorian medical and health research to the tune of $50 million. Given the relative size of the State's population, a large proportion of this $50 million is likely to have come from NSW. Unless NSW secures an increasing proportion of the NHMRC budget, NSW taxpayers will pay an increasing subsidy to Victorian medical and health research as the NHMRC budget grows.

NHMRC grants and awards of all types are classified into five Broad Research Areas: basic science, clinical medicine and science, public health, preventive medicine, and health-services research. For the purposes of this report, public health, preventive medicine, and health-services are combined. Of the total NHMRC funding Australia-wide in 2003 (newly awarded and current grants, fellowships and scholarships), 59% was awarded for basic science, 27% for clinical medicine and science, and 14% for public health, preventive medicine and health-services research. Basic science is clearly dominated by Victoria. While Victoria leads NSW by a much smaller margin in clinical medicine and science, NSW is just ahead in public health, preventive medicine and health-services research (Figure 5.3).

Figure 5.3: NHMRC funding by Broad Research Area and by State (NSW, Victoria and Queensland), 2003



Source: NHMRC

5.2.2 NHMRC Program and Project Grants

NHMRC Program Grants 'acknowledge the scientific excellence of research teams who are working collaboratively on a small number of health and medical research projects in related fields. Awarded for five years, or four years…, these grants provide support which is more flexible than that provided by three-year Project Grants' (NHMRC Grants Book, 2002). Program Grants rely more heavily on the track record of a research team than Project Grants, and provide more substantial funding. Table 5.1 lists Program Grants where NSW researchers were principal investigator, current as at November 2003 or due to commence in 2004.

Table 5.1: NHMRC Program Grants awarded to NSW researchers, current as at November 2003, or to commence in 2004

First year	Topic	Institution
2004	Mechanisms of breast and prostate cancer progression: implications for improved clinical management and treatment	Garvan Institute of Medical Research
2004	Post-traumatic mental health	University of NSW
2003	Causes of depressive disorders and factors predicting their response and resistance to treatment	Euroa Centre, Prince of Wales Hospital, University of NSW
2003	Advances in clinical trials research and evidence-based decision making	NHMRC Clinical Trials Centre, University of Sydney
2003	Evaluating health policy by understanding consumer and provider decisions about health care: a new approach	Centre for Health Economics Research and Evaluation, University of Technology, Sydney
2003	Atherosclerosis	Centre for Thrombosis and Vascular Research, University of NSW; Department of Cardiology, Royal Prince Alfred Hospital; Hanson Institute, South Australia
2002	Cellular and molecular studies of the adaptive immune response in health and disease	Centenary Institute of Cancer Medicine and Cell Biology
2002	Vascular biology	Centre for Thrombosis and Vascular Research, University of NSW; Monash University; Australian National University
2002	Screening and diagnosis: accuracy, outcomes and informed decision making	School of Public Health, The University of Sydney

2000	Experimental neurology	Prince of Wales Medical Research Institute
1999	Typology, aetiology and neurobiology of the depressive and bipolar disorders	Mood Disorders Unit (now Black Dog Institute), University of NSW

Source: NHMRC Grant Books

In addition, three Program Grants, which were also current at the time of writing, were awarded to research institutions outside NSW, with a NSW-based researcher as a collaborating principal investigator (Table 5.2).

Table 5.2: NHMRC Program Grants with interstate Chief Investigators and NSW-based Principal Investigators

First year	Topic	Institution
2004	Understanding HIV infection and development of new vaccines	University of Melbourne (with University of NSW)
2004	How can people be helped to exercise properly so as to improve their health?	University of Queensland (with University of NSW; team moved to University of Sydney)
2002	Epidemiology of chronic disease, health interventions and DNA studies	University of Melbourne (with University of Western Sydney)

Source: NHMRC Grant Books

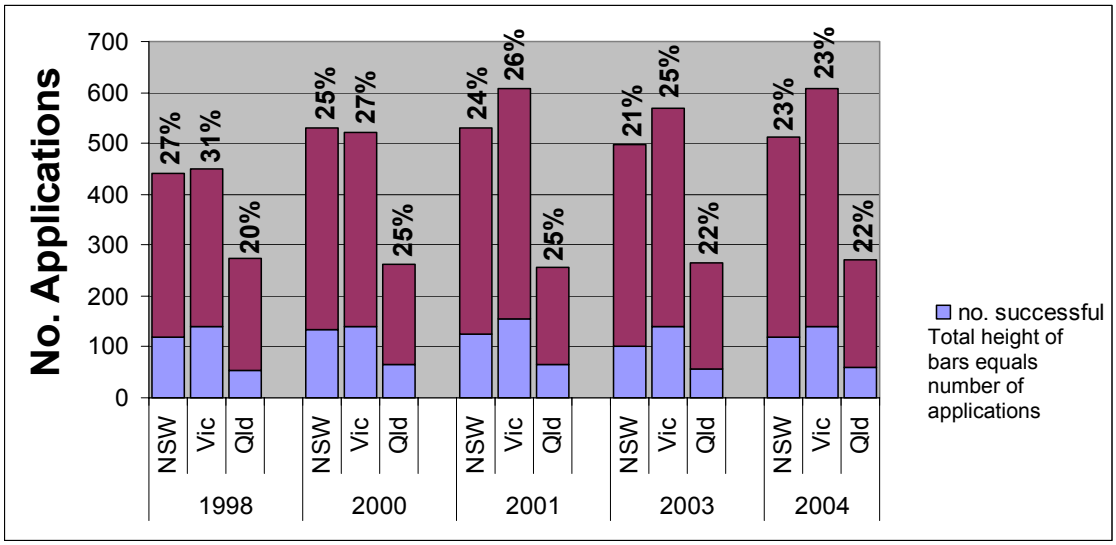
The Program Grants illustrate the research fields in which NSW has strong research groups: cardiovascular disease, cancer, mental health, nervous system disorders, neonatology, infectious diseases (especially HIV) and immunology, clinical trials, health services, and public health.

NSW researchers have a relatively poor track record in obtaining NHMRC Program Grants. Results of applications for Program Grants to commence in 2004 were particularly disappointing. Only two of seven applications were successful, with a total value of $9.5 million. In contrast, Victorian researchers submitted eight applications, of which six were successful, attracting Program Grants worth $44.3 million. Queensland researchers attracted three Program Grants worth $19.4 million (Table 5.3).

An NHMRC Project Grant is 'a funding agreement with an eligible Australian institution to enable an individual researcher or group of researchers to undertake a scientific investigation.' Project Grants may be of one to five years' duration, but applications for more than three years require special justification. Special justification is also required if the application is for more than $300,000 in any one year, or if the total budget exceeds $750,000.

The success rate of Project Grant applications in NSW is slightly lower than that for Victoria, and the number of applications from NSW has been appreciably lower in every recent year except 2000 (Figure 5.4).

Figure 5.4: Numbers of grant applications and success rates for NHMRC Project Grants by State (NSW, Victoria and Queensland) and by year (1998–2004, where data were available)



NSW researchers have greatly improved their performance in securing Project Grants in 2004. Given that Program Grant holders are not eligible to apply for Project Grants in the research field of their Programs, Project Grants funding might be expected to be higher where Program Grant funding is lower. However, the combined value of Program and Project Grants in NSW remains much lower than that in Victoria, with Queensland catching up (Table 5.3).

Table 5.3: New NHMRC Project and Program Grants by State (NSW, Victoria and Queensland), 2003 and 2004

	New Projects $ million		New Programs $ million		New Project +Program $ million	
	2003	2004	2003	2004	2003	2004
NSW	$ 35.7	$ 52.6	$ 28.2	$ 9.5	$ 63.9	$ 62.1
Victoria	$ 55.4	$ 55.6	$ 72.8	$44.3	$128.2	$ 99.9
Queensland	$ 21.8	$ 22.7	$ 4.0	$19.4	$ 25.8	$ 42.1

Source: NHMRC

NSW has performed relatively well in obtaining NHMRC Project Grants in the following Broad Health Areas to commence in 2004: mental health and neurosciences; infection and

immunity; endocrine diseases and diabetes; respiratory diseases; human genetics and inherited disorders; and social and environmental health issues (Table 5.4).

Table 5.4: NHMRC Project Grants awarded to NSW-based principal investigators to commence in 2004

Broad Health Area	No of applications	Number funded	Proportion funded	Average Budget	Total Budget
Mental health and neurosciences	105	28	27%	$341,469	$9,561,125
Other health issues, diseases and conditions	66	17	26%	431,475	7,335,075
Cancer, cancer prevention and related disorders	73	11	15%	615,015	6,765,163
Infection and immunity	56	15	27%	441,292	6,619,375
Endocrine diseases and diabetes	32	9	28%	577,172	5,194,550
Cardiovascular health and diseases	43	8	19%	462,758	3,702,066
Respiratory diseases	28	8	29%	415,872	3,326,975
Bone, joint and muscle diseases	25	5	20%	491,771	2,458,855
Human genetics and inherited disorders	12	5	42%	485,750	2,428,750
Social and environmental health issues	15	5	33%	483,998	2,419,988
Liver, kidney and gastro-intestinal health and diseases	28	5	18%	414,075	2,070,375
Reproductive health	17	3	18%	306,667	920,000
Injury	14	0	-	-	-
Total	**514**	**119**	**23%**	**443,717**	**52,802,296**

Source: NHMRC

5.2.3 NHMRC priority-driven research funding

While NSW researchers have improved their position with regard to NHMRC Project Grants in 2004, their performance in securing NHMRC priority-driven research grants has remained disappointing.

Most significantly, NSW researchers were awarded two Centres of Clinical Research Excellence Awards in 2003, with a total value of $4 million. They were in the fields of renal medicine (University of Sydney) and liver disease (Westmead Hospital). By contrast, Victorian researchers received five such awards, with a total value of $10 million.

Across a diverse range of smaller priority-driven research grants awarded through the NHMRC Strategic Research Development Committee, NSW generally attracted less than its expected share of national funding.

5.2.4 NHMRC Scholarships and Fellowships

The NHMRC offers a wide range of scholarships and fellowships of different types in the various broad areas of research (biomedical, clinical, and public health and related fields). They fall into four broad classes according to the stage of the applicant's career:

- Postgraduate (mainly doctoral) research-training scholarships
- Postdoctoral training fellowships (no more than two years postdoctoral)
- Career development fellowships (usually three to nine years postdoctoral)
- Senior postdoctoral fellowships (usually more than nine years postdoctoral).

The performance of the NSW research community in securing research fellowships is generally below expectation, mirroring its performance in securing NHMRC grants (Table 5.5). This does not bode well for the development of a strong medical and health research workforce in NSW.

Table 5.5: NHMRC Research Fellowships and Career Development Awards for 2004 announced 13 November 2003

State	Clinical Career Development Awards	Population Health Career Development Awards	Biomedical Career Development Awards	Uncoupled Research Fellow-ships	Practitioner Research Fellowships	Total
NSW	0	3	7	10	2	22 (19%)
Victoria	5	4	9	36	6	60 (53%)
Queensland	0	2	3	11	2	18 (16%)
National Total	7	10	24	62	10	113 (100%)

Source: NHMRC

The NHMRC has not yet announced postgraduate research training scholarships to commence in 2004. The 2003 awards show NSW trailing behind Victoria, but not as far behind as with Fellowships in 2004 (Table 5.6).

Table 5.6: NHMRC Postgraduate Scholarships awarded for commencement in 2003 by State (NSW, Victoria and Queensland)

State	Number of NHMRC Postgraduate Scholarships	Proportion of national total
NSW	53	34%
Victoria	60	39%
Queensland	19	12%
National Total	154	100%

Source: NHMRC

The Commonwealth Department of Education, Science and Training collects data on doctoral completions in health fields. These include doctoral students with NHMRC Postgraduate Scholarships as well as all others pursuing doctoral studies in health fields. Table 5.7 shows that, in 2002, the rate of completion of doctorates in NSW in 2002 was almost 50% lower than that in Victoria, while in 1993 NSW and Victoria had very similar rates.

Table 5.7: Doctoral completions in health fields per million of State population, 1993 and 2002

State	Completions per million population		Ratio
	1993	2002	2002/1993
NSW	11.4	30.6	2.7
Victoria	11.6	44.6	3.8
Queensland	8.0	19.8	2.5

Source: DEST

The combination of a lower-than-expected number of research fellowships, strong competition from Victoria in the award of NHMRC postgraduate research scholarships, and a mediocre doctoral completion rate in health-related fields, does not bode well for the development of a strong medical and health research workforce in NSW.

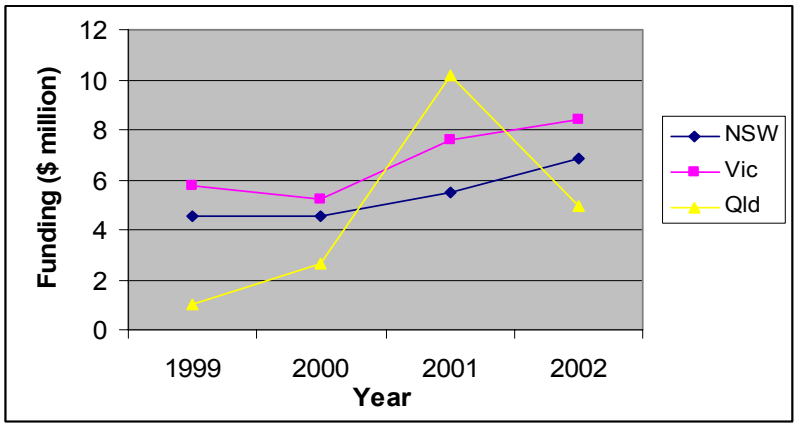
5.2.5 Australian Research Council grants in health-related fields

In 2003, ARC funding of life sciences, encompassing medical and health research, totalled about $39.1 million - less than one-sixth of NHMRC funding of research. As noted in section 5.1, total funding of the ARC has increased since 2001, and funding of life-sciences research has increased accordingly; the figure in 2000 was $19.6 million. ARC funding for research in health-related fields is awarded through the Discovery-Projects and Linkage-Projects Programs. Fields of research comprise health and medical sciences, physiology, biochemistry and cell biology, genetics, biotechnology, and microbiology.

The ARC Discovery-Projects Grant Program, which has subsumed the former ARC Large Grants Program, 'supports a continuum of activities, from smaller single research projects to clusters of larger projects…'. It funds both research projects and fellowships.

NSW has consistently trailed Victoria in total funding obtained from Large Grants and Discovery-Project Grants in health-related fields. Total funding to Queensland from these programs was below that of NSW and Victoria in 1999, 2000 and 2002, but was the highest of any State in 2001, due to a small number of large grants (Figure 5.5).

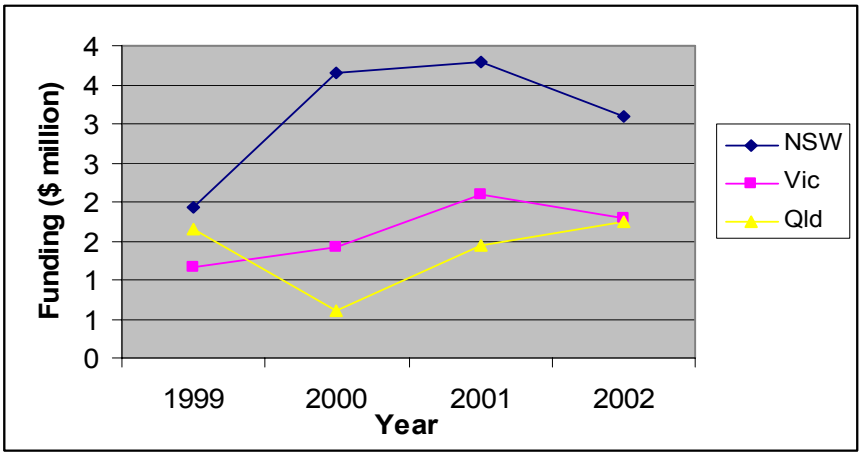
Figure 5.5: Total ARC funding for Large Grants and Discovery-Project Grants in health-related fields, by State (NSW, Victoria and Queensland) and by year (1999 to 2002)



Source: ARC

ARC Linkage-Projects grants support R&D projects involving researchers in higher-education institutions and industry. Proposals for Linkage-Projects grants must contain a contribution from an eligible industry partner organisation, which may be a private-sector industry organisation, a not-for-profit organisation, or a government agency. The Linkage-Projects Program has subsumed the former SPIRT program. NSW has consistently outranked Victoria and Queensland in total funding from SPIRT and Linkage-Project Grants, mostly by a factor of at least two, although Queensland was a close runner-up in 1999. NSW earnings peaked in 2001 (Figure 5.6).

Figure 5.6: Total ARC funding for SPIRT and Linkage-Project Grants in health-related fields, by State (NSW, Victoria and Queensland) and by year (1999 to 2002)



Source: ARC

5.3 US National Institutes of Health grants

The NIH is an entity of the US Department of Health and Human Services. It conducts research in its own laboratories, supports research in universities, health services and research institutes throughout the USA and elsewhere in the world, helps in the training of researchers, and fosters the communication of medical information. Its appropriation in 2002 was almost US$3.4 billion. Almost 84% of the investment is made through grants and contracts supporting research and training in more than 2,000 research institutions throughout the USA and abroad. These grants and contracts comprise the NIH Extramural Research Program.

The total value of NIH grants awarded to Australian researchers has increased steadily in recent years, reaching US$16.74 million in 2003. Over the period 1993-2003, Victoria received the largest proportion of total NIH funding awarded in Australia (42%). NSW received the second-largest proportion (22%), closely followed by Queensland (21%).

Individual NIH grants vary greatly in size. Those awarded in Australia in recent years have ranged from US$5,500 to $3.96 million. NSW researchers figured strongly in 2000 and 2001, with two very large awards for HIV immunisation research going to the National Centre for HIV Epidemiology and Clinical Research directly and through the University of NSW. However, in 2002 and 2003, NSW researchers trailed both Victorian and Queensland researchers, with Victorian researchers securing a large number of relatively small grants. (Table 5.7).

Table 5.7: Number and total value of NIH grants awarded in Australia by State (NSW, Victoria and Queensland), 2001-2003 (note: this includes new and continuing grants for each year)

State	2001		2002		2003	
	No of grants	Total value $US	No of grants	Total value US$	No of grants	Total value US$
NSW	9	$5,250,000	13	$1,310,000	14	$2,380,000
Victoria	22	$3,620,000	26	$6,000,000	36	$7,460,000
Queensland	9	$1,820,000	10	$3,110,000	14	$4,080,000
National Total	47	$12,130,000	60	$12,660,000	73	$16,740,000

Source: NIH website (www.nih.gov)

Most of the NIH funding in NSW went to, or was administered through, the university sector. Over the period 1993-2003, 51% of funding awarded in NSW went to the University of NSW, and 25% to the University of Sydney. The remaining 25% went to independent research institutes. In recent years, the proportion going to independent institutes has increased, reaching 43% in 2003 (Table 5.8).

Table 5.8: Number and total value of NIH grants awarded in NSW by sector, 2001-2003 (note: this includes new and continuing grants for each year)

Sector	2001		2002		2003	
	No of grants	Total value	No of grants	Total value	No of grants	Total value $million
University	6	$4,659,281	10	$830,907	8	$1,301,841
Hospital	0		1	$108,000	0	
Research institute	3	$590,381	2	$369,264	6	$966,157

Source: NIH website (www.nih.gov)

The institutions administering the grants between 2001 and 2003 were:

- The Children's Hospital at Westmead,
- Sydney Centre for Reproductive Health Research,
- Victor Chang Cardiac Research Institute,
- Institute of Dental Research,
- National Centre for HIV Epidemiology and Clinical Research,
- University of Newcastle,
- University of NSW,
- University of NSW (for the National Centre for HIV Epidemiology and Clinical Research),
- University of Sydney,
- University of Sydney (for the Save Sight Institute),
- University of Sydney (for the Institute for International Health), and
- University of Wollongong.

NSW researchers were awarded NIH grants between 2001 and 2003 in the following fields:

- Cancer,
- Cardiovascular disease,
- Mental health,
- Infectious diseases,
- Respiratory diseases,
- Reproductive health,
- Neonatology,
- Ophthalmology,
- Oral health, and
- Social and environmental health issues.

This indicates that NSW researchers in these fields are carrying out research of international significance.

5.4 Integrating research priorities with research capacity

The Review Panel integrated data on the main causes of the overall burden of disease in the NSW population, national and State health priorities, State research priorities, and topic areas where the State has strong research groups. Our analysis of the integrated data is given in Appendix E.

6 Publications and patents

Main points

- NSW has a large medical and health research publication output, produced predominantly in the university and hospital research sectors.

- However, NSW researchers are struggling to maintain that output: signs of a downturn have emerged in the last 2-3 years.

- While NSW produces slightly more publications, Victorian research generates more citations, an indicator of quality. The citation rates of Victorian medical research-institute publications are exceptional.

- NSW has displayed growth in its relatively small research-institute sector since about 1994. The NSW Infrastructure Grants Program, introduced in 1997, has been a positive influence in this.

- As in other States, the number of research publications emanating from the NSW hospital sector has levelled off since the mid-1990s. The difficulties of carrying out clinical research are increasing as demands grow for the delivery of day-to-day clinical services within constrained budgets.

- While recent Commonwealth reports on R&D suggest that patents are becoming less important to business, this is not the case for biotechnology companies. The high cost and risk of development requires strong protection of intellectual property.

- Australia's international performance on patent protection for medical research is poor. Australian researchers patent one fifth the international average per 100 medical research publications.

- Within that generally unsatisfactory Australian context, the NSW share of Australian biomedical patents is solid. NSW patents come mainly from the business sector; relatively few come from universities, research institutes, and hospitals. Counterpart research sectors in Victoria and Queensland perform better.

- In particular, Queensland's research culture is marked by a higher propensity to patent than NSW and Victoria.

6.1 Short- and medium-term outcomes of research

Two of the products of research that can be measured in the short and medium term are publications and patents.

Research findings typically appear in print in leading peer-reviewed journals 12-18 months after completion of the research. Today many journals are trying to shorten the publication time through electronic publishing. Two different types of measures of publication are used. Both make use of online databases compiled by the US Institute for Scientific Information (ISI).

The first is the number of publications, which simply reflects research productivity. The second is a count of citations (how often a scientific paper is cited by others). Citations reflect the quality, originality and value of research, and show that knowledge transfer is taking place. Publication counts can be rated in relation to journal impact factor, which is the average number of citations received by a given journal for the previous two years of its publication. The impact factor thus reflects a journal's visibility and importance, relative to other journals, and in turn is regarded as an indicator of the quality and importance of an article published in it.

As a response to large increases in numbers of publications, measures of quality have been introduced into the evaluation of scientific publication. Scientists try to publish in journals with the highest possible impact factors, as this ensures the high profile of their work and helps to determine funding and promotions. While valuable, bibliometric measures cannot be considered in isolation, but must be used in concert with other forms of evaluation.

Bibliometric data appear to be more reliable when the numbers of articles are large (for example at State and sector level), and when they are being used to compare research output within a field of research, rather than across different fields. We emphasise that publication and citation data *can be compared within research fields*, but *cannot be compared among research fields without appropriate adjustments.* This is because different fields inherently have different publication and knowledge-transfer patterns.

Citations obviously take time to occur, and are cumulative. An article is unlikely to be first cited until several months after publication. Indeed, a publication that is a cornerstone of its field may be cited again and again for decades. For comparative purposes, citation data are usually related to a defined time period.

Our inquiries focused on publications specifically categorised as being in fields of medicine and health.

Patents are used as a measure of innovation and as a way of protecting the commercial benefits of discoveries. Some discoveries are kept proprietary and are not revealed, because patent applications become public in Europe 18 months after submission.

For our inquiries we used the databases of IP Australia and the US Patents and Trademark Office to identify patents. We focused on patents ascribed to the following categories: medical science and hygiene; areas of organic chemistry associated with medicine; specific medicine-related subcategories of biotechnology; and specified medicine-related subcategories of chemical analysis of biological material. We took the address of the individual or organisation registering the patent as the place from which the patent originated (e.g. NSW patents were assumed to be those from registrants with NSW addresses).

6.2 Publications from medical and health research in NSW

6.2.1 Allocation of publications to research sectors

The detailed bibliometric analysis prepared for the Review will be published separately in a second volume. Publications were categorised according to the research sector from which they originated – universities, hospitals, medical research institutes, the CSIRO, and other. The 'other' category covered a miscellaneous collection of smaller publication producers such as government research groups and private industry. Articles written by authors from different sectors were allocated to those sectors on a proportional basis by institution. For example, an article authored by a university group and a medical research institute group was counted as 0.5 in the university sector and 0.5 in the institute sector, regardless of the number of individual authors.

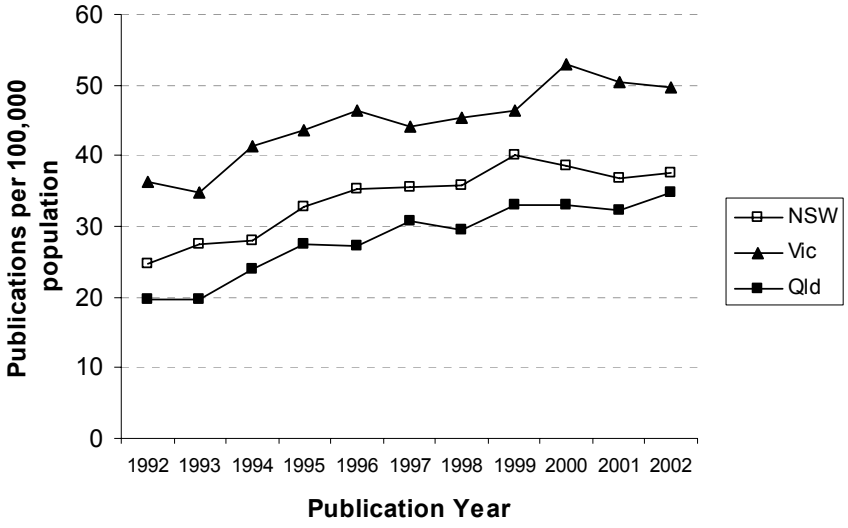
6.2.2 Publication counts

Australia produced 2.88% of the world's medical research publications in 2002, precisely the same percentage that Australian science contributed to world scientific output as a whole.

Over the 11 years 1992-2002, NSW and Victoria were well ahead of the other States and Territories in publication output. Between January 1998 and September 2003, NSW medical and health researchers published 13,930 articles in total – 31% of the national output (compared to 30% from Victoria). NSW, Victoria and Queensland have shown good growth in total medical and health research publications over a decade, although both NSW and Victoria have experienced a downturn in the last 2-3 years.

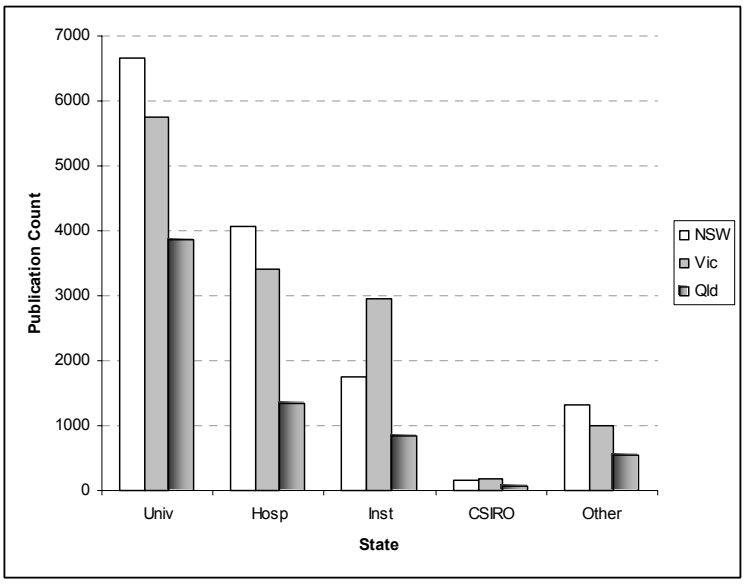
However, NSW lags behind Victoria when the respective populations of the States are taken into account (Figure 6.1). This suggests that the medical and health research publication output of NSW is not keeping pace with population and economic growth.

Figure 6.1: Total number of publications per 100,000 population, by year (1992–2002) and by State (NSW, Victoria, and Queensland)



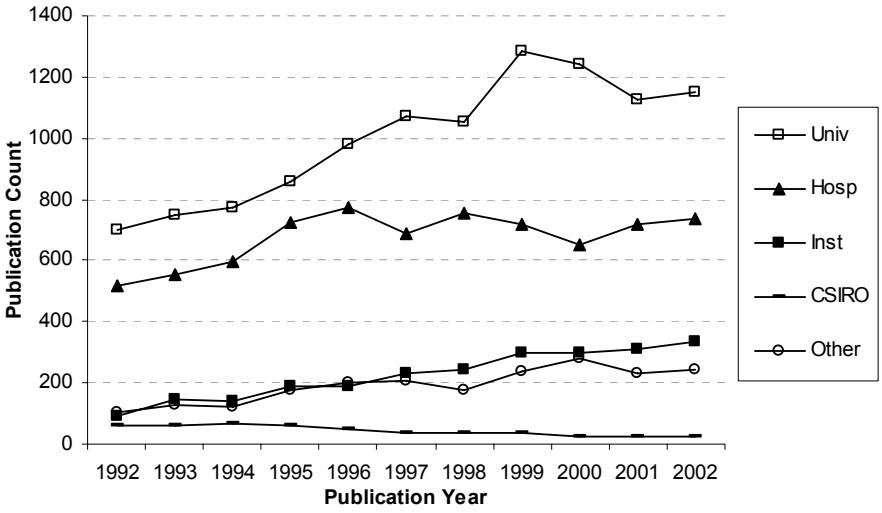
Within NSW, the university sector was by far the largest producer of medical and health research publications, generating 48% of the State's output between 1998 and 2003. It was followed by the hospital sector (29%) and research institutes (13%). In total numbers of publications from 1998 to 2003, NSW has led the other States in the university and hospital sectors, but Victoria has dominated the research-institute sector (Figure 6.2). Again, however, the State's national leadership in the number of publications originating in the university, hospital and 'other' sectors is lost when publication output is standardised for population.

Figure 6.2: Numbers of publications by sector and by State (NSW, Victoria and Queensland), 1998–2003



Longitudinal trends show a leveling off in the growth rate of the NSW hospital sector's publications from the mid-1990s (Figure 6.3). Submissions received by the Panel and anecdotal evidence both suggest that this is likely to reflect increasing difficulties faced by clinical researchers in securing time and resources for clinical research in the face of increasing pressures for clinical service delivery. Most other States have shown a similar trend.

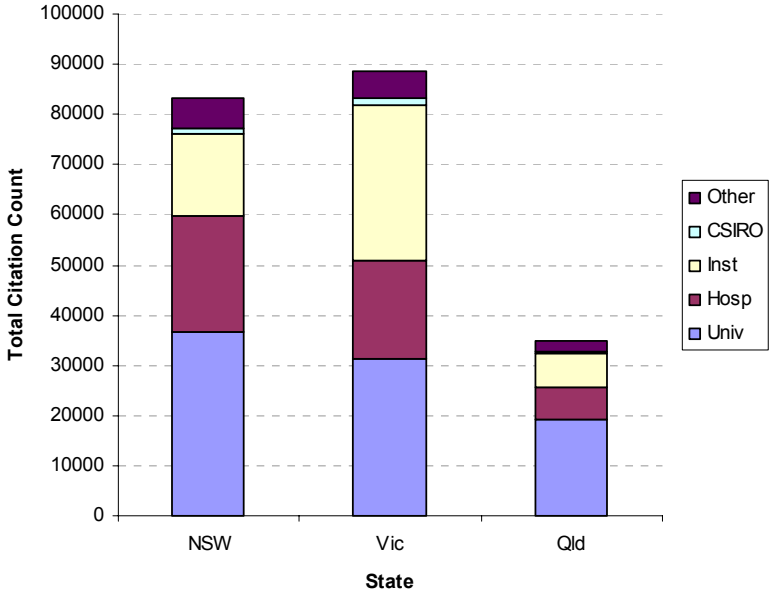
Figure 6.3: Numbers of publications from NSW by sector and by year (1992-2002)



6.2.3 Citations

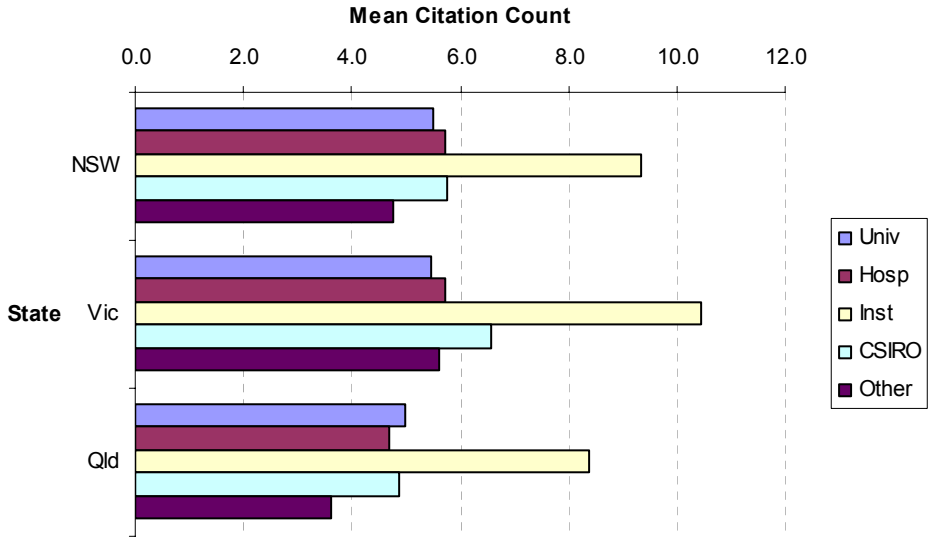
The respective performance of NSW, Queensland and Victorian researchers in attracting citations is illustrated in Figures 6.4 and 6.5. Although NSW produced more publications than Victoria over the period January 1998 to September 2003, Victorian publications generated a larger number of citations overall.

Figure 6.4: Numbers of citations by State (NSW, Victoria and Queensland) and sector, January 1999 to September 2003



In NSW, Victoria and Queensland, publications from research institutes had a much higher mean citation rate than publications from any other sector. This may in part reflect the fields in which they work, but is more likely to reflect the excellence of the research that the institutes support. Publications from Victorian research institutes had the highest mean citation rates in Australia (Figure 6.5).

Figure 6.5: Mean numbers of citations per publication by State (NSW, Victoria and Queensland) and sector, January 1998 to September 2003



6.3 Patents from medical and health research in NSW

6.3.2 Australian patents

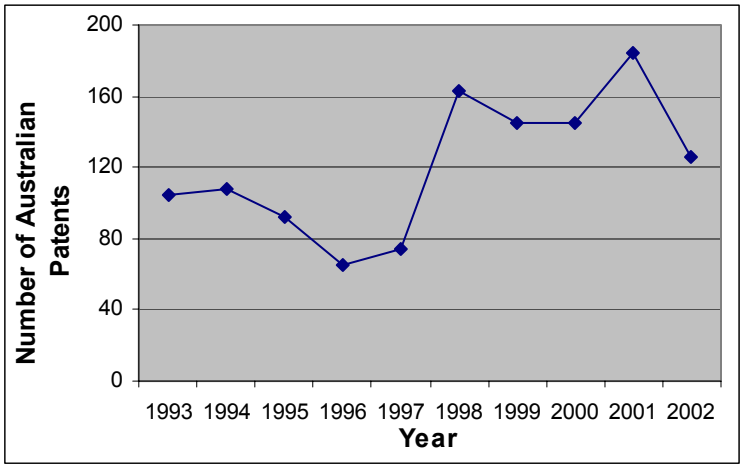
Companies, universities, research organisations and individuals from all around the world protect their IP in the Australian market by taking out Australian patents. In the decade 1993–2002 IP Australia calculates that some 36,600 Australian patents were secured with a biomedical application. Of this total, approximately 1,200 (3.3%) were taken out by Australian 'residents' that could be companies, individuals or other groups.

More than half the total number of Australian patents (18,528) were taken out by entities resident in the USA. Other countries taking out more than 1,000 Australian patents over the 10-year period were:

- the United Kingdom (2,823 Australian patents),
- Japan (2,791),
- Germany (2,790),
- France (1,889), and
- Switzerland (1,294).

The number of 'Australian' biomedical patents secured by Australian residents each year has been highly variable. Numbers have followed an upward trend. However, the number of new medical and health related patents registered in 2002 slumped to 112. One contributory factor, but almost certainly not the whole explanation, is the introduction of the new, interim processes for protecting IP, the 'innovation patent'. Economic factors, and market sentiment affecting biotechnology business generally, may also have been considerations.

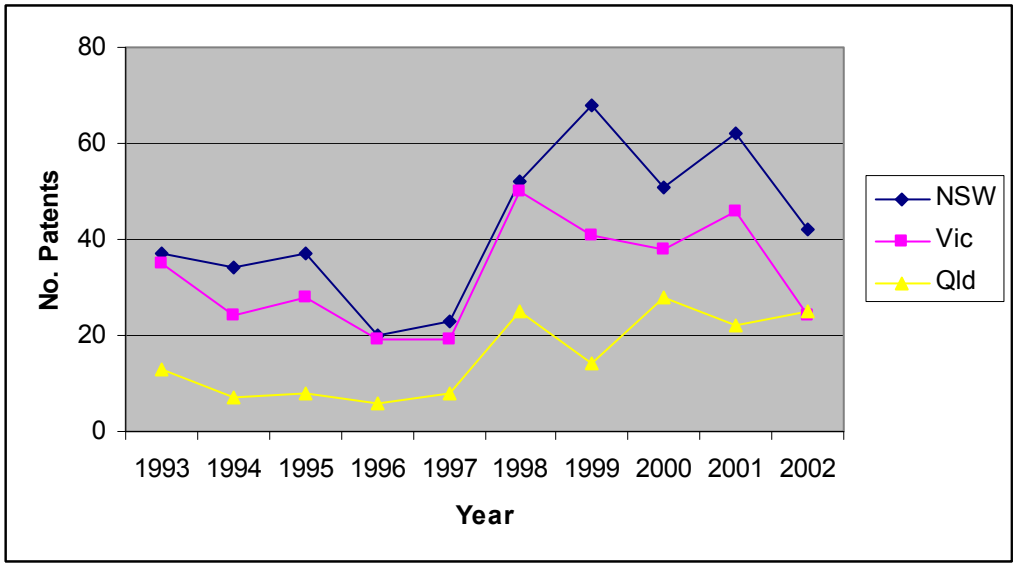
Figure 6.6: Number of Australian patents taken out by Australian residents in medical and related fields, by year (1993–2002)



Over the 1993–2002 decade NSW residents secured some 33% of the Australian resident total, 25% by Victorian residents, 13% from the ACT, and 12% by Queensland residents (Figure 6.7). Whether the NSW figure is a true indicator of its contribution to Australian biomedical innovation is hard to gauge. Most companies seem to register patent applications through their head office, a consideration that boosts NSW numbers, given that many biotechnology companies are headquartered in Sydney.

There is, however, a factor working in the other direction that leads to an implicit understatement of the performance of NSW and the other States. This is the CSIRO practice of registering all its patents through its Canberra office (as does the Australian National University). The CSIRO practice greatly inflates the apparent contribution of the ACT to all areas of Australian scientific activity and leads to the ACT accounting for about 13% of biomedical patents for the decade as a whole. This effectively reduces the shares of the other States below their likely actual contribution. All in all, the best estimate is that the performance of NSW meets expectations in the patenting of biomedical intellectual property, given the State's size and GDP.

Figure 6.7: Number of Australian patents in medical and related fields, by State in which applicants were resident (NSW, Victoria and Queensland) and by year (1993 – 2002)



To damp out the effect of annual fluctuations, we calculated the average numbers of Australian patents over the five years 1998–2002 and over the three years 2000–2002 (Table 6.1).

Table 6.1: Annual average numbers of Australian patents by State in which applicants were resident in 2002, and averaged over 10 years, five years, and three years

Annual average number of patents	NSW	Victoria	Queensland	All States and Territories
1993–2002	43	32	16	130
1998–2002	55	40	23	164
2000–2002	52	36	25	154
2002	42	24	25	113

In 2001 and 2002, a much larger proportion of NSW patents (63%) was issued in the business sector than was the case in Victoria (43%) or Queensland (40%). Conversely, much larger proportions of the Victorian and Queensland patents (42% and 33% respectively) originated from academic, institutional and government research settings than was the case for NSW patents (16%) (Table 6.2).

Table 6.2: Australian patents held by Australian residents, by State of residence (NSW, Victoria and Queensland) and by sector, 2001 to 2002

Settings from which Australian patents originated	Business sector Number (row %)	University, institute and government sector Number (row %)	Individuals Number (row %)	Total (%)
New South Wales	66 (63%)	17 (16%)	21 (20%)	104 (100%)
Victoria	30 (43%)	29 (42%)	10 (14%)	69 (100%)
Queensland	19 (40%)	16 (33%)	13 (27%)	48 (100%)

The relative strength of the business sector in NSW and the weakness of the academic and research sectors in initiating this first stage of commercialisation have important policy implications. These are addressed in Chapter 7.

6.3.3 US patents

Australian researchers' performance in protecting their IP falters when seen in an international context.

The USA has its own classification system for patents, different from the International Patent Classification (IPC) used by IP Australia. Hence it is not possible to compare data derived from the two systems precisely.

If a discovery is to have any chance of achieving its true commercial potential, the IP has to be protected in the US market. This is particularly so for biomedical products, both because of the size and hence commercial significance of the US market, and because the USA is the home of most of the major pharmaceutical companies that have global reach. Therefore the US Patent and Trademark Office is the most important international register where people seek IP protection. Many entities may opt not to protect their IP in the Australian market, but see the US protection of IP as essential.

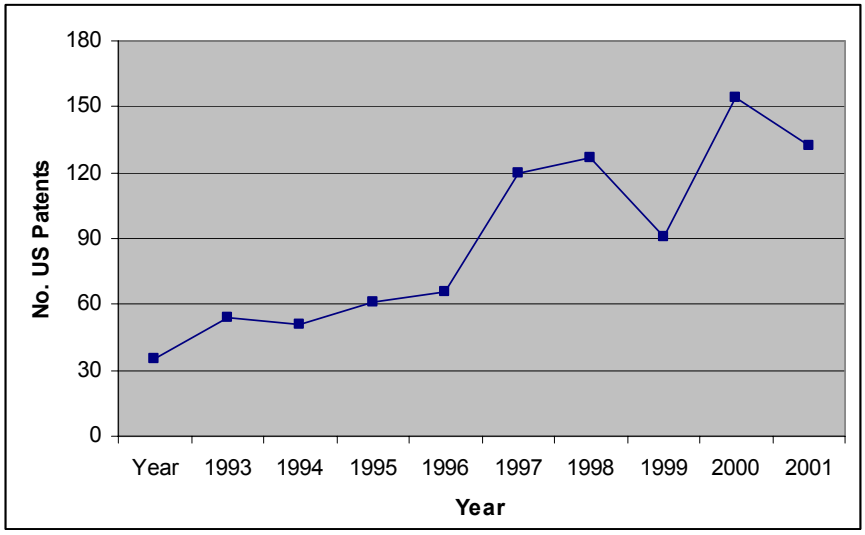
The evidence suggests that Australian residents secure much the same number of medically-related patents in the USA as they secure in Australia. However, the Australian share of US-registered medical patents is small. Regardless of the method that we used to examine the data on patents, Australia's maximum share of US medical patents in any year was only 0.7% of all patents registered.

To achieve greater precision, we examined US data in two ways – first using the IPC (as applied to Australian patents), and then using the US classification.

Patents according to the International Patent Classification

Over the period 1993 to 2002, a total of 189,804 patents relating to medical and health research (according to IPC criteria) were registered with the US Patent and Trademark Office from all over the world. Of these, 891 (0.5%) were registered to Australian residents. The total numbers registered to Australian residents rose overall from 35 in 1993 to a peak of 154 in 2001. The numbers were of the same order of magnitude as Australian patents registered by Australian residents (Figure 6.8).

Figure 6.8: Number of US patents in medical and health-related fields registered by Australian residents, by year (1993-2002)



Source: US Patent and Trademark Office, www.uspto.gov, (accessed 6 November 2003).

Registrations of patents to Australian residents represented between 0.3% and 0.7% of total US patents.

Patents according to the US classification

More reliable data for US patents registered to Australian residents are provided using the US classification, with reference to the years 1997-2002. According to the US classification, the numbers of medical and health-related patents registered to Australian residents were somewhat higher than those obtained using the IPC. According to the US classification, the total number of patents awarded to Australian residents over the six-year period was 952, while the figure obtained using the IPC was 690. The share registered to Australian residents was slightly higher when the US classification was used: 0.5% of all US patents in 1997, and 0.7% each year from 1998 to 2002 inclusive.[1]

6.3.4 Implications

Patents and publications compared.

Australia is a major contributor to global medical research. Some 2.88% of all international medical publications are from Australian research outcomes. Yet in striking comparison we secure few medically-related patents.

The following ratios compare medical and health-related patents registered with the US Patent and Trademark Office to publications in medical and health fields. Two sets of ratios have been calculated:

> (a) patents registered by Australian residents per 100 publications by Australian researchers in medical and health fields; and
>
> (b) all patents registered per 100 medical and health research publications from throughout the world.

The results suggest that Australian medical and health researchers are about one-fifth as likely to take out patents as are their colleagues from around the world (6.30/1.23 = 5.12) (Table 6.3).

[1] It is possible that the difference in counts may be due to some US patents not having been classified to the IPC at all. If this were the case, use of the IPC to examine US patents would lead to an under-ascertainment. Alternatively, the two systems may simply yield different counts due to variations in inclusions and exclusions.

Table 6.3: Australian and worldwide medical patents (registered with the US Patent and Trademark Office) in relation to medical and health research per 100 medical and health research publications, 1999–2002

Ratio	1999	2000	2001	2002	1999–2002 average
Australian patents registered with USPTO* per 100 publications by Australian researchers	1.32	0.89	1.46	1.25	1.23
Worldwide patents registered with USPT0* per 100 worldwide publications	6.42	5.98	6.43	6.40	6.30

*US Patent and Trademark Office

We were unable to explore State differentials within Australia using the same database, as we could not obtain US Patent and Trademark Office data at a State level. However, to determine the extent of State differentials in patents versus publications, we examined patents registered with IP Australia by NSW, Victorian, Queensland, and all Australian residents, in relation to publications by Australian researchers in medical and health fields (Table 6.4).

The data suggest that Queensland medical and health researchers have had a greater propensity to take out patents than NSW researchers; Victorian researchers a lesser propensity than NSW researchers.

Table 6.4: NSW, Victorian and Queensland medical and health patents (registered with IP Australia) in relation to medical and health research publications, 1999–2002[2]

Place of residence of patent registrant	Patents registered with IP Australia per 100 publications				
	1999	2000	2001	2002	1999–2002 average
NSW	1.98	1.42	1.67	1.15	1.55
Victoria	1.27	1.07	1.21	0.65	1.04
Queensland	2.31	4.63	3.41	1.40	2.44
Australia – overall	1.74	1.69	1.69	1.07	1.54

It is hard to imagine that Australia's medical research output does not have at least the same potential for commercialisation as that of other similar countries. Conceivably the low rate of patenting may reflect the field of study, lack of funds to pursue patents, lack of access to knowledge of patenting, and a low priority given to patents by the responsible institution. This same phenomenon is endemic to other areas of Australian science and research. However, it is particularly striking in medical and health research.

[2] For patents registered with IP Australia from all over the world in relation to publications from all over the world, the average ratio for 1999–2002 was 1.22, with little year-to-year variation between 1999 and 2002. However, this ratio is likely to be a gross under-estimate, because relatively few patents from around the world would be registered in Australia.

Our conclusion is that Australia has excellent researchers who are poor at translating discovery into intellectual property. Neither at the national nor the State level can we afford to lose opportunities that provide the precursor to successful commercialisation.

At issue seems to be the mindset of Australian researchers. Certainly commercialisation is not uppermost in the minds of most Australian researchers. In one sense that may be a positive. It may also be a reflection of the status that Australian research institutions attach to different outputs and outcomes. As mentioned in Chapter 2, amongst the things that matter to them, Australian researchers as a whole attach very little significance to commercial potential.

The fact that this attitude can be quickly changed is again implied by the Queensland figures. The Queensland rate of patenting to publishing, while still low by international standards, is roughly twice the NSW or Victorian levels. As the data in Chapter 4 data show, industry in Queensland has a much closer interaction with other research sectors than does industry in NSW and Victoria. The main Queensland medical research institutes place emphasis on commercial outcomes amongst their performance indicators. But at both the national and the State levels, it would be at least as prudent for Australian research organisations to be as active as their international counterparts in protecting IP.

Finally, a recent Commonwealth report on R&D suggests that patents are becoming less important to business. This is not the case for biotechnology companies. The high cost and risk of development requires strong protection. These issues are addressed in Chapter 7.

7 Health, health service and economic outcomes

Main Points

- The benefits of medical and health R&D include the extensive societal and economic gains due to health improvement and longer life expectancy and the economic gains from the commercialisation of discoveries.

- There are many examples of the successful commercialisation of Australian R&D in NSW. These include ResMed, Cochlear and Ventracor.

- Start-up companies will be a major source of future commercial activity. It is essential for NSW to provide an environment that enables start-up companies to secure adequate funding and to flourish.

- NSW has the potential to capture a larger share of the R&D carried out by the biotechnology and pharmaceutical industries throughout the world, particularly from clinical research.

- NSW is already a base for Australian biotechnology and pharmaceutical companies. However, data on the distribution of BIF and R&D START grants by State raise doubts as to the recent performance of NSW in growing new companies from local R&D. Moreover, NSW is the headquarters for few Cooperative Research Centres in medical and health fields.

- NSW can enhance commercialisation by investing in excellent basic science and postgraduate education, attracting R&D nodes of international companies, removing impediments to the patenting of public-sector research, and providing pre-seed funding and incentives to encourage increased local commercialisation activity, in preference to early licensing of intellectual property to international companies.

- NSW should aim to be the location of first choice for the biomedical industry in Australia.

7.1 The benefits of medical and health R&D

7.1.1 Improvements in health and health care, and economic gain

The benefits of medical and health R&D are of two broad types: improvements in health and healthcare, and economic gain. The two types of benefits have separate and joint effects. Economic gain can create better conditions of life for the population and make more resources available for health care, thereby improving the health of communities and individuals. Improvements in health and health care strengthen the vitality and productivity of the population, and enhance the quality of life of individuals. Improvements in health and the efficiency of health care also have the potential to reduce need for health services.

7.1.2 Demonstrating the benefits: health and health-care outcomes

The population of NSW – in common with the Australian population as a whole – has experienced some spectacular improvements in health in the last few decades, and some of these improvements appear to have accelerated over the last 5–10 years. Perhaps the clearest index is the fall in death rates, due to the reductions in some of the major causes of death. The following are examples.

- Death rates from coronary heart disease – the biggest single cause of death – have declined since their peak in 1968. Over the five years 1996–2000, coronary heart disease death rates fell by about 6% each year. The reduction is understood to be due to both prevention and improved medical management.

- Death rates from stroke – the second-largest cause of death – have also fallen consistently since 1970. The annual rate of decline is just under 5%. As for coronary heart disease, the reduction in stroke deaths is understood to be due to both prevention and improved medical management.

- Death rates from colorectal cancer – the second most common cause of cancer deaths – declined by 2.5% per annum during the five years 1996–2000. Death rates from breast cancer – the most common cause of cancer deaths in women – have fallen by about 3% per annum since 1993. Death rates from prostate cancer – the second most common cause of cancer deaths in males – have also fallen by about 3% per annum since 1993. These improvements have been mirrored by increased rates of survival from most cancers.

- Death rates from chronic obstructive pulmonary disease – the fourth most common cause of death in males and the sixth most common in females – fell by more than 5% in males and more than 4% in females per annum between 1995 and 2000.

- Infant death rates have also declined markedly, due both to the implementation of research-based methods for preventing sudden infant death syndrome and to improvements in the care of the newborn.

The falls in disease-specific death rates underpin the continuing, indeed accelerating increases in life expectancy. Between 1996 and 2000, life expectancy at birth increased by about six months every five years for females, and by more than eight months every five years for males. The declines in death rates have been accompanied by improvements in 'healthy life expectancy', i.e. the numbers of years expected to be lived without reduced functioning.

To what extent are these improvements in health due to medical and health research? It is impossible to come up with a quantitative relationship linking 'big-picture' outcomes such as life expectancy with specific research findings. However, individual research findings are building blocks that contribute to better health and health care, and the building blocks can certainly be identified. Many have been created by researchers in NSW. The State's strengths in various fields of research have a ready application to clinical and public-health practice: research in these fields depends on a strong basic-research capacity.

The ability to respond rapidly to new diseases such as AIDS or SARS depends on a strong research capacity, integrated with diagnostic and epidemiological expertise and mechanisms for the application of research findings.

7.1.3 Demonstrating the benefits: economic gain

The report, *Exceptional Returns, The Value of Investing in Health R&D in Australia* (Access Economics, 2003) finds that Australian R&D expenditures are at least recouped by health gains resulting from Australian R&D, and that annual returns may be more than five times initial expenditures. These estimates take account of both increases in lifespan and improvements in wellness, and the economic benefit of both.

7.1.4 Commercialisation of medical research: a major opportunity for NSW

With improved focus, Australia can expect a clear return on its R&D investment. Professor Robin Batterham, Australia's Chief Scientist, has proposed a five-year goal of creating 250 start-up companies from public investment in R&D. He estimates that this would add $20 billion per annum to Australia's exports. Since a significant proportion of Australia's R&D investment is in biomedical research, there is an expectation of very significant commercial benefits from biomedical research.

The direct economic benefits of medical research can be enormous. In 1997, the US pharmaceutical industry employed 260,000 people and generated US$87 billion in sales. The

biotechnology industry employed 110,000 people and generated US$9.3 billion in sales. Examples of successful companies in NSW illustrate what can be achieved.

For example, Cochlear developed and marketed devices for those with hearing disorders, based on research carried out in the 1970s at the University of Melbourne. Today, Cochlear is one of Australia's top 100 companies. Its market capitalisation is $1.5 billion, and it employs 400 Australians. ResMed developed and marketed devices for the management of sleep disorder, based on research at the University of Sydney. It also has a market capitalisation of around $1.5 billion, and employs more than 400 Australians. Ventracor developed and marketed cardiac pump devices, based on research at University of Technology, Sydney, and the University of NSW. Its market capitalisation is $400 million and it has 80 employees. There are other successful companies in the instrumentation field, such as Proteome Systems. The biotechnology therapeutic field is less evolved, but companies such as Biota and Amrad in Victoria, and Pharmaxis, recently listed in NSW, are working in it.

7.2 What needs to be done to achieve further success in NSW?

7.2.1 Australia's comparative performance

As a nation we perform high-quality, internationally-respected research, but our performance in converting that research into commercial outcomes falls short of that in other countries.

Recent reports suggest that Australia's performance in the commercialisation of research is mixed. Based on measurements of income from licenses and on the number of start-up companies, our performance is above that of either the USA or Canada, relative to expenditure on research and the size of the national economy. Based on other indicators, such as the number of licenses executed and, in particular, US patents issued, our performance is below that of both the USA and Canada.

There is evidence, however, that our start-up companies are often poorly funded. This comes through clearly when we compare our funding to that of Canadian companies (Table 7.1).

Table 7.1: Comparison of Australian and Canadian biotechology companies

Biotechnology company average	Australia	Canada
Total employees	32	450
Revenues	US$2 million	US$32 million
Market capitalisation	US$34.5 million	US$361.1 million
Months of cash on hand	58.01	49.86
CEO salary plus bonuses	US$120,336	US$244,972

Source: Deloitte Touche Tohmatsu (2003)

7.2.2 Intellectual Property

Intellectual property is the cornerstone in the process of deriving commercial value from research. The creation and optimal management of IP depends on two elements. The first is a strong capacity for the performance of the research and the evaluation and documentation of the resultant discovery or invention. The second is a mechanism for taking the discovery or invention through the development process and beyond. This may involve either setting up a corporate entity to support and manage the development process, or licensing the IP to an existing corporation for the same ends.

In Chapter 6 we reported that Australia's share of US patents is low (around one-fifth of the global average), relative to other countries and relative to Australia's output of medical and health research publications. For the successful commercialisation of research, it is critical to encourage more patenting and defending of patents.

7.2.3 Optimal delivery of returns to Australia

The report of the National Innovation Summit held in February 2001 suggested that, in the long run, the licensing route to commercialisation rarely delivers substantial returns. By contrast, the creation of spin-off companies is likely to deliver far greater benefits in the longer term. While there are differing views on this, it is noteworthy that the research commercialisation strategy in Canada focuses on the formation of start-up companies.

In a licensing arrangement, the licensee pays the research entity a fee and/or royalties for the right to use the IP. The fee and royalties usually depend on the extent of development of the IP; the more highly developed the IP, the lower will be the risk and development costs to the licensee, and the higher the license fee and royalties. Licensing arrangements to large international entities free researchers from the responsibility of developing IP, and may produce some income in the shorter term as well as royalties in the longer term, but the financial gains are probably lower.

The results of the National Survey of Research Commercialisation provide an empirical basis for debate on the balance between the various elements of our commercialisation activity in Australia, and on the most appropriate strategies that Australian publicly-funded research organisations might pursue in order to maximise future returns on investment. It is critical for Australia, and therefore NSW, to form a view on the balance, and implement policies that lead to the desired outcome.

The term 'spin-off' or 'start-up' is usually used to describe a corporate entity set up by the inventor to support and manage the development of the IP. This term recognises the fact that the corporate entity is usually an offshoot of the inventor's research unit. If the 'spin-off' is a company limited by guarantee, the research unit may be protected against commercial failure of the IP development, but it bears the risk associated with the investment of time, energy and

resources in the development process, and there may be a long wait, typically years, before the IP generates income. If the IP is profitable, the inventor and/or the research unit stand to gain handsomely. It is important to note that commercial success can come for the investors in many ways: a trade sale, merger, public listing of the start-up company, licensing deals, or ultimately selling a product. Australia benefits from start-ups, because an estimated 91% of start-ups have their headquarters in Australia. One approach to the subsequent expansion of these companies is to establish a 'front door' operation in the USA for business development and finance, but to continue R&D in Australia.

Unfortunately venture capital and investment by individual 'angel' investors are difficult to obtain in Australia. Thus the recent increase in early biotechnology has been driven largely by government matching funding, BIF grants, R&D START grants, and State programs such as Bioinnovation South Australia or Biostart in Queensland.

There are also broader commercial benefits to Australia from the many advances in biological sciences. These include not just the development of new products, therapeutics, diagnostics, and devices, but also the supporting service sectors - financial and legal, as well as contract research organisations and other suppliers.

7.3 Factors affecting commercialisation nationally and in NSW

A major issue is that, relative to government expenditure, Australian business-sector expenditure on biomedical R&D is low compared to that in other countries (see Chapter 6). In Australia, only 25% of funding for R&D in medical and health fields comes from the business sector. In Canada, the figure is 40%; in the USA, 50-60%; and in the UK, 75%. While the report 'Mapping Australian Science and Innovation' suggests this is a problem for Australia in many sectors, it is particularly significant in biotechnology, because biotechnology is one of only three or four scientific areas in which Australia has a leading position in basic research.

The Wills Review suggested that fostering a partnership between business and academic research would result in a 'virtuous cycle', which would enhance both sectors and build a significant biotechnology industry in Australia. One of the challenges is that the commercialisation of research can take many forms. What may suit an individual inventor or an academic institution may not be optimal for building a strong industrial base in the longer term. While numerous Government policies are in place to assist in R&D, there appears to be little attempt to define a long-term plan across different jurisdictions. Such a plan should signal the importance of retaining in Australia the benefits of Australian research investment.

Australia can benefit from the commercialisation of products in the medical area in several ways. In general, biotechnology is built on excellent R&D. In the case of therapeutics and diagnostics, the expenditure on manufacture of the end product is small compared to the expenditure on R&D. Large pharmaceutical companies typically spend up to 20% of the value of their sales on R&D. Biotechnology companies may spend up to 60% of shareholder funds on

R&D. Sales and marketing are other major areas of pharmaceutical company spending, but these areas will never represent large opportunities to bring money to Australia, as the Australian market is small on the international scale. But if pharmaceutical and biotechnology companies can be induced to invest in R&D in Australia, the potential gains for Australia are substantial.

International pharmaceutical and biotechnology R&D can be done anywhere in the world. Of the many economic benefits of biotechnology, the greatest opportunity for Australia is capturing more of the R&D. However, there is competition. Many regions and countries have seen the opportunity created by the unprecedented pace of biomedical discovery, and are keen to reap the benefits for their region. Australia has natural advantages: excellent science, an educated workforce, location in an expanding region, and medical practices that are similar to those in the largest pharmaceutical market, the USA. Australia also has disadvantages: distance, a small capital base for investment in biotechnology, and a small local market for final products. Nevertheless, the commercial opportunities and the synergy that can be achieved between academic research and biotechnology are tremendous. NSW should be the Australian leader in biotechnology, given the State's attractiveness to business, the location of many international pharmaceutical and biotechnology company headquarters in Sydney, the availability of capital, and the quality of science.

7.4 Status of biotechnology in NSW

7.4.1 General description

We analysed the current status of biotechnology in NSW by interviews and the collection of financial data. Qualitatively, the medical-device industry in NSW appeared healthy, with the location of both Cochlear and ResMed and many smaller device companies in NSW. The opinion was voiced that the presence of a large pharmaceutical company in NSW would galvanise the industry. It is not clear that CSL has had that effect in Victoria, and it is likely that Australia will continue to have to grow its industry from the start-up stage, as well as attracting more of the international R&D. Until now, NSW has done well in attracting business activity from US pharmaceutical companies and excels in the device and instrumentation area in Australia.

The NSW Department of State and Regional Development website notes that NSW is the base for 40% of biotechnology companies in Australia, 80% of multinational pharmaceutical companies, and 70% of pharmaceutical companies with regional headquarters. In 1999-2000, the biotechnology and pharmaceutical industry in NSW exported A$900 million of medicinal and pharmaceutical products. NSW biotechnology companies are estimated to generate A$300 million in revenue annually. Over 50% of this revenue is generated through export. In 1999-2000, the NSW pharmaceutical industry had an estimated turnover of A$2.3 billion and exports of A$530 million.

In all fields (not just the medical area), the NSW biotechnology industry employs 2,300 people. In addition the pharmaceutical industry employs approximately 6,900 people. There are over 60 small to medium-sized biotechnology companies wholly focused on biotechnology in NSW. An additional 190 companies are involved in related areas such as pharmaceuticals, services, medical instrumentation and other life sciences.

In their recently-published *Bio-Industry Review 2003*, Dr Kelvin Hopper and Ms Lyndal Thorburn reported on a survey of the development of 'core biotechnology firms'. Their survey excluded medical-device companies, firms working in traditional areas of biotechnology such as brewing, and firms that were information technology based. In the areas of diagnostics and therapeutics, Victoria had 80 core biotechnology firms, NSW had 56 firms, and Queensland had 33 firms. Employment in core biotechnology firms was almost three times higher in Victoria (with 2,800 employees) than in NSW and Queensland, which had similar employment levels. Dr Hopper and Ms Thorburn concluded, 'Victoria is clearly building a lead in the development of a life sciences industry…Victoria had more start-ups and company stock market listings and received the most funding from NH&MRC, BIF and START programs related to biotechnology.'

Recently NSW has initiated a strategy to commercialise more of its early research and to foster biotechnology clusters. The strategy includes the BioFirst biotechnology programs. The NSW Department of Health administers a program of awards, known as BioFirst Awards, aimed at attracting researchers to work in NSW. The BioFirst Awards are intended for topping up researcher salary packages, each award having a value of $100,000 per annum over three years. NSW also supports a biotechnology incubator facility. This has been set up at the Australian Technology Park (ATP) in Sydney, and will be able to host 16 start-up companies. The NSW Government contributed $2.5 million to this initiative, matched by funds from ATP Innovations.

As described in section 3.4, the NSW Government supports regional clusters or 'biocentres' at major hospitals and institutes. The Office of Western Sydney and the research institutes at Westmead Hospital and The Children's Hospital at Westmead are establishing a biocentre embracing the Westmead research and health precinct. This capitalises on the strengths of Westmead Hospital, the Westmead Millennium Institute, The Children's Hospital at Westmead, the Children's Medical Research Institute and other research and industry centres. Development of the research facilities in the St Vincent's Research and Biotechnology Precinct has been boosted by the injection of $20 million and Westmead Millennium (Stage 2) by $8 million from the BioFirst program.

The BioMed North cluster, established December 2002, is being developed but its exact membership is still evolving: it will initially focus in the Northern Sydney Area.

The therapeutics area is very high risk and in Australia requires early support from Governments. NSW does not have a fund to provide pre-seed money to early-stage firms.

Queensland has BioSTART, a $6 million three-year program designed to provide early funds to progress research to a proof of concept stage. BioInnovation SA has a fund that gives up to $150,000 for the earliest stages of commercialisation in biotechnology. Victoria has also allocated $8 million to Clinical Trials Victoria, aiming to attract more clinical trials to the State. Clinical trials represent a field in which NSW also has strength and further potential.

7.4.2 The State's performance in the earliest stages of the commercialisation of biotechnology

The data given in section 7.4.1 underline the fact that NSW currently has a substantial industrial and commercial presence in the pharmaceutical and biotechnology areas. But is the State continuing to be the location of preference for Australian companies developing business based on Australian research efforts?

To analyse NSW performance in the earliest stages of biotechnology, we examined BIF and R&D START grants awarded to NSW companies. BIF grants have a value of up to $250,000, and are given to new biotechnology companies, including those in the biomedical field, to aid in the movement of projects from the research phase to the early commercialisation stage. BIF is a partnership funding program, and the NSW Government has strongly committed to provide matching funds to different ventures under this scheme. Applicants for BIF grants have a high success rate (50%). In 2001-02 and 2002-03 respectively, totals of 55 and 82 BIF grants were awarded across all fields of science and innovation throughout Australia. Of these, 28 (51%) were awarded to biomedical companies (as self-categorised by applicants) in 2001-02, and 29 (35%) in 2002-03. Table 7.2 shows BIF funding for biomedical ventures in 2001-2 and 2002-03.

Table 7.2: BIF grants awarded to biomedical companies in 2001-02 and 2002-03, by State (NSW, Victoria and Queensland) and Australia wide.

State	2001-02		2002-03	
	Number	Value (millions)	Number	Value (millions)
NSW	9	$1.79	9	$2.01
Vic	9	$2.02	11	$2.52
Qld	6	$1.41	3	$0.75
National total	28	$6.09	29	$6.78

Source: Industry Research & Development Board

Grants of up to $ 3.0 million are awarded under the R&D START program. To date Victoria has received about 44% of START grants in the biomedical area (Table 7.3).

Table 7.3: R&D START grants awarded to biomedical companies, 2000-01 to 2002-03, by State (NSW, Victoria and Queensland) and Australia wide

State	2000-01		2001-02		2002-03	
	Number	Value Million	Number	Value Million	Number	Value Million
NSW	1	$2.00	2	$1.25	1	$3.01
Vic	7	$9.29	2	$2.40	1	$0.41
Qld	1	$1.99	1	$1.21	0	-
National Total	12	$15.46	6	$7.37	3	$3.76

As described in Chapter 5 (section 5.2.5), NSW researchers have been very successful in securing grants under the ARC Linkage-Projects grants. The Linkage-Projects Program, which has subsumed the former SPIRT program, is also a partnership program, with funding provided by an industry partner as well as the ARC. Table 7.4 compares SPIRT and Linkage-Projects grants for health and medical sciences and other research fields relevant to medical biotechnology.

Table 7.4: ARC Linkage-Projects and SPIRT Grants, 1999-2002, by State (NSW, Victoria and Queensland) and Australia-wide, for the following research fields: health and medical sciences (all), biochemistry and cell biology, genetics, microbiology, physiology, biotechnology

State	Funding ($ Millions)				
	1999	2000	2001	2002	Total
NSW	1.94	3.65	3.78	3.09	12.46
Victoria	1.16	1.41	2.09	1.79	6.45
Queensland	1.65	0.60	1.45	1.75	5.45
National Total	5.76	6.66	9.11	8.27	29.79

Another funding model that involves academic and industry collaboration is the Cooperative Research Centres Program. As described in Chapter 3, to date 65 CRCs have been established across all fields of R&D. Ten of these are in medical fields, of which two have their headquarters in NSW (in the fields of asthma and vision). Five of the medical CRCs have their headquarters in Victoria. Although three other medical CRCs have members in NSW, more NSW involvement in CRCs would have been expected, given the size of the State and the extent of its established biomedical industry.

The numbers are small and the time period is short. But the available statistics suggest that due note has to be taken of the anecdotal evidence. In essence, while NSW predominates in established pharmaceutical and biotechnology companies, it is not as effective in generating new companies based on State-based research. We may be starting to see the effect of the

sub-optimal biomedical research sector in these parameters, although clearly more data are needed to reach a definite conclusion on this.

7.5 Some impediments: intellectual property and publicly funded research in NSW

The Panel received a number of criticisms about the absence of a clear policy for the management of intellectual property created within the NSW Health system or benefiting from State Government financial assistance. The lack of a clear policy creates complications, especially where potential IP is generated by several collaborating organisations and researchers. In this situation, the question of who can fairly lay claim to what requires the wisdom of Solomon.

The Panel has been advised that a general policy governing these and related issues has been submitted to the Minister for Health for consideration. The Panel is unaware of the exact stage which has been reached in that consideration.

Analogous issues have been addressed by other Australian Governments and by numerous universities in recent years. In the main, Governments have been stepping back and not themselves laying claim to the IP. Rather, they prefer to vest IP in the originating institution, in some cases with the individual inventor. IP policies have differed among jurisdictions. However, regardless of the details, there is a need for policies or protocols that allow the parties involved in the creative process to be acknowledged, recompensed, and, ultimately, rewarded if possible. Recent analysis of the effects of different policies suggests that vesting IP in the originating institution is the preferred approach, and coincides most closely with Common Law.

Whatever the policy details may be, the basic principle, increasingly accepted, is that the over-riding objective of Government IP policy should be to encourage organisations and individuals to create, secure and protect potential IP. For the State to be preoccupied with securing its 'cut' as a policy objective is counter-productive, not least because it is de-motivating. Rather, the State should secure its reward from greater employment, investment, economic activity, possible cost reduction, taxation, and other flow-on benefits of successful development of IP.

Part of this judgement is based on empirical evidence. The prospects of Governments securing significant income through royalties, while an inherently tempting prospect, is not (so far) backed by actual evidence, at least internationally. For example, in the USA the total income from royalties coming to all US universities is estimated to be US$1 billion a year. On a pro rata basis, if the equivalent flow were secured by NSW public-sector bodies from an equivalent success rate, the amounts involved would be around $A 20 million a year (in fact, Australian researchers patent at about one-fifth the rate of their overseas counterparts). The income to the medical and health sector might perhaps be one-third of that, say $7 million a

year. While this may be significant for an institute or an individual, the magnitude of the income is not such as to transform the State health budget.

We make no specific recommendations other than to argue for a minimum of red tape, and a maximum concern to use policy to create credible justifiable incentives that encourage NSW researchers working within the State system to secure IP.

We received submissions about Bio-Link and another similar organisation associated with BioMed North. The Panel was of the view that a proliferation of State-sponsored commercialisation arms would not be desirable. However, the State could play an important role in providing pre-seed funds.

7.6 What can NSW do?

NSW is in a good position to exploit the advantages that it already has. These include a relatively strong biotechnology and pharmaceutical sector employing thousands of people; and successful models for developing new companies, such as ResMed and Cochlear. It is also well placed to pursue other successful models, such as partial licensing to bring in funds that can be used to expand a start-up company.

The ingredients for a successful biotechnology strategy are as follows.

- Excellent science – the Panel has pointed out that, while NSW currently has some excellent research groups, Victoria has more.
- Knowledge of the processes of commercialisation – all of Australia is learning, and returning expatriates are helping.
- Entrepreneurs and investors with access to discoveries.
- Access to funding by knowledgeable investors.

Based on these points, we offer the following recommendations for the development of biotechnology in NSW:

- Enunciate the critical role that NSW must play to achieve a successful biotechnology industry in Australia. Create incentives for this to happen. An example is support for those researchers who bring in overseas R&D work. Our specific recommendations are described in the 'Prescription' (Chapter 9).

- Invest in excellent basic science and education. The proposed Premier's Awards for Excellence and the Scholarship Scheme in the Prescription are targeted to this objective.

- Attract R&D nodes of international companies, particularly those wishing to serve the Asia-Pacific region.

- Use the clinical excellence in NSW to capture more of the $30-40 billion spent by the pharmaceutical industry on clinical R&D each year. The points described above will contribute to this objective.

- Encourage public-sector researchers to take out IP protection, but make it clear that the State does not have a financial interest in commercialisation, and that the rewards of commercialisation are to be retained locally.

- Encourage international entrepreneurs, venture capitalists, and analysts to Australia. This does not require extensive funding and should be a responsibility of the Department of State and Regional Development.

- Establish a forum to promote business interaction with medical researchers.

- Give serious consideration to participation in Australian shared infrastructure initiatives, such as in bioinformatics and the Synchrotron. Everyone will benefit.

- Educate the public and interest groups on the benefits of a strong commercial, as well as a publicly-funded, R&D enterprise. This should be a joint function of the Ministry of Science and Medical Research and the Department of State and Regional Development.

There are many reasons to expect that NSW can remain the dominant contributor to biotechnology in Australia. But to do so, the State must boost its investment in basic research and in the creation of a skilled workforce. In the Panel's view, NSW should aim to be the location of first choice for the biomedical industry in Australia.

8 Conclusions

Australian investment in research and development lags behind that of our international peers. Australian business in particular spends far less on R&D than is the international norm.

Of Australia's areas of research strength, the main one, by many measures, is medical and health research, which accounts for approximately one third of Australia's total scientific publications. Nationally, medical and health research is a strength that we must further foster and augment. The contribution that NSW makes to the national effort will be critical to Australia's success.

The benefits of medical and health research are multifaceted. Medical and health research has been a major contributor to the twenty-year increase in life expectancy that has occurred over the last century. It is difficult to put a price on good health or longer life, although various methods have been developed to do so. The actual benefits are immense, be they improved wellbeing or greater individual productivity.

The rapid development of new biomedical and biotechnology industries presents a great opportunity. The economic benefits of these sectors are directly derived from top-quality medical research. Massive international investment is being made by competitor countries, including many that start well behind us in their scientific and research capacity. Their aim is to develop critical mass in biotechnology and reap not only the direct health benefits but also the commercial benefits.

Another important factor is the role of clinical research within the hospital system. Research can have a systemic benefit for hospitals and the health system more broadly. It can do so by changing their philosophy and ethic, attracting the best people, and fostering best practice. Public-health research, clinical research and health-services research are directed to the particular priorities of the health care system and to ensuring the delivery of better treatment, best practice and cost savings.

Medical research is a global activity. If developed countries like Australia are to use the outcomes of global medical research, they can rightly expect to contribute to the effort. We benefit from it. One benefit of an effective research capacity is that it ensures that Australia has ready access to discoveries made abroad, can assess them, and can quickly incorporate them into practice. We also need research capacity to address health problems that occur frequently in our own environment. The capacity to solve such health problems means that we may have the competitive advantage that allows us to contribute to progress globally.

Most research outcomes are still treated as a public good, to be globally shared. Evidence suggests that this is changing. Worldwide, researchers are becoming more inclined to claim intellectual property as private property. Universities and research institutes are increasingly preoccupied with technology transfer and commercial development, exemplified by the

growth of business arms within research enterprises and the employment of experts in research commericialisation. Government departments responsible for the higher education sector, and universities themselves, have published numerous strategic reviews and planning documents that define structures and processes for promoting and supporting the commercialisation of research. Whether this is a desirable trend for humanity is not really the issue; it is the trend.

Australian researchers have tended to be less focused on the IP potential of their discoveries, perhaps for altruistic reasons. We only secure one fifth of the average number of patents for a given number of publications. That needs to change. Nationally we can expect to be incurring greater costs for high-technology medical care on which the Australian people place high expectations. We have to do more to capture the economic potential of our own creativity and have the means with which to pay for that of others. This is especially true where we have both established performance and great potential.

This comment also extends to research that is undertaken within the jurisdiction of governments, including NSW Government-funded research. NSW is finalising a policy for the management of IP developed in whole or in part within its public-sector entities. In our view, it is important for that policy to encourage researchers to secure IP rights, and not to treat it as inappropriate or create unnecessary obstacles or complications.

NSW itself has a very substantial medical research capacity. In the main that research effort is directed to national and State health priorities. Our sense is that this will always tend to be the case. Research channels and reinterprets its apparent purpose according to health needs, and according to the direction of funding flows.

The NSW medical and health research effort is generally well aligned with State and national health priorities. There is evidence of increasing research collaboration within and across institutions, within the State, nationally, and internationally. NSW has strengths in biomedical research (e.g. vascular biology, atherosclerosis, experimental neurology, immune responses, and breast and prostate cancer); substantial strengths in clinical research (e.g. mental health, kidney disease, liver disease, and clinical trials); public-health research (e.g. screening, and decision making processes); and health-services research (e.g. health economics and policy evaluation).

The State has had significant success in the field of medical devices (e.g. ResMed). Aggregate figures suggest that NSW is home to much of Australia's pharmaceutical and biotechnology industry. We question whether this is the full picture. There is a sense that many firms may have headquarters in and report through NSW, but have a substantial research capacity elsewhere. Commercialisation is often drawn toward the successful researchers, and there is evidence that NSW is being eclipsed by other States when it comes to start-up activity. For Australian biotechnology firms generally, adequate initial funding is critical.

It is clear from the data that NSW biomedical industries, for all their size, are interacting less actively with the medical research communities than are their counterparts in, say, Queensland. Much of the philosophy that has prompted the Commonwealth Government to increase investment in medical research is summed up in the concept of the 'virtuous cycle', a self reinforcing, symbiotic interaction between researchers, government and industry, leading to increased investment in research and industry. Queensland has signed on to that philosophy but its enterprise is still small. Because of the size of the State, it is of much greater significance for Australia as a whole that NSW becomes more involved in creating a 'virtuous cycle'.

State and Territory Government funding accounts for around one tenth of Australia's investment in medical research, yet has a profoundly significant influence on the location, level, and ultimate success of medical research.

In NSW, medical and health research is feeling the pressure. Its ability to attract money from the major Commonwealth Government and international peer-reviewed funding streams is suffering. Victoria secures, on merit, about 40% of NHMRC peer-reviewed funding. NSW receives around 24%; Queensland's share is edging up. The Queensland Government is investing heavily in medical research. Victoria, on a per capita basis, is currently contributing at about twice the level that NSW is to funding medical research.

Victoria's leading research institutes, longer established in the main than their NSW counterparts, also have better endowments to draw upon. In the 2003-04 to 2005-06 triennium, NSW has held funding of its main support scheme for medical and health research, the Infrastructure Grants Program, at much the same level as in the previous triennium, notwithstanding significant increases in grant funding levels from other government sources. Commonwealth Government peer-reviewed grants are predicated on the existence of State infrastructure funds.

Competition from Victoria and Queensland for funding may intensify. Certainly NSW is not matching the pace set internationally and by other States. Leaving aside all other benefits (and there are many), Victoria gains at least $50 million a year in direct taxpayer dollars by virtue of the additional share of medical research investment that it has been able to secure, over and above its expected share as measured by population.

Hence, the creation in the NSW Government of the portfolio of the Minister for Science and Medical Research, the NSW Government with the Hon Frank Sartor MP as Minister, is very significant, and represents a clear recognition of the importance of medical and health research for health outcomes and for the economy of the State. The Premier has publicly pledged his strong support for the research sector.

Enhancing NSW medical research capacity is not part of some 'zero sum game'. A competitive advantage in an area of science should be built on nationally. With clear support and purpose, NSW can make a quantum leap in its own standing in the Australian and international research

rankings. The benefits, as mentioned, flow through in many areas and many ways. NSW can be in the international forefront of medical research and attract international funding. There is great potential for constructive interaction if the NSW business and research sectors could engage with each other more actively and productively.

NSW could capture more of the global R&D carried out by the international biomedical industries. Investing in first-rate basic science and in postgraduate education is the core to this. Attracting R&D nodes of international companies is also important.

The State should concentrate on maximising the value of its intellectual property. The later in the stage of commercialisation, the greater are the potential gains. Manufacturing is often far less economically significant than the location of the R&D itself. In other words R&D itself is a 'product'.

Our recommendations, our 'prescription', is fairly ruthless in its implications. It advocates a quantum lift in support for medical research in NSW, based on an unqualified commitment to excellence. The funding arrangements that we recommend are directed to securing stellar people, reinforcing the role of the exceptionally successful institutions and giving them the means to get on with ground-breaking research. We would also argue that it is crucial to re-inject research back into the teaching hospital environment, as part of a research continuum but also as a means of influencing the ethos of clinical practice.

The pressures on research in the State will not abate. If NSW capacity is not strongly supported, it could wilt, with the potential loss of some of the best of the State's scientific leadership. As well as interstate competition, there is a global market for top international medical research talent. As one example, Canada (often seen as a point of comparison for Australia) has given a major boost to its medical research investment. Other countries have a similar intent.

Research in NSW tends to be located in numerous physically separate clusters rather than in a few areas of concentration. Most Sydney medical researchers, and certainly most of their interstate colleagues, see this as a disadvantage. It is not one that is easily corrected. In NSW, for practical and cost related reasons, it is more difficult to build the sort of facility that Queensland has established with the Institute of Molecular Bioscience. Possibly, the very operation of the NSW grant schemes may have contributed to an increase in the number of medium-sized research configurations. Certain minimum fixed costs are inevitable for such organisations: few are likely to be optimal in size or focus. Costly research equipment needs to be efficiently and optimally utilised, preferably with open access protocols.

One recent and unique feature of NSW research capacity is the Institute for Health Research, which provides an inclusive network of clinical, public health and health services research strongly linked to the NSW Department of Health and its priorities. The circumstances of NSW make such a research-broker role particularly appropriate.

It is not desirable for funding policy per se to be the trigger generating 'offspring' institutes. Amalgamations are desirable where appropriate. We certainly advocate steps to avoid the first-mentioned issue – the most important step being to adjust the eligibility threshold for peer-reviewed grants. We also recommend practical and legal assistance if individual institutes, of their own inclination, see advantages in amalgamation.

Due Process

"Nothing so needs reforming as other people's habits" (*Mark Twain).*

A recurrent theme in many submissions was the importance of due process in deciding research funding allocations. At the same time as they cavilled with aspects of program design, the authors of submissions received by the Panel supported fair, clear, publicly-known, universally-applicable rules for program administration. This was argued even by some who would be seen as transgressing that edict. Mark Twain got it right.

Whatever other defects were attributed to the Infrastructure Grants Program, it was consistently applauded as preferable to the earlier non-system, which was seen as marred by special treatment and intrusive lobbying. Replacing it with a rules-based system, especially one built around independent judgement of merit, was strongly supported. Any sign of preferential treatment, while no doubt welcomed by the recipient, was a cause of unease to all others competing for the same fund. Basically, researchers want decisions that allow for full consideration of competing claims. The vigour with which claims for special treatment are pushed often tends to be in inverse proportion to their merit. If one research institution tries to 'steal a base', then all feel compelled to try to do likewise. Influential citizens are enlisted, influence peddled, and political levers and heartstrings pulled.

This Panel has recommended major modifications to research funding programs. While recognising the many strengths of the current research capacity in NSW, our view is that there are many reasons to give medical and health research in the State a quantum boost. The recurrent theme in our design is to emphasise the importance of excellence. Our intent is to attract additional stellar researchers, who in turn attract funding and students, act as mentors, create interest from and involvement with industry, attract international support, create local community awareness, and attract public support. Concrete results, health improvements and economic benefits, once achieved, create their own momentum, generate leverage, attract more outstanding researchers, and foster the 'virtuous cycle' that the Wills Review advocated.

This design only works if decisions about funding, grant allocations, appointments, capital investment and other elements are based on objective, hard-headed assessments. To the unsuccessful, such decisions will often be jarring and unpalatable. They may well attempt to reverse them.

To withstand that pressure requires decision-making processes that are insulated, widely accepted as reasonable, and expertly informed. This is most likely to involve peer assessment in such decisions, as long as the peers have no direct or indirect stake in the outcome. This may require peers to be drawn from outside the State to avoid any possible conflict of interest. Any decision-making process that does not provide for merit-based decisions is counter-productive, especially given the purpose of the recommendations.

What, then, is the best design, and who is best placed to make the decisions that affect medical and health research?

Without limiting the scope for public policy or political debate, only governments can logically set overall health priorities and health and medical research priorities. Beyond question, governments will draw on expert advice, assess the burden of disease (nationally and in the State), form a view as to the State's potential to contribute to an overall research effort, and weigh the costs against the available funding and against other priorities. Necessarily these are matters that Ministers and Cabinets should decide.

Similarly, governments have to decide on the design of funding programs or financial allocation mechanisms. Departments, officials, advisers, and reviews like this one may make suggestions and recommendations, but that is the extent of their input. Policy in related areas is highly relevant but can only be settled at a high political level. For example, intellectual property or ethical issues take account of wider considerations than those posed by medical research alone.

Just where specific decisions on program administration should be taken is more open to debate. Wherever it rests, it works best if it employs transparent, expert, impartial and accountable decision-making processes, where the decisions are taken within Government agencies or through other processes.

Decisions in highly-specialised fields like medical and health research particularly require expert judgement as to the worth and the plausibility of any research proposal. There is also a need to make a judgement on the capacity and track record of the researchers involved. These are tough calls. In this situation, governments often choose to put in place decision-making processes where the effective decision is one step removed. The Commonwealth Government has followed that path, for example by relying on the NHMRC to make the decisions on specific research grant allocations, although strictly speaking the NHMRC makes recommendations to the Commonwealth Minister for Health. NSW may wish to consider that option, especially given the rationale for our suggested design.

Hence one option, but not the only one, would be to create a separate statutory body for this purpose. Keeping the assessment process at arm's length by no means removes all conflict, but removes much of it, and gives Government a point of independent advice, reference and recourse. It would obviously require Parliamentary approval and a Medical Research Act. It

would also be essential for such an authority, or its board, not to be 'captured' by any interest group.

We have elsewhere suggested the creation of a position of Chief Scientist (Medical Research). Arguably that person could also be the head of such a statutory organisation. There could be an issue of vesting too much power in any one person. But presumably enough checks and balances are in place under the NSW system, or could be put in place, to ensure that he or she is subject to due scrutiny, and is not giving advice on the performance and management of his or her own organisation.

In the course of our review, we have appreciated the cooperation given to us by the medical and health research community in NSW, and by those involved in expanding the biotechnology industry. There are many strengths and there is much to build on. We strongly recommend an expansion of the effort. We are confident that the citizens of NSW will benefit and the State will prosper. We also believe that the benefits will extend throughout and beyond Australia.

9 NSW Research: a prescription for health

Recommendations

Principles

By pursuing a commitment to excellence, NSW will build a capacity for fundamental and priority-driven research equalling that with comparable resources anywhere in the world.

To improve health outcomes and lower health costs, NSW will strengthen its capacity to capture and transfer the results of medical and health research, whether undertaken in Australia or overseas. NSW research will focus on the State's health priorities.

The State's health system will increasingly value research and research-based knowledge, and demand continuous improvement in health and health-service outcomes informed by research.

NSW is committed to being the location of first preference for the biotechnology industry in Australia.

Strategic Initiatives

The following initiatives are proposed to implement these principles.

A. Outstanding people

A.1 Support outstanding research teams

Establish a NSW Government program to support the formation of up to three additional top-level research teams. Funding should be assured for a five-year period.

This program, to be known as the *NSW Premier's Research Excellence Program*, is designed to bring outstanding scientists from interstate and/or overseas (including excellent expatriate researchers) to augment major successful institutions in NSW. Research Excellence teams are likely to include top NSW scientists as well as those from interstate and overseas.

For team members who hold existing ARC and NHMRC awards, the program will take advantage of the recently-introduced portability of grants, scholarships and fellowships.

Successful proposals will be selected through a process involving peer review.

A.2 Develop the next generation of researchers

Establish a NSW Government funding program for topping up scholarships to support research training at doctoral level. The program should be designed to encourage young NSW researchers to pursue NHMRC and similar research-training scholarships in NSW research centres.

A.3 Develop a research culture within the NSW health system and enhance the State's capacity to translate the results of medical research into practice.

A.3.1 Appoint a Chief Scientist (Medical Research) in NSW

Appoint a Chief Scientist (Medical and Health Research) within the NSW Government and ensure that the position has sufficient dedicated resources to:

- provide authoritative coordination of the State's medical and health research investment;
- promote the uptake of research into policy and practice;
- support research management in Area Health Services; and
- facilitate or commission research that addresses NSW health priorities.

The Chief Scientist (Medical and Health Research) would be the NSW representative on the NHMRC.

The position of Chief Scientist (Medical and Health Research) could be held by the CEO of the proposed Medical Research Authority (see below).

A.3.2 Appoint a Director of Research in each Area Health Service

Appoint a Director of Research in each Area Health Service (AHS) to:

- provide research leadership;
- rebuild Area clinical research infrastructure;
- encourage effective translation of research; and
- contribute to cohesion of the research effort within the Area and across the State.

The designated person would be responsible for overseeing and accounting for research activity in the particular AHS. Directors of Research will have responsibility for the Area research budget.

Area Director of Research positions need not be full time.

A.3.3 Improve communication

Review the Ministerial Advisory Council after its initial year of operation with a view to:

- developing wider interaction between researchers, medical and health system practitioners, the business sector and the community generally; and
- ensuring regular meetings between the Chief Scientist (Medical and Health Research), the Area Directors of Research, and the Ministerial Advisory Council.

B. Excellence in Research

B.1 Refocus infrastructure funding

B.1.1 Modify the NSW Health Research Infrastructure Grants Program to provide basic infrastructure funding for health and medical R&D organisations within the NSW health system that have peer-reviewed grant incomes above a threshold figure.

Under the modified program – renamed the *Research Support Program* – the threshold for eligibility would be reviewed periodically, but should be adjusted to reflect changes in national peer-reviewed funding. The threshold level should be announced 12 months before research entities are invited to make submissions for the next funding cycle. The intent of this funding is to put State medical research organisations that do not receive Commonwealth infrastructure funding on a par with those that do.

The Panel is conscious of the State's budgetary preference for disbursing a set sum rather than an externally-determined figure as was the case in the first two rounds of the Infrastructure Grants Program. However, from the perspective of the research institutes, predictability in funding levels and funding arrangements is also extremely important. It is essential that the research community be given adequate advance notice of any changes in the level of funding under the Program. Insufficient notice creates uncertainty, both for institutes and for their highly-qualified staff, and prevents institutes from planning their research. Institutes need to be able to predict the State Government commitment to future research with reasonable certainty.

Accordingly we suggest that each recipient of funding under the Research Support Program receives a fixed proportion of their national peer-reviewed grant income. This proportion may vary between funding rounds, and will be determined by the total budget available for the Research Support Program. However, it is critical that the sums awarded under the Research Support Program represent a significant proportion of the value of national peer-reviewed grants. As a guide, 2006 awards under the Research Support Program, for funding in 2006-08, might be of the order of 30 percent of the total value of recipients' national peer-reviewed grants to commence in 2006.

The Research Support Program provides the foundation on which to build a commitment to excellence within the State's most productive health-system-based research entities.

B.1.2 To provide adequate 'deep' infrastructure an *Independent Institutes Fund* should be established. Payments under this fund would only apply to those grants that are administered by institutes themselves and not those administered through organisations that benefit from assistance from affiliated Universities or Area Health Services.

The appropriate funding payment rate would be half of the rate of the Research Support Program. As a guide, 2006 awards under the Independent Institutes Fund, for payment in 2006-08, might be of the order of 15% of the value of those peer reviewed-grants administered by the institutes themselves.

This support is additional to funding through the *Research Support Program* described in B.1.1 above.

B.2 Encourage and reward excellence

Provide bonus funding via the *Research Excellence Fund* to entities that receive infrastructure funding and fulfil excellence criteria. The criteria comprise:

- the award of NHMRC Program and/or Capacity Building Grants, and/or
- Centre for Clinical Research Excellence (CCRE) awards, and/or
- grants from the US National Institutes of Health (NIH).

Bonus funding should be calculated as a percentage of the value of NHMRC Program Grants, CCRE awards, and NIH grants (unit rate 20%).

Unlike the *Underpinning Research Program* and *Independent Institutes Fund*, awards under the *Research Excellence Fund* should be provided to any NSW research group, including entities in universities that can attract these categories of grants.

Other prestigious awards could be considered in future as possibly warranting NSW Government bonus funding for excellence (eg Human Frontiers Science Program).

B.3 Strengthen NSW core capacities

NSW appears to be reasonably well served with core platform technologies such as those for microarray, imaging and proteomics. It is important to maintain a watching brief to allow the rapid commitment to new technologies and capacities. We recommend attention to the following areas.

Bioinformatics: Strengthen the State's capacity in bioinformatics by providing funding for one major bioinformatics group in NSW. The funding allocation for this should be determined through a peer-reviewed process of competitive bids. The facility must be open to access to all research institutes – access must not be confined to any one discipline or research entity.

A core criterion for funding should be the ability of the group to contribute to and be linked with national initiatives in bioinformatics.

Clinical research: There is consistent evidence that pressure on hospital-system budgets has caused a hollowing of research activity within teaching hospitals. It is important to re-build clinical research activity within Area Health Services and with it the means to undertake and sustain clinical research in teaching hospitals. This will be a key responsibility of the Area Directors of Research. It will require augmentation of current resources. We also recommend audit of the Teaching and Research Program, a budget program of the NSW Department of Health

Clinical trials: The State's acclaimed expertise in clinical trial methodology, and its productivity in leading multi-centre clinical trials, should be fostered (see also recommendation 5.1).

Streamline ethical clearance of multi-centre research: Repetitious ethics-clearance processes involving multiple ethics committees are a barrier to multi-centre research, especially clinical trials. Strong support (primarily scientific expertise but also financial support) is warranted for current efforts. Every possible means to minimise the repetitious nature of these processes and the delays and costs that they impose should be taken. The State should take a vigorous approach to these issues with the AHEC.

C. An efficient research structure

C.1 Encourage the attainment of critical mass

While we recognise that not all research is best undertaken in larger institutes, we recommend encouraging outstanding smaller research groups that are willing and inherently compatible to coalesce or co-locate. This can be promoted by:

- setting the threshold of eligibility for *Underpinning Research Program*, *Independent Institutes Fund* and *Research Excellence Fund* grants at a level that reflects the output of a critical mass of researchers and a substantial track record of national peer-reviewed grant income (see A.2 above). Significant prior notice would need to be given of intended threshold changes; and
- providing incentives and assistance for such groups, so that they can coalesce and attain a critical mass.

Incentives and assistance could include fixed grants-in-aid and access to advice on legal aspects of mergers.

C.2 Promote co-location

Research collaboration benefits from proximity, collocation, shared facilities, and opportunities for scientific interaction and cooperation. At one level modern communications help overcome distance. However, the advantages in co-location are real. Sydney in particular, is challenged by geography, with well-established but scattered facilities.

Capital investment directed at co-location would be highly desirable, but the Review Panel is conscious of the expense.

C.3 Fund major medical research equipment and facilities

Establish a NSW Government fund for major equipment, facilities, and co-funded initiatives. Funding would be conditional on open and collaborative access.

Funding decisions should be based on careful assessment involving external peer-review.

Explicit selection criteria should give preference to applications for equipment, facilities and initiatives that are jointly funded by the Australian Government, another State or Territory Government, or by industry.

It should be a requirement that such facilities are to be used collaboratively and shared among different research entities; or, if co-funded, that they help to build strategic partnerships and have demonstrable potential to amplify the State's investment in medical and health R&D.

There should be periodic assessments as to the level of utilisation of funded equipment. This should assess the extent to which protocols regarding access are being equitably administered.

C.4 Facilitate research collaborations

Facilitate research collaborations and partnerships, including constructive links with the NSW Department of Health.

The Institute for Health Research (IHR) is an example of an institution that has a 'research broker' role. This includes facilitating and managing complex multi-centre, multi-disciplinary bids for research grants and commissions. The IHR is strongly linked to NSW Department of Health.

D. Public policies and health priorities

D.1 Strengthen the State's competitiveness in public-health research, primary health-care research, and health-services research

The Capacity Building Infrastructure Grant Program (CBIG), introduced in 2003 for entities involved in public-health research, primary health-care research and health-services research, should be retained. To underline its intended focus, it should be re-named as the *Health Systems Improvement Research Fund.*

D.2 Promote priority-driven research and the transfer of research results into policy and practice

NSW should co-fund research and research-transfer proposals with the Area Health Services and other research entities in NSW. The aim is to:

- promote peer-reviewed research that addresses specific NSW health priorities;
- develop an enhanced capacity for NSW to adopt new knowledge rapidly from medical and health research done throughout the world;
- promote the rapid uptake within the NSW health system of research findings from all parts of the world;
- commission research on a competitive peer-reviewed basis where there is a particular need to address State health priorities; and
- help sustain a research culture within the teaching hospitals and the area health system.

As a first step the NSW Departments of Health and Science and Medical Research should commission an audit of current levels research activity and expenditure undertaken under the Teaching and Research Program of the Department of Health budget.

An appropriate level of funding from this existing program should be quarantined for clinical research.

Area Health Services would bid for funding for specific research projects from the (desirably) augmented, centralised funding pool so established.

D.3 A Medical Research Act?

The Panel recommends the consideration of a Medical Research Act, the main purpose of which would be to establish a statutory body, akin to the National Health and Medical Research Council, to administer independently the allocation of the specific funding allocations under the different NSW funding programs.

E Seizing opportunities: promote NSW as the preferred location for health-industry R&D

E.1 Provide incentives for industry partnerships

Provide incentives for organisations that initiate public-good research which attracts industry funds, including clinical trials, in NSW.

The incentives could comprise a small proportion of the amount spent by the industry specifically on the public-good research (possibly 2%).

The arrangements should include a requirement that, with an agreed delay, nothing will preclude the results of such research being published by the researcher.

E.2 Support a consistent intellectual-property policy in NSW Health

It is essential that the NSW Department of Health has in place an intellectual-property policy that facilitates the commercialisation of research undertaken wholly or in part in public-sector health organisations.

E.3 Encourage public-sector research entities to register patents

All individual Area Health Services should develop policies for recognising and rewarding public-sector researchers and research entities that register patents.

E.4 Pre-seed assistance to commercialise R&D

NSW should consider adopting a pre-seed funding program for NSW public-sector research, along the lines of that adopted by the South Australian and Queensland Governments and by the Commonwealth Government.

E.5 Strengthen links between researchers and the business community

Establish a forum for research groups in NSW to interact regularly with elements of the biomedical industry and the wider business community interested in investing in medical and health research.

E.6 State involvement in biotechnology

Provide State Government Departments with a 'contingency funding' finance facility that would allow NSW to make authoritative commitments to major Australian Government and industry proposals requiring co-funding. This is crucial when decisions are required in a timeframe that does not coincide with the NSW budget cycle.

Biotechnology Industry Fund grant support: Continue the effective support of the NSW Government for industry applicants for Commonwealth Biotechnology Innovation Fund (BIF) funding, or any successor program.

E.7 Enable clinicians' trust funds to be used more easily for research

Streamline regulations governing the utilisation of trust funds in Area Health Services, with the aim of allowing trust-fund holders to obtain access to funds in a timely manner for research.

References

Access Economics, for the Australian Society for Medical Research. Exceptional Returns. The Value of Investing in Health R&D in Australia. Australian Society for Medical Research, Canberra, 2003.

The Allen Consulting Group, for the Australian Institute for Commercialisation. The Economic Impact of the Commercialisation of Publicly Funded R&D in Australia. Melbourne, 2003.

AusIndustry. Industry Research and Development Board Annual Report 2001-02. Commonwealth of Australia, Canberra, 2002.

AusIndustry. Industry Research and Development Board Annual Report 2002-03. Commonwealth of Australia, Canberra, 2003.

Australian Bureau of Statistics. Human Resources by Selected Qualifications and Occupations. Catalogue No 8149.0. Canberra, 2003.

Australian Institute of Health and Welfare. Australia's Health 2002: the 8th Biennial Health Report of the Australian Institute of Health and Welfare. AIHW, Canberra, 2002

Bioinformatics Expert Taskforce. Draft: the National Bioinformatics Strategy. Department of Industry, Tourism and Resources, Canberra, 2003 (unpublished).

Butler L. Monitoring Australia's Scientific Research: Partial Indicators of Australia's Research Performance. Australian Academy of Science, Canberra, 2001.

Commonwealth of Australia. Higher Education Funding Act 1988.

Department of Education, Science and Training. Backing Australia's Ability. The Australian Government's Innovation Report 2003-04. Australian Government, Canberra, 2003.

Department of Education, Science and Training. Higher Education Research. http://www.detya.gov.au/highered/research/index.htm (accessed June 2003).

Department of Education, Science and Training. National research priorities. http://www.dest.gov.au/priorities/ (accessed October 2003).

Department of Education, Science and Training. Evaluation of *Knowledge and Innovation* Reforms Issues Paper. Australian Government, Canberra, 2003.

Department of Education, Science and Training. Higher Education Report 2002-2004 Triennium. Australian Government, Canberra, 2003.

Frommer M. Research and Development in the NSW Health System – Discussion Paper. NSW Department of Health, Sydney, 1995.

Harrison AJ. UK Policies on Medical Research. The King's Fund, London, 2003.

Harrison A, New W. Public Interest, Private Decisions. Health-related Research in the UK. The King's Fund, London, 2002.

Holm T, Johansson H, Cedermark B, Ekelund G, Rutqvist L-E. Influence of hospital- and surgeon-related factors on outcome after treatment of rectal cancer with or without preoperative radiotherapy. British Journal of Surgery, 1997; 84(5): 657-663.

Hopper K and Thorburn L. 2002 Bio-Industry Review: Australia and New Zealand. Aoris Nova and Advance Consulting and Evaluation, 2002.

Howard Partners Pty Ltd, for the Department of Education, Science and Training. Evaluation of the Cooperative Research Centres Programme. Canberra, 2003.

Kemp DA. Knowledge and Innovation: a policy statement on research and research training. Commonwealth of Australia, Canberra, 1999.

Lenfant C. Clinical research into clinical practice – lost in translation? New England Journal of Medicine, 2003, 349: 868-874.

Major Research Infrastructure Taskforce. Discussion Paper. Department of Education, Science and Training, Canberra, 2003.

Nelson B. Higher Education Report for 2003-2005 Triennium. Commonwealth of Australia, Canberra, 2003.

National Health and Medical Research Council (NHMRC). Health and Medical Research Strategic Review. Implementation of the Government's Response. Final Report. Commonwealth of Australia, Canberra, 2000.

NSW Department of Health. Report of the Chief Health Officer on the health of the people of NSW. NSW Health, Sydney, 2002

NSW Government. NSW Biotechnology Strategy, Bio*First*. Sydney, 2002.

NSW Health. Application Kits. NSW Health R&D Infrastructure Grants Program and Capacity Building Infrastructure Grants. NSW Department of Health, Sydney, 2002.

Public Health Division. Year in review: communicable disease surveillance, 2002. NSW Public Health Bulletin, 2003; 14 (9-10): 189-191.

Science and Innovation Mapping Taskforce. Mapping Australian Science and Innovation. Department of Education, Science and Training; Department of Industry, Tourism and Resources; and Department of Communications, Information Technology and the Arts, Commonwealth of Australia, Canberra, 2003.

Therapeutic Goods Administration. Clinical trials at a glance. Access to unapproved therapeutic goods – Clinical trials – May 2001. www.health.gov.au/tga/docs/pdf/unapproved/ctglance.pdf.

Therapeutic Goods Administration. The Clinical Trial Notification (CTN) Scheme. Access to unapproved therapeutic goods – Clinical trials in Australia – May 2001. www.health.gov.au/tga/docs/pdf/unapproved/clintrials.pdf

Wills PJ, for the Review Committee. The Virtuous Cycle. Working together for health and medical research. Health and Medical Research Strategic Review. Commonwealth of Australia, Canberra, 1999.

List of abbreviations

ABS	Australian Bureau of Statistics
ANSTO	Australian Nuclear Science and Technology Organisation
ARC	Australian Research Council
BIF	Biotechnology Innovation Fund
CBIG	Capacity Building Infrastructure Grant(s) (program, NSW)
COMET	Commercialising Emerging Technologies (program)
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEST	Department of Education, Science and Training (Australian Government)
HREC	Human Research Ethics Committee
IGP	Infrastructure Grants Program (NSW)
IGS	Infrastructure Grants Scheme (DEST)
IIF	Innovation Investment Fund
IP	Intellectual property
IPC	International Patent Classification
ISI	Institute for Scientific Information (USA)
MNRF	Major National Research Facilities
NHMRC	National Health and Medical Research Council
OECD	Organisation for Economic Cooperation and Development
R&D	Research and development
RIBG	Research Infrastructure Block Grants (Scheme) (DEST)
RTS	Research Training Scheme (DEST)
SCI	Science Citation Index
SSI	Systematic Infrastructure Initiative
SSCI	Social Sciences Citation Index
USPTO	US Patents and Trademarks Office

Appendix A:

Terms of reference of the Review

Aim:

To review medical and health research in New South Wales and recommend:

1) priorities for NSW Government expenditure;
2) how to better utilise the strengths and overcome any weaknesses inherent in the NSW research environment;
3) how to optimise funding in NSW; and,
4) future directions for its development.

Timeframe:

The Review should include both short term (< 5 years) and longer term goals (up to 20 years).

Review Process:

The Minister for Science and Medical Research will appoint a panel to conduct the Review.

The Review panel will report to the Minister for Science and Medical Research.

The Ministerial Advisory Council on Medical and Health Research (MACMHR) will serve as a reference group to advise the Minister in relation to the Review.

The NSW Health Department Research and Development Policy Branch will provide secretariat support to the MACMHR and to the Review.

The Review will be completed by November 2003, with monthly progress reports to the Minister.

The Review report will be prepared in consultation with the MACMHR.

Terms of Reference:

In particular, the review will undertake the following tasks:

1) To review all existing NSW government funded medical and health research programs, including Bio*First*, Research Infrastructure Grants, and Department of Health research programs to:

   a) identify current NSW strengths in the areas of biomedical research, clinical research, public health research, health services research and health policy research;

   b) identify other strengths and advantages of health & medical research in NSW;

   c) assess whether the balance between basic, translational and clinical research is optimal;

   d) whether there are areas where greater collaboration or aggregation can occur, and examine possible impediments to this (such as intellectual property issues) so as to achieve critical mass and/or optimal size and avoid duplication; and,

   e) identify how NSW can best leverage and contribute to interstate and international research efforts.

2) To review and recommend strategic priorities for NSW Government expenditure on medical & health research in the context of:

   a) health priorities for NSW both in terms of health of the population and the operation of the health system;

   b) research goals;

   c) maximising benefits from developments in knowledge; and,

   d) key drivers for research excellence such as common platforms, clusters of excellence and attracting top researchers.

3) To review investment in medical & health research in NSW as a whole (including the private sector) and recommend how to optimise its value by:

   a) identifying the benefits likely to accrue from additional investment in medical & health research in NSW;

   b) developing a funding framework that supports NSW priorities, including recommendations regarding an appropriate level of infrastructure funding, and the formula used for allocation;

c) investigating how the NSW Government's contributions to medical & health research might be used to leverage greater contributions from the Commonwealth, private sector and industry; and,

d) identifying opportunities within and between research entities in NSW, both public and private, not receiving NSW Government funding.

4) To identify future directions for the development of medical & health research in NSW.

5) To advise on any other matter as may be relevant to the aims of the Review.

August 2003

Appendix B:

List of interviews

In New South Wales

Group meeting of applicants to the NSW Health Infrastructure Grants Program – directors and senior staff of biomedical /clinical research institutes

Professor Robert Baxter	Director	Kolling Institute of Medical Research
Professor Philip Barter	Director	Heart Research Institute
Ms Denyse Bartimote	Chief Operating Officer	Centenary Institute of Cancer Medicine and Cell Biology
Professor Norbert Berend	Director	Woolcock Institute of Medical Research
Mr Peter Bogard	Chief Operating Officer	Woolcock Institute of Medical Research
Professor Sam Breit	Co-Director	Centre for Immunology
Professor Colin Chesterman	Director	Centre for Vascular Research
Professor David Cooper	Director	National Centre in HIV Epidemiology and Clinical Research
Professor Tony Cunningham	Director	Westmead Millennium Institute
Mr Mark Dado	Chief Operating Officer	Westmead Millennium Institute
Dr Michael Davies	Deputy Director	Heart Research Institute
Professor Simon Gandevia	Acting Scientific Director	Prince of Wales Medical Research Institute
Professor Robert Graham	Executive Director	Victor Chang Cardiac Research Institute

Professor Michelle Haber	Director	Children's Cancer Institute Australia for Medical Research
Professor David Handelsman	Executive Director	ANZAC Research Institute
Dr Neil Hunter	Director	Institute of Dental Research
Professor Stephen MacMahon	Co-Director	Institute for International Health
Dr Rebecca Mason	Deputy Director	Institute of Biomedical Research
Professor Gordon Parker	Director	Black Dog Institute
Professor Peter Rowe	Director	Children's Medical Research Institute
Professor John Shine, AO	Executive Director	The Garvan Institute of Medical Research
Dr David Tan	Chief Operating Officer	Prince of Wales Medical Research Institute

Group meeting of applicants to the Capacity-Building Infrastructure Grants Program:

Professor Lyn Fragar	Director	Australian Rural Health Research Collaboration
Professor Kathy Eagar	Director	Centre for Health Service Development
Professor Wayne Smith	Director	Hunter Medical Research Institute Capacity-Building Program
Professor Branko Cellar	Co-Director	Centre for Health Informatics
Dr Yvonne Zurynski	Director	Primary Health Institute Ltd
Associate Professor Jeffrey Braithwaite	Director	Centre for Clinical Governance Research in Health
Professor Trevor Parmenter	Director	Centre for Developmental Disability Studies

Professor Susan Kippax	Director	Consortium for Social and Policy Research on HIV, Hepatitis C and Related Diseases
Professor Dianne O'Connell	Senior Epidemiologist and Manager	Cancer Epidemiology Research Unit, NSW Cancer Council
Ms Marie Malica	Co-ordinator	Cancer Trials NSW NSW Cancer Council
Mr Garwain Powell-Davies		The Centres for Primary Health Care and Equity

Individual interviews:

Professor John Shine AO FAA	Chair	National Health and Medical Research Council
Dr Jonathan Izant	Chair	Bio-Link
Professor Elspeth McLachlan	Pro-Vice Chancellor (Research)	The University of New South Wales
Ms Kerry Doyle	Director	NSW BioUnit The Cabinet Office
Mr Peter Wills AC	Chairman	CRI Australia Pty Limited
Professor Jim Bishop	NSW Chief Cancer Officer	Cancer Institute NSW
Mr Michael O'Sullivan	Executive Director	Industry Innovation Department of State and Regional Development
Dr Mark Bradley	Chief Executive Officer and Chair	ATP Innovations and AusBiotech, NSW Branch
Dr Kelvin Hopper	Managing Director	Aoris Nova Pty Ltd
Mr Peter Burrows AO	(1) Stockbroker; (2) Chair	(1) Bell Potter; (2) University of Sydney Finance Committee
Professor Ron Penny AO	Senior Clinical Advisor	NSW Health

Professor Stephen Leeder	Director	Australian Health Policy Institute The University of Sydney

In relation to the Legislative Inquiry into Science and its commercialisation:

The Hon Tony Burke, MLC	Chair	Standing Committee on State Development Legislative Council, Parliament NSW
Mr Bayne McKissock	Senior Project Officer	Standing Committee on State Development Legislative Council, Parliament NSW

Ministerial Advisory Council on Medical & Health Research:

Members present at the meeting

Professor Andrew Coats (Chair)
Professor Jim Bishop
Professor Judy Black
Professor Simon Chapman
Professor Enrico Coiera
Professor Bruce Dowton
Professor Kathy Eagar
Professor Carolyn Geczy
Professor Robert Graham
Professor Ron Penny AO
Professor Carol Pollock
Emeritus Professor Beverley Raphael, AO
Professor John Rostas
Dr Greg Stewart

In Canberra

Ms Lynne Pezzullo	Senior Economist	Access Economics
Professor Vicki Sara	Chief Executive Officer	Australian Research Council
Mr Craig Pennifold	General Manager	Pharmaceuticals and Biotechnology Branch Department of Industry Tourism and Resources
Mr Bob Wells	First Assistant Secretary	Health Services Improvement Division, Department of Health and Ageing
Professor Robin Batterham	Chief Scientist	

Commonwealth Department of Education, Science and Technology:

Mr Graham Cook	Deputy Secretary	
Ms Jessie Borthwick	Group Manager	Research Analysis and Evaluation Group
Dr Martin Gallagher	Branch Manager	Policy Development Taskforce Research Analysis and Evaluation Group
Dr Evan Arthur	Branch Manager	Innovation and Research Branch Higher Education Group

In Melbourne

Professor Suzanne Cory	Director	Walter and Eliza Hall Institute of Medical Research
Professor Tony Burgess AC	Director	Ludwig Institute of Cancer Research
Sir Gustav Nossal AC CBE FAA FRS	Professor Emeritus	Department of Pathology The University of Melbourne

Victorian Department of Human Services:

Dr Robert Hall	Director Public Health and Chief Health Officer	Department of Human Services
Dr John Carnie	Director and Deputy Chief Health Officer	Disease Control and Research Public Health Group, Department of Human Services
Dr Ross Bury	Manager	Biomedical and Public Health Research Public Health Group Department of Human Services
Professor Tony Burgess AC	Director	Ludwig Institute of Cancer Research

In Brisbane

Professor Michael Good	Director	Queensland Institute of Medical Research
Dr Peter Riddles	Deputy Chief Executive Officer and Director and President	IMBcom Pty Ltd and AusBiotech Ltd
Professor John Mattick	Director	Institute for Molecular Bioscience

Department of Innovation and Information Economy:

Mr Mark Jacobs	Director	Innovation/ Research and Development Policy
Mr Pat Bell	Acting Program Director	Science Research and Innovation Unit
Ms Gehann Molachino	Principal Policy Officer	Science Research and Innovation Unit.

Office of the Premier, Queensland:

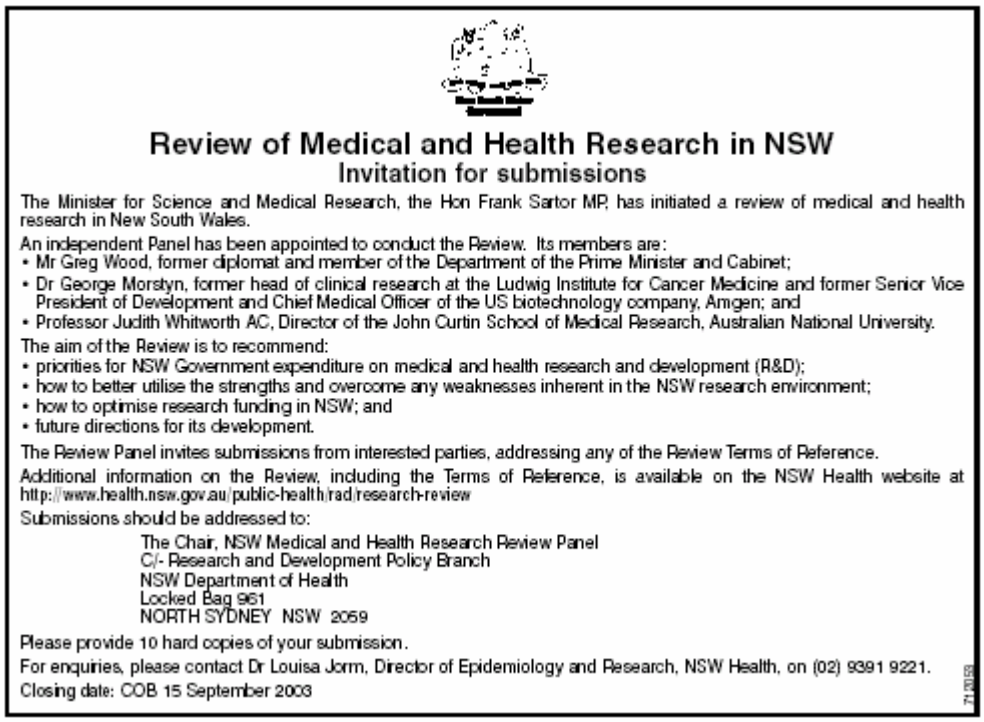
Mr Michael Todd	Premier's Advisor	Health
Mr Matthew Carter	Premier's Advisor	Health

Queensland Department of Health:

Ms Gina Clare	Principal Adviser	Research and Ethics Office of the Chief Health Officer
Dr David Evans	CEO – Elect	*Scientia* Fund Former Foundation CEO Uniseed

Appendix C:

Call for submissions



Review of Medical and Health Research in NSW

Invitation for submissions

The Minister for Science and Medical Research, the Hon Frank Sartor MP, has initiated a review of medical and health research in New South Wales.

An independent Panel has been appointed to conduct the Review. Its members are:

- Mr Greg Wood, former diplomat and member of the Department of the Prime Minister and Cabinet;
- Dr George Morstyn, former head of clinical research at the Ludwig Institute for Cancer Medicine and former Senior Vice President of Development and Chief Medical Officer of the US biotechnology company, Amgen; and
- Professor Judith Whitworth AC, Director of the John Curtin School of Medical Research, Australian National University.

The aim of the Review is to recommend:

- priorities for NSW Government expenditure on medical and health research and development (R&D);
- how to better utilise the strengths and overcome any weaknesses inherent in the NSW research environment;
- how to optimise research funding in NSW; and
- future directions for its development.

The Review Panel invites submissions from interested parties, addressing any of the Review Terms of Reference.

Additional information on the Review, including the Terms of Reference, is available on the NSW Health website at http://www.health.nsw.gov.au/public-health/rad/research-review

Submissions should be addressed to:

The Chair, NSW Medical and Health Research Review Panel
C/- Research and Development Policy Branch
NSW Department of Health
Locked Bag 961
NORTH SYDNEY NSW 2059

Please provide 10 hard copies of your submission.

For enquiries, please contact Dr Louisa Jorm, Director of Epidemiology and Research, NSW Health, on (02) 9391 9221.

Closing date: COB 15 September 2003

Appendix D:

List of submissions

1. Professor Bernie Tuch, Director, Diabetes Transplant Unit, Prince of Wales Hospital

2. Mr Lewis Kaplan, Chief Executive, Alzheimer's Australia NSW

3. Ms Kylie Evans, Communications Manager, CRC for Eye Research and Technology, UNSW

4. Mr David L Morris, Professor of Surgery, The St George Hospital, Kogarah, NSW

5. Dr Jim Hyde, President , NSW Public Health Association of Australia Inc

6. Anonymous

7. Mr Maxwell Bennett AO FAA, Professor and University Chair, Brain & Mind Research Institute, University of Sydney

8. Professor W H McCarthy AM, Chairman, Melanoma and Skin Cancer Research Institute, Royal Prince Alfred Hospital

9. Dr John F Thompson, Director, The Sydney Melanoma Unit, Academic Director, Melanoma Foundation, Royal Prince Alfred Hospital

10. Ms Brooke O'Donnell, Chief Administrator, Institute for Magnetic Resonance Research, University of Sydney

11. Mr Nick Hunt (Director) and Rebecca Mason (Deputy Director), Institute for Biomedical Research, University of Sydney

12. Mr Brian Magrath, International Institute of Psychosomatic Medicine

13. Dr Diana Horvath AO, Chief Executive Officer, Central Sydney Area Health Service, and Chairperson, Sydney Health and Medical Research Hub

14. Dr Greg Stewart, Deputy Director-General, Public Health and Chief Health Officer, NSW Health

15. Mr Michael Barnes, Area Library, Dubbo Base Hospital

16. Professor Colleen Stainton, Chair, Women's Health Nursing, Royal Hospital for Women, Centre for Women's Health Nursing

17. Professor Peter Schofield, Director, Neurobiology Research Program, Garvan Institute of Medical Research

18. Professor Hugh Dickson, Chairperson, Research Ethics Committee, South Western Sydney Area Health Service

19. Professor John McAvoy, Save Sight Institute

20. Dr Douglas Joshua, Director, The Institute of Haematology, and Head, Haematology, Central Sydney Area Health Service

21. Dr Peter Hill, Acting Chief Dental Officer, Oral Health Branch, NSW Health

22. Professor R John Aitken, Director, ARC Centre of Excellence in Biotechnology & Development, University of Newcastle

23. Dr Levon Kachigian, Director, Australian Society of Medical Research

24. Dr Chris Rissel, Director, CSAHS Health Promotion Unit

25. Professor Kim Oates, Chief Executive, The Children's Hospital at Westmead

26. Ms Jane Ewing, Department of Mathematical Sciences, Faculty of Science, University of Technology, Sydney

27. Ms Carol O'Donnell, School of Behavioural and Community Health Sciences, Faculty of Health Sciences, University of Sydney

28. Professor Robert Baxter, Director, Kolling Institute of Medical Research Royal North Shore Hospital

29. Mr Peter Rowe, Lorimer Dods Professor and Director, Children's Medical Research Institute

30. Associate Professor Bob Gibberd, Director, Health Services Research Group, Faculty of Health, University of Newcastle

31. Dr Stuart Carr, Director, Radiopharmaceuticals, Australian Nuclear Science & Technology Organisation

32. Professor Gavin Brown, Vice-Chancellor and Principal, The University of Sydney

33. Westmead Millennium Institute & Research Division Children's Hospital at Westmead

34. Professor Mark Burton, Dean, Faculty of Health Studies, Charles Sturt University

35. Associate Professor John Snowdon, Area Director of Psychogeriatric Services, Central Sydney Area Mental Health Services

36. Professor R J MacDonald, Deputy Vice-Chancellor (Research) University of Newcastle, and Hunter Medical Research Institute

37. Victor Chang Cardiac Research Institute

38. Professor Lesley Johnson, Pro Vice-Chancellor (Research & Development), University of Technology, Sydney

39. Mr Ken Hillman, Director, The Simpson Centre for Health Services Research South Western Sydney Area Health Service

40. Associate Professor Ross Smith, University Department of Surgery, Royal North Shore Hospital

41. Professor John Kaldor, Deputy Director, National Centre in HIV Epidemiology and Clinical Research, University of NSW

42. Professor Les Irwig, School of Public Health, Faculty of Medicine, The University of Sydney

43. Professor Judy Lumby, Executive Director, The College of Nursing

44. Professor Sally Redman, Chief Executive Officer, Institute for Health Research

45. Professor Susan Kippax, Director, National Centre in HIV Social Research

46. Ms Susan Murray, General Manager, National Breast Cancer Foundation

47. Professor Elspeth McLachlan, Pro-Vice-Chancellor (Research), The University of NSW

47a. Professor Elspeth McLachlan, Pro-Vice-Chancellor (Research), The University of NSW, for the Randwick BioHub

48. Dr Stephen Wilson, Director and Area Advisor, Ambulatory Care Consortium, Macarthur Health Service, Camden Hospital

49. Mr Michael Sugrue, Director, Department of Trauma Services, Liverpool Health Service

50. Mr Ian Grainger, CEO, Fitness NSW

51. Professor David Handelsman, Director, ANZAC Research Institute

52. Mr John Cumming, Research & Policy Officer, People Living with HIV/AIDS (NSW)

53. Dr Terry Clout, Chief Executive Officer, Mid North Coast Area Health Service

54. Mr Craig Patterson, Chief Executive Officer, The Royal Australasian College of Physicians

55. Woolcock Institute of Medical Research, Camperdown

56. Professor Warwick Britton, Department of Medicine, University of Sydney and Department of Clinical Immunology, Royal Prince Alfred Hospital

57. Professor Philip Barter, Director, The Heart Research Institute Ltd

58. Professor Mark Harris, Centres for Primary Health Care and Equity Research and Development, University of NSW

59. Professor Colin Chesterman, Director, Centre for Thrombosis and Vascular Research

60. Professor Simon Gandevia, Acting Scientific Director, Prince of Wales Medical Research Institute

61. Dr Darrell Duncan, Area Director, Health Improvement and Information Services, Central Coast Health

62. Institute for International Health

63. Cr Lucy Turnbull, Chair, Sydney Cancer Institute Board

64. Joint submission from the Directors of the major medical research institutes in NSW

65. Professor Rob Sutherland, Director, Cancer Research Program, The Garvan Institute of Medical Research

66. Dr Jason Smythe, Science and Technology Leader – NSW, CSIRO Molecular Science, North Ryde

67. Professor Philip Mitchell, Head, School of Psychiatry, University of NSW

68. Associate Professor Jeffrey Braithwaite, Director, Centre for Clinical Governance Research in Health, University of NSW

69. Ms Elizabeth Harris, Director, Centre for Health Equity Training Research & Evaluation, South Western Sydney Area Health Service

70. Professor Steven Boyages, Chief Executive Officer, Western Sydney Area Health Service

71. Associate Professor Michael Levy, Acting CEO, Corrections Health Service

72. Professor Ian Chubb AO, Vice-Chancellor and President, Australian National University

73. Professor Bernard Stewart, Director, Cancer Services, South Eastern Sydney Area Health Service

74. Professor John McCallum, Dean, College of Social and Health Sciences, University of Western Sydney

75. Ms Rosemary Bryant, Executive Director, Royal College of Nursing, Australia

76. Professor Anthony Zwi, School of Public Health and Community Medicine, The University of NSW

77. Professor John Shine AO, Executive Director, Garvan Institute of Medical Research

78. Dr Ian Southwell, Chief Executive Officer, South Western Sydney Area Health Service

79. Dr Vasco de Carvalho, Acting Chief Executive Officer, Central Coast Area Health Service

80. Centre for Culture and Health, University of New South Wales

81. Dr Michael Bird, Coordinator of Aged Mental Health, Southern Area Health Service

82. Dr Neil Hunter, Institute of Dental Research, Westmead

83. Professor Kathy Eagar, Director, Centre for Health Service Development

84. Professor Margaret Sheil, Pro-Vice-Chancellor (Research), University of Wollongong

85. Professor Tony Basten AO & Ms Denyse Bartimote, Centenary Institute of Cancer Medicine and Cell Biology

86. Ms Mary Foley, Chief Executive Officer, St Vincent's & Mater Health, Sydney

87. Professor Tony Cunningham, Director, Westmead Millennium Institute

88. Professor Jim Bishop, NSW Chief Cancer Officer

89. NSW Department of State and Regional Development

Appendix E:

Capacity for priority-driven medical and health research in NSW

In addition to basic research, the NSW Government will support research directed at the State's health priorities, and build and sustain research capacity in priority areas.

Decisions about strategic investment in research on priority areas require answers to the following questions.

Which diseases or conditions cause the greatest burden of ill health in NSW?
Which of these conditions is a particular problem in relation to the ageing of the State's population?
Have these conditions been identified as national or State health priorities?
For which of the priority conditions does NSW have a track record of excellence in research?
What is the existing level of expenditure on research into the priority conditions, both in NSW and elsewhere in Australia?

1 Burden of disease

The overall burden of disease in a population, such as the population of NSW, can be calculated by combining the *number of years lost due to premature death* and the *number of years lived with a disability*. From this calculation, the number of *disability-adjusted life years* (DALYs) can be estimated. Because the data are difficult to compile, figures on burden are published only occasionally, and the most recent Australian figures refer to the calendar year 1996. In that year the total burden of disease in NSW amounted to 864,652 DALYs. Eleven conditions accounted for more than 90% of the total burden (Table 1).

Table 1: Diseases or conditions accounting for more than 90% of the total burden of disease in NSW, 1996

Disease or condition	Burden due to the disease or condition (number of disability-adjusted life years), NSW, 1996	Proportion of total NSW burden (percent)
Cardiovascular disease	198,258	22.9
Malignant neoplasms	163,375	18.9
Mental disorders	116,558	13.5
Nervous system disorders	82,056	9.5
Chronic respiratory diseases	63,197	7.3
Unintentional injuries	41,509	4.8
Musculo-skeletal diseases	30,965	3.6
Digestive system diseases	22,647	2.6
Intentional injuries	21,900	2.5
Genito-urinary diseases	21,540	2.5
Diabetes mellitus	21,288	2.5

Source: The Health of the People of NSW. Report of the Chief Health Officer, 2002

Cardiovascular disease, cancer, and mental and nervous-system disorders predominate, accounting for about two-thirds of the total burden.

Certain conditions impose a particularly heavy burden in specific populations. For example, much of the excessive morbidity and mortality of Aboriginal and Torres Strait Islander peoples in NSW can be attributed to cardiovascular disease (ischaemic heart disease), type 2 diabetes, injuries, and chronic renal failure.

2 Morbidity and the ageing of the population

The Premier has drawn attention to the ageing of the population as one of the most critical policy challenges facing the State in the coming years. To deal with this challenge, it is important to identify gaps in knowledge relating to the major causes of morbidity that affect older people. Strategic research can then be supported or commissioned to fill these gaps. With the exception of intentional injuries, the occurrence of almost all of the 11 conditions listed above increases with age. The following are of particular importance:

Cardiovascular disease: atherosclerosis, cardiac failure.
Cancer: many cancers, most notably colorectal, breast, lung and prostate cancer.
Mental disorders and nervous system disorders: depression, dementia, and disorders of balance, sight and hearing.
Chronic respiratory diseases: chronic obstructive pulmonary disease.
Musculo-skeletal diseases: arthritis, osteoporosis.
Genito-urinary diseases: urinary incontinence.
Diabetes mellitus: type 2 diabetes.

3 National and State health priorities

The following have been established as National Health Priority Areas, endorsed by the Australian Health Ministers' Council:

Heart disease, stroke, and vascular disease*
Cancer*
Asthma*
Diabetes*
Injury*
Mental health*
Arthritis and musculo-skeletal disease

The National Health Priority Areas picked out by the NSW Department of Health as priorities for research are marked with an asterisk (*). The Department has also identified the following conditions as priorities for research:

- Developmental disorders in children,
- Chronic neurodegenerative diseases,
- Blood-borne infections,
- Nosocomial infections,
- Vaccine-preventable diseases, and
- Diseases potentially amenable to gene therapy.

In addition, the Department has highlighted the following topics and issues as research priorities:

- *Health-related biotechnology* – functional and structural genomics, proteomics, bioinformatics, the convergence between biotechnology and other technologies.
- *Health risks* – smoking, obesity, inadequate physical activity, alcohol use, use of licit and illicit drugs.
- *Health of specific populations* – Aboriginal and Torres Strait Islander peoples, rural and remote populations, older people, and children.
- *Health inequalities* – addressing the impact of socioeconomic inequalities on health.
- *Health system issue*s – the organisation, financing and delivery of health services to promote equity of access and equity of outcomes, and optimise continuity of care for people with chronic and complex health conditions.
- *Health informatics* – surveillance systems for epidemiologic trends and clinical quality assurance, current awareness tools to facilitate the implementation of new and existing knowledge, electronic information dissemination systems.

- *Research transfer* – barriers and enablers to implementation of research findings, effective methods for synthesising research evidence, encouraging commercial development of the products of research.

4 Areas of research excellence

4.1 Competitive peer-reviewed grants as markers of excellence

The most consistent marker of research excellence is the award of prestigious competitive peer-reviewed grants. Such grants reflect the quality and originality of the research, the potential of the research to generate useful new knowledge, and the esteem in which the research team is held by peers. Importantly, the award of a peer-reviewed grant represents a prospective judgement of the value of a research project or program. International grants provide an indication of the international competitiveness of Australian research.

The review panel considered that three types of grants would be useful indicators of research excellence:

- NHMRC Program Grants,
- Centres of Clinical Research Excellence awards, and
- US National Institutes of Health grants.

4.2 NHMRC Program Grants in NSW, 1999-2004

'Program Grants acknowledge the scientific excellence of research teams who are working collaboratively on a small number of health and medical research projects in related fields. Awarded for five years, or four years, these grants provide support which is more flexible than that provided by three-year Project Grants' (NHMRC Grants Book, 2002). Table 2 lists Program Grants awarded to NSW researchers that were current at the time of writing (November 2003) or were due to commence in 2004.

Table 2: NHMRC Program Grants awarded to NSW researchers, 1999-2004

First year of funding *	Topic	Institution
2004	Mechanisms of breast and prostate cancer progression: implications for improved clinical management and treatment	Garvan Institute of Medical Research
2004	Post-traumatic mental health	University of NSW
2003	Causes of depressive disorders and factors predicting their response and resistance to treatment	Euroa Centre, Prince of Wales Hospital, University of NSW
2003	Advances in clinical trials research and evidence-based decision making	NHMRC Clinical Trials Centre, University of Sydney
2003	Evaluating health policy by understanding consumer and provider decisions about health care: a new approach	Centre for Health Economics Research and Evaluation, University of Technology, Sydney
2003	Atherosclerosis	Centre for Thrombosis and Vascular Research, University of NSW; Department of Cardiology, Royal Prince Alfred Hospital; Hanson Institute, South Australia
2002	Cellular and molecular studies of the adaptive immune response in health and disease	Centenary Institute of Cancer Medicine and Cell Biology
2002	Vascular biology	University of NSW
2002	Screening and diagnosis: accuracy, outcomes and informed decision making	University of Sydney
2000	Experimental neurology	Prince of Wales Research Institute
1999	Typology, aetiology and neurobiology of the depressive and bipolar disorders	University of NSW

*Year in which funding commenced or will commence.
Source: NHMRC Grant Books

Each Program Grant listed above was awarded to a research institution in NSW with a NSW-based researcher as chief investigator. In addition, the following NHMRC Program Grants, which were also current at the time of writing, were awarded to research institutions outside NSW, with a NSW-based researcher as a collaborating principal investigator.

Table 3: NHMRC Program Grants with interstate Chief Investigators and NSW-based Principal Investigators

First year of funding *	Topic	Institution
2004	Understanding HIV infection and development of new vaccines	University of Melbourne (with University of NSW)
2004	How can people be helped to exercise properly so as to improve their health?	University of Queensland (with University of NSW)
2002	Epidemiology of chronic disease, health interventions and DNA studies	University of Melbourne (with University of Western Sydney)

*Year in which funding commenced or will commence.
Source: NHMRC Grant Books

4.3 Centre for Clinical Research Excellence awards

Two NSW research groups received five-year Centre for Clinical Research Excellence awards in 2002. Topics and administering institutions were as follows.

Renal medicine – University of Sydney
Liver disease – Westmead Hospital.

4.4 US National Institutes of Health grants

NSW researchers were awarded NIH grants between 2001 and 2003 in the following fields:

Cancer
Cardiovascular disease
Mental health
Infectious diseases
Respiratory diseases
Reproductive health
Neonatology
Ophthalmology
Oral health
Social and environmental health issues.

The institutions administering the grants were:

Children's Hospital at Westmead
Sydney Centre for Reproductive Health Research
Victor Chang Cardiac Research Institute
Institute of Dental Research
National Centre for HIV Epidemiology and Clinical Research
University of Newcastle
University of NSW
University of Sydney
University of Sydney (for the Save Sight Institute)
University of Sydney (for the Institute for International Health)
University of Wollongong.

4.5 Priority areas and grants

The award of prestigious national and international peer-reviewed grants indicates that NSW has demonstrated research excellence in relation to the following national and State priority health conditions:

Vascular disease
Cancer
Respiratory disease
Mental health
Nervous-system disease
Infectious disease

In addition, the State's researchers have demonstrated excellence in relation to the following priority health issues:

Health risks – inadequate physical activity.
Health system issues – the organisation, financing and delivery of health services.
Research transfer – factors relating to the implementation of research findings, with particular reference to clinical trials and evidence-based decision-making, and informed decision-making about screening and diagnostic tests.

5 Research expenditure

The Australian Bureau of Statistics provided data on medical and health research expenditure by socio-economic objectives (SEOs) in 2000-01. These data exclude expenditure in the business sector. SEOs with relatively large research expenditure in NSW were cancer and related disorders; cardiovascular system and diseases; infectious diseases; nervous system and disoders; endocrine organs and diseases (including diabetes); hearing, vision, speech, and their disorders; clinical health not specific to particular organs, diseases and conditions; and skeletal-system and disorders (including arthritis). In the data collection, allocation of research expenditure to specific SEOs is done by the researchers themselves. However, because of possible inconsistencies in self-allocation, the distribution of expenditure by SEOs should be regarded as approximate.

6 Conclusions

Table 4 summarises information on the burden of disease in NSW, national and State priorities, areas of research excellence, and expenditure (comparing expenditure on research in NSW with that in Victoria and Queensland). It includes conditions that have been identified as priorities in NSW but are not among the top causes of disease burden in the State.

In general, NSW researchers have attracted prestigious peer-reviewed grants in most areas that are identified as major contributors to the burden of disease in the State. Unintentional injuries and musculo-skeletal diseases are exceptions. However, research expenditure in NSW has been substantially lower in absolute terms than that in Victoria (and, in some instances, Queensland) for most of the major contributors to disease burden. NSW expenditure is higher than that in Victoria for research on injuries (intentional and unintentional), musculo-skeletal diseases, and digestive-system diseases.

NSW researchers have also attracted prestigious peer-reviewed grants in most other State priority areas. Again, however, research expenditure in NSW has been substantially lower in absolute terms than that in Victoria.

Table 4: Research performance and expenditure for major contributors to the burden of disease and health priority areas

Major contributors to burden of disease in NSW	National or State health priority	Excellence – Major peer-reviewed grants	Expenditure $000 NSW (% NSW total) *	Comparative expenditure $000 Vic (% Vic total) Qld (% Qld total)*	Relevance to ageing of the population
Cardiovascular disease	National and State	P – atherosclerosis P – vascular biology NIH	$22,467 (7.3%)	V $47,645 (11.8%) Q $6,994 (3.7%)	High
Malignant neoplasms	National and State	P – breast and prostate cancer NIH	$24,300 (7.9%)	V $56,564 (14.1%) Q $25,827 (13.6%)	High
Mental disorders	National and State	P – post-traumatic mental health P – depressive and bipolar disorders. NIH	Mental health $4,449 (1.5%)	V $17,041 (4.2%) Q $10,174 (5.4%)	High
Nervous system disorders	State (neurodegenerative diseases)	P – experimental neurology NIH – ophthalmology	Nervous system and disorders $19,440 (6.3%) Hearing, vision, speech and their disorders $14,587 (4.7%)	V $35,448 (8.8%) Q $6,049 (3.2%) V $8,238 (2.1%) Q $1,962 (1.0%)	High
Chronic respiratory diseases	National and State (asthma)	NIH	$4,600 (1.5%)	V $6,244 (1.6%) Q $2,614 (1.4%)	High
Unintentional injuries	National and State		Injury control $649 (0.2%)	V $612 (0.2%) Q $822 (0.4%)	High

Musculo-skeletal diseases	National		$10,080 (3.3%)	V $7,544 (1.9%) Q $1,710 (0.9%)	High
Digestive system diseases		CCRE – liver disorders	$5,200 (1.7%)	V $3,550 (0.9%) Q $3,527 (1.9%)	
Intentional injuries	Covered in mental health or injury		Injury control $649 (0.2%)	V $612 (0.2%) Q $822 (0.4%)	
Genito-urinary diseases		CCRE – renal medicine NIH	$1,791 (0.6%)	V $2,542 (0.6%) Q $991 (0.5%)	High
Diabetes mellitus	National and State		Endocrine organs and diseases (incl. diabetes) $14,731 (4.8%)	V $15,220 (3.8%) Q $4,798 (2.5%)	High
Other health issues in NSW	National or State health priority	Excellence – Major peer-reviewed grants (P=NHMRC Program Grant)	Expenditure $000 NSW (% NSW total)*	Comparative expenditure $000 Vic (% Vic total) Qld (% Qld total)*	Relevance to ageing of the population
Childhood developmental disorders	State	P – neonataology	Child health $3,538 (1.2%)	V $17,237 (4.3%) Q $2,748 (1.5%)	
Infectious diseases	State (blood-borne diseases, nosocomial infections, vaccine-preventable diseases)	P – HIV infection NIH – HIV, hepatitis C	Infectious diseases $20,513 (6.67%)	V $28,020 (3.2%) Q $6,909 (3.7%)	

Diseases potentially amenable to gene therapy	State		Inherited diseases (incl. gene therapy) $2,157 (0.7%)	V $5,048 (1.3%) Q $4,181 (2.2%)	
Risk factors	State	P – exercise and health	**		High
Health-system issues	State	P – health economics P – screening and diagnosis	***$8,711 (2.8%)	V $10,426 (2.6%) Q $2,414 (1.3%)	

P – NHMRC program grant; NIH – US National Institutes of Health grant; CCRE – NHMRC Centres of Clinical Research Excellence

***** Excludes expenditure in the business sector

****** Total expenditure on public health research was $57,293 (18.6%) in NSW, $91,141 (22.6%) in Victoria and $48,855 (25.8%) in Queensland. However, this exceeded the scope of 'risk factors'.

******* Includes the following SEO rubrics: diagnostic methods; evaluation of health outcomes; health policy evaluation; and health policy economic outcomes