EXCEPTIONAL RETURNS

THE VALUE OF INVESTING IN HEALTH R&D IN AUSTRALIA

Prepared for

THE AUSTRALIAN SOCIETY FOR MEDICAL RESEARCH

by

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DISCLAIMER

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EXECUTIVE SUMMARY

Investment in health R&D surpasses every other source of rising living standards in our time. Our 8-year (11.5%) gain in life expectancy as well as improved wellness over 1960-99 were worth $5.4 trillion to Australians – a figure more than 8 times larger than the entire national output last year. The gains associated with the prevention and treatment of cardiovascular disease alone totalled $1.7 trillion.

Improvements in lifespan account for almost half of the actual gain in Australian living standards in the past 40 years (46% of consumption). Health R&D that further reduced cancer deaths by just 20% would be worth $184bn to Australians, more than the entire annual Commonwealth spending budget.

While it is not always entirely possible to pin down cause and effect, the likely returns from health R&D are so extraordinarily high that the payoff from any strategic portfolio of investments is enormous. This paper estimates that half the historical gains in healthspan are attributable to global health R&D – as opposed to public health awareness, promotion and prevention programs and other factors. 2.5% – Australia's share of global R&D activity – is assumed attributable directly to Australian R&D. These assumptions lead to the conclusions that:

- Historically, annual rates of return to Australian health R&D were up to $5 for every $1 spent on R&D.
- Public sector returns were 72% for longevity and 62% for wellness, while private sector returns were 208% for longevity and 179% for wellness.
- Returns to cardiovascular R&D were 8-fold, to respiratory R&D 6-fold and to digestive system R&D 5-fold.

These stunning results are comparable with similar findings for the US by eminent American economists from Yale, Harvard, Stanford, Columbia and Chicago Universities, whose methodologies have been utilised here.

However, in 2000-01, Australia spent only $1.7bn on health R&D, 0.25% of GDP, low by OECD standards (0.15% to 1.1%). The public sector's share of financing and research activity fell over the 1990s by around 8%.

- With the reduction of public finance, the share of basic health R&D also fell from 47% to 43% of the total. Basic health R&D is an important underpinning for applied research and commercial development.
- The public sector's share of capital R&D investment also fell over the 1990s, further eroding the critical underpinnings of an optimal future Australian health R&D sector.

Initiatives flowing from the Wills Review have very recently stepped up Commonwealth investment in health R&D, in particular through the NHMRC. These welcome initiatives aim to make smarter health R&D investments primarily through enhanced collaboration and workforce measures. However, some key issues remain.

- State, Territory and local governments need to match and stay in line with the Commonwealth effort.
- Care needs to be taken that the erosion of basic research and of capital investment that accompanied the public sector decline of the 1990s are adequately reversed also.
- Continued boosts to investment in health R&D relative to GDP are still warranted given Australia's poor ranking relative to other OECD countries.

Moreover, Australia has a comparative advantage in health R&D given our levels of discovery, publications, citations and other evaluative criteria relative to our size in the global market.

- Australian discoveries save huge ongoing costs in the treatment of stomach ulcers, as well as reducing deaths from SIDS to one fifth of former levels, more cheaply and effectively treating bipolar disorder with lithium, and contributing to amazing reductions in cardiovascular and cancer mortality rates. Our eminent prize-winning health scientists include a major contributor to the founding of the global biotechnology industry.

In addition to the 'good international citizen' arguments, there are weighty economic reasons for enhancing our health R&D investment, in particular balance of payments and employment multiplier arguments, where Sweden

is an important comparator. These benefits, and the positive and negative lessons we have learned in the past from both domestic and international experience, should outweigh any tendencies that might still remain to seek a poorly-conceived 'free ride' on our OECD colleagues' research efforts.

Health R&D must be seen as an investment in wellness with exceptional returns. The corollary is that public finance should be strategically targeted to cost-effective high priority R&D areas.

- Priorities need to be balanced with risk in our R&D portfolio, so that promising lines of attack against minor sources of mortality and morbidity are included as well as higher risk investigations against major ones.
- Collaborative partnerships with the private sector should be carefully and strategically nurtured, particularly with a view to attracting ongoing high levels of funding growth from overseas sources.
- It is also vital that, due to 'critical mass' and serendipity, a broad coverage of fundamental research areas is maintained.

In the coming decades, the effects of demographic ageing will place unprecedented demands on the Australian health system in particular in relation to chronic conditions of ageing such as dementia, arthritis, cardiovascular disease and cancer. The projected direct and indirect costs of chronic illness are forecast to present a challenging burden whose greatest hope is new R&D discoveries.

- Direct health expenditures totalled $60.8bn in 2000-01, with 30% of these in the private sector and 70% in the public sector. National spending on health is projected, on the basis of what we know now, to increase from 9% to 17% GDP over coming decades, the subject of the 2002 Intergenerational Report.
- Although there are as yet no official data on the indirect costs of illness, Access Economics has estimated these as $77bn in 2000-01, 27% higher than direct costs, with 97% borne by the private sector.
- The 'burden of disease' – pain, suffering and premature death – in Australia already costs 13.7% of our healthspan. The forecast rise of burden from chronic disabling conditions such as dementia also looms large as measured in DALYs (Disability Adjusted Life Years), in the absence of R&D breakthroughs.

The past 40 years have witnessed an amazing epidemiological transition, riding on the technological wave. Our generation has benefited from standards of living never before experienced. In this country we now face a future full of promise and challenge for preventing and treating disease for ourselves and our children, by virtue of ethically applying recent dramatic advances in genetics, bioengineering, neuroscience and molecular and structural biology. The challenge is to translate the promise into the reality of new understanding, communication, collaboration and improved clinical outcomes.

This report has shown that every dollar invested in this challenge in Australia has historically been recouped as highly valued healthspan, even in the worst case scenario, and in most cases, many times over. The findings of this paper should change the way that Australian policy makers view health spending, in particular investments in health R&D. The conclusion for the future must be that Australian health R&D represents an exceptional investment, with exceptional returns.

INTRODUCTION

The central objectives of this report are to:

- advance understanding about the magnitude of health R&D in Australia;
- compare Australian health R&D activity with that overseas; and
- analyse the cost-effectiveness of that research.

In Chapter 1, we present the best available estimates of the level of health R&D in Australia, with the dual goals of achieving as great a degree of sub-categorisation as possible with the greatest degree of accuracy. We survey a range of data sources and explain the differences between them.

In Chapter 2, we compare Australian health R&D activity with that overseas. We look also at worldwide health advances, at methods for assessing returns on investment in health R&D and at international comparisons of returns for selected countries.

In Chapter 3, we analyse the cost-effectiveness of Australian health R&D investment, noting that rates of return may be different for various types or sources of research activity.

Chapter 4 summarises the findings of the report and draws out the implications for policy.

The appendix provides detailed statistical tabulations.

1. EXPENDITURE ON HEALTH R&D IN AUSTRALIA

Since numerous definitional and methodological issues arise in measuring health R&D, this chapter begins by looking at Australian standard definitions (Section 1.1) and the processes for measurement (Section 1.2), which are based on international guidelines provided by the Organization for Economic Cooperation and Development (OECD). Section 1.3 then provides an analysis of the Australian data, derived from a special data request from the Australian Bureau of Statistics (ABS). Section 1.4 briefly raises some issues of Australian health R&D, including issues identified in the Wills Review.

1.1 DEFINITIONS AND CLASSIFICATIONS

In this paper, the general term 'research' is used interchangeably with the slightly more technical term 'research and development' (R&D). R&D activity is defined in Australia (ABS, 2002) as:

> '*Systematic investigation or experimentation involving innovation or technical risk, the outcome of which is new knowledge, with or without a specific practical application, or new and improved products, processes, materials, devices or services. R&D activity extends to modifications to existing products/processes. R&D activity ceases and pre-production begins when work is no longer experimental*'.

This concords with the OECD standard definition of R&D as '*creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications*' (OECD, 1994).

Classification of research, by the ABS and in this paper, is based on the Australian Standard Research Classification 1998 (ABS, 1998), which in turn is based on OECD guidelines for member nations for both R&D measurement and survey data collection. An excellent historical background to health R&D in Australia, its rationale and measurement is found in Nichol et al (1994).

1.1.1 Categorisation by sector

Four sectors are recognised as sources of R&D activity:

- **Business** – includes all businesses whose primary activity is the production of goods and services for profitable sale to the general public, and the private non-profit (PNP) institutions mainly serving them. It excludes businesses mainly engaged in agriculture, forestry and fishing (Division A ANZSIC) because of difficulties of collection and because their R&D activity is estimated to be minimal.
- **Government** – includes all Commonwealth, State/Territory and local government departments and authorities. Local government organisations are excluded because their R&D activity is estimated to be minimal. Public sector organisations mainly engaged in higher education are included in 'higher education', while those mainly engaged in trading or financial activities are included in 'business'.
- **Higher Education** – includes all universities and other institutions of post-secondary education whatever their source of finance or legal status, except non-university post-secondary institutions (e.g. technical and further education colleges) because their R&D activity is estimated to be minimal. Calendar year data are used for higher education e.g. CY2000 for FY2000-01.
- **PNP** – includes private or semi-public incorporated organisations established with the intention of not making a profit.[1]

[1] It should be noted that in many cases attribution of the research performance is complex. For example, the Walter & Eliza Hall Institute and the Baker Heart Research Institute are both distinct entities classified to the PNP sector. However, they are both associated with universities. Academics and postgraduates carry out research at these Institutes. Funding and control of projects determine whether the research is reported by the universities or by the Institutes themselves. The majority of the research at each Institute is reported by the Institute and hence is included in the PNP sector.

1.1.2 Type of research

Research is also categorised by 'type of R&D activity', identifying three stages of R&D processes (ABS, 2002a).

- **Basic research** – is experimental and theoretical work undertaken primarily to acquire new knowledge without a specific application in view. It consists of:
  - *pure basic research,* carried out without looking for a long-term benefit other than the advancement of knowledge (for example, study of cell biology); and
  - *strategic basic* research, directed into specified broad areas in the expectation of useful discoveries and providing the broad base of knowledge for the solution of recognised practical problems (for example, mapping of the human genome).
- **Applied research** – is original work undertaken in order to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and predetermined objectives (for example, study of immune responses that destroy beta-amyloid, with a view to developing a treatment for Alzheimer's disease).
- **Experimental development** – is systematic work, using existing knowledge gained from research or practical experience, for the purpose of creating new or improved products/processes (for example, using an understanding of cholesterol and triglycerides to develop and trial lipid lowering drugs that reduce cardiovascular events).

The data used in Chapter 3 include all types of R&D activity (aggregated), as it was deemed too complex and arbitrary to attribute rates of return to each type, given the inter-relationships. The ABS also notes that:

> '*Data in this classification are subjectively allocated by respondents at the time of reporting, using OECD/ABS definitions. The ABS makes every effort to ensure correct and consistent interpretation and reporting of this data and applies consistent processing methodologies. Analysts using this classification should bear the original subjectivity in mind*' (ABS, 2002a, p17).

1.1.3 Health R&D: SEO/FOR classification

The Australian Standard Research Classification (ABS, 1998) is a set of three related classifications, two of which can be used to identify health R&D – the socio-economic objective (SEO) classification and the field of research (FOR) classification (ABS, 2000a).

- **Socio-economic objective (SEO)** identifies all R&D with an objective or purpose of health. It includes:
  - *Subdivision 730000 Health (130000 up to 1998-99) – directed to human health including the understanding and treatment of clinical diseases and conditions and the provision of public health and associated support services;*
  - *Group 670400 Human pharmaceutical products (70400 up to 1998-99) – directed to the manufacture of pharmacotherapies for use in the prevention, diagnosis and treatment of human diseases;*
  - *Group 191000 Advancement of knowledge: medical and health sciences – pure basic research in the medical and health sciences (this category subsumed in others from 2000-01);*
  - *Class 671402 Medical instrumentation (071402 up to 1998-99) – directed to the manufacture of medical instruments; and*
  - *Class 160604 Environmental health – directed to understanding the surroundings of people and environmental issues pertaining to health (now subsumed in 730210).*

  In Australia, for reasons of minimising the undue reporting burden on businesses, business data are not collected at the most detailed (class) level, so is only available for the first three items above.
- **Field of research (FOR)** identifies all R&D undertaken using health disciplines. It includes only one item:
  - *Subdivision 320000 Medical and health sciences (100000 up to 1998-99). This includes 100100 Immunology, 100200 Medical biochemistry and clinical chemistry, 100300 Medical microbiology, 100400*

Pharmacology, 100500 Physiology, 100600 Neurosciences, 100700 Clinical Sciences, 100800 Public health research, 100900 Health services research and 109900 Other medical and health sciences.

R&D in biological sciences without application to human health and disease is excluded.

In Australia, data are available for both classifications and there is some healthy debate about which method is superior. For FOR, there is the risk of understatement due to possible exclusion of some pure basic research. However, business R&D for medical instrumentation and environmental health may possibly be better captured, although this is likely to be relatively smaller. There is also the possibility that SEO Group 191000 may overstate, for example by including a small amount of pure basic research into animal biology or physiology. It is arguable whether such research should be included since it may or may not ever have a human application.

For these reasons, health R&D is likely to be lower as measured by FOR than by SEO, and indeed this is what the data show. The likely result is probably somewhere between the two estimates, although the authors of this paper take the view that SEO is likely to be a closer estimate. There is also the theoretical issue of whether an approach using the discipline in which the research (FOR) is undertaken is conceptually superior to that of the ultimate purpose of the research (SEO). Again the authors would lean to the superiority of the SEO approach on this basis as well.

Table 1 summarises the individual items that are included using the SEO approach adopted in this paper. Note that the subdivision 730000 Health is shown by its three groups – 730100 (clinical health), 730200 (public health) and 730300 (health support services). Also note that in 2000-01 there was a methodological change in data gathering such that there is no longer an equivalent for 191000 (research in the health and medical sciences) in the new classification.

Table 1 Items included in health R&D, Australia, SEO basis, 2000-01

730100 CLINICAL (ORGANS, DISEASES & CONDITIONS)	730209 Rural health
730101 Infectious diseases	730210 Environmental health
730102 Immune system and allergy	730211 Mental health
730103 Blood disorders	730212 Disease distribution and transmission
730104 Nervous system and disorders	730213 Preventive medicine
730105 Endocrine organs and diseases (incl. diabetes)	730214 Dental health
730106 Cardiovascular system and diseases	730215 Nutrition
730107 Inherited diseases (incl. gene therapy)	730216 Food safety
730108 Cancer and related disorders	730217 Health status (e.g. indicators of well-being)
730109 Surgical methods and procedures	730218 Social structure and health
730110 Respiratory system and diseases (incl. asthma)	730219 Behaviour and health
730111 Hearing, vision, speech and their disorders	730220 Injury control
730112 Oro-dental and disorders	730299 Public health not elsewhere classified
730113 Digestive system and disorders	**730300 HEALTH AND SUPPORT SERVICES**
730114 Skeletal system and disorders (incl. arthritis)	730301 Health education and promotion
730115 Urogenital system and disorders	730302 Nursing
730116 Reproductive system and disorders	730303 Occupational, speech and physiotherapy
730117 Skin and related disorders	730304 Palliative care
730118 Organs, diseases and abnormal conditions n.e.c.	730305 Diagnostic methods
730199 Clinical health n.e.c.	730306 Evaluation of health outcomes
730200 PUBLIC HEALTH	730307 Health policy evaluation
730201 Women's health	730308 Health policy economic outcomes
730202 Men's health	730399 Health and support services not elsewhere classified
730203 Health related to ageing	**670400 HUMAN PHARMACEUTICAL PRODUCTS**
730204 Child health	670401 Prevention – biologicals (e.g. vaccines)
730205 Substance abuse	670402 Diagnostics
730206 Aboriginal and Torres Strait Islander health	670403 Treatments (e.g. chemicals, antibiotics)
730207 Health related to specific ethnic groups	670499 Other
730208 Occupational health (excl. ec. development aspects)	

Source: ABS special data request. Note: For previous years also 191000 and 191000 Medical and Health sciences

There is also a distinction made in the data between the type of research expenditure by the researcher unit and the source of funds for that unit.

Type of expenditure is categorised as:

- Capital expenditure – which comprises 'land and buildings', and 'other capital expenditure'; and
- Current expenditure – which comprises 'labour costs' and 'other current expenditure'.

Source of funds is categorised as:

- Commonwealth government;
- State and local government;
- Business;
- Other Australian; and
- Overseas.

This latter categorisation is highly relevant to this study, with the former two categories being a proxy for public investment in R&D (given that higher educational facilities are largely funded from public sources) and the latter three categories being a proxy for private investment in R&D (given that they are dominated by private commercial and philanthropic sources).

Data are also available by the **State/Territory** of the research unit, however, this level of disaggregation has not been reported in this study.

Cross-tabulation has been conducted between SEO and source of funds. Where there was a single SEO and/or a single source of funds, the data were easy to allocate. Where there was more than one source of funds and more than one SEO, this was provided by the ABS as a 'multiple' category. These were allocated in accordance with the distributional fit relative to all category totals.

1.2 DATA COLLECTION IN AUSTRALIA

1.2.1 The Australian Bureau of Statistics (ABS)

The ABS has a comprehensive data-gathering process utilising a bottom-up approach (i.e. the reports of the performer of the research). Data are reported primarily in four publications:

- Cat No. 8104.0: *Research and Experimental Development Australia 2000-01: Businesses* (ABS, 2002c);
- Cat No. 8109.0: *Research and Experimental Development Australia 2000-01: Government and Private Non-Profit Organisations* (ABS, 2002b);
- Cat No. 8111.0: *Research and Experimental Development Australia 2000-01: Higher Education Organisations,* (ABS, 2002d); and
- Cat No. 8112.0: *Research and Experimental Development Australia 2000-01: All Sector Summary* (ABS, 2002a).

Collecting data from the four sectors involves the following processes:

- **Business** – The Survey of Research and Experimental Development is conducted (most recent data for FY2000-01) on the basis of a complete enumeration of businesses identified by the ABS as likely R&D performers (excluding those involved in agriculture, forestry and fishing, as noted in the Section 1.1). The survey is conducted by mailed questionnaires and, for 2000-01, a 92% response rate was obtained. For businesses that do not respond but reported R&D activity previously, data are imputed based on previous

expenditures. If no R&D activity had been reported previously, non-respondents are deemed to be non-R&D performers.

- **Government and PNP** – Again, the Survey of Research and Experimental Development is used to collect data on the basis of a complete enumeration of likely R&D performers, by mailed questionnaire. For the most recent survey (FY2000-01), a 96% response rate was obtained. Non-respondents are deemed to be non-R&D performers.
- **Higher Education** – The Survey of Research and Experimental Development applies in this case to data collected from universities for the calendar year (most recently CY2000).

To optimise coverage, avoiding double counting or data gaps, the ABS expends considerable effort:

- educating and providing information to respondents through meetings, seminars and printed materials;
- establishing project contact officers with follow-though of project forms/questionnaires at the project level;
- attributing University and hospital research activities;
- attributing all elements of large projects which may have some components sub-contracted;
- ensuring, where there is joint research activity between two research units, the unit that funded the research reports it;
- fine-tuning the treatment of extramural R&D activities;
- cross-checking against new grants listed and against tax concession scheme data; and
- given that there is a risk of missing small amounts of research activity by new and small-scale enterprises, identifying and revising previously published data (historically these revisions have been very small).

Data are available biennially for the years 1992-93, 1994-95, 1996-97, 1998-99 and 2000-01. The latter data were released in July 2002.

The ABS (2002a, p19) notes that the statistics should be used with caution for the following reasons:

- Many data providers had to make estimates because their accounts do not separately record R&D data;
- The OECD standard definition of R&D used in this survey differs in some respects from what respondents may regard as R&D activity, particularly since the definitions used within the Grants for Industry R&D scheme for the allocation of grants, and the 125% Tax Concession Scheme for tax deductibility for specific R&D activities undertaken within Australia, differ slightly from the R&D survey definition.
- Some data providers had difficulties describing their R&D programs in terms of socio-economic objectives, research fields, courses and disciplines and type of R&D activity. The data presented under these classifications therefore reflect a degree of subjectivity.

1.2.2 The Australian Institute of Health and Welfare (AIHW)

The AIHW aims to report annual expenditure on research that has a 'health' socio-economic purpose, on the basis of who funds it and with expenditure allocated by State/Territory. The AIHW use the four main ABS publications to estimate such expenditure. Since the publications are available on a biennial basis, for non-survey years the AIHW assumes straight-line growth.

The ABS published data reports national expenditure on the basis of who funds it, but it only splits the expenditure on a State/Territory basis in relation to the site of activity (i.e. who undertakes the research). The AIHW has a process of converting the ABS State/Territory by site expenditure data into State/Territory by source of funds estimates, as follows. The sources of funds for research that the AIHW uses are Commonwealth government, State and Territory governments, local governments, governments nec (not elsewhere classified), universities, PNP organisations and private business. The sites of research activity reported by ABS are university, business and 'other'. The steps for each sector are:

(1) The AIHW inputs ABS health research expenditure on a site basis for each State/Territory. This comes directly from the ABS publications.

(2) Because the ABS site-based data are allocated to the different sources of funding at the national level only, an arbitrary allocation of the national funding estimates by State/Territory is undertaken using an assumption that the source of funds allocation is similar to the site of activity allocation by State/Territory.

The estimates of expenditure on health research thus developed are *inputs* into the AIHW national health expenditure database. It is important to record that AIHW is using a national accounting framework. The estimates of health spending are presented as estimates of *final* health goods and services. To the extent that expenditure on health research is financed or recovered through the price to consumers of final health goods and services, it is considered to be an *intermediate input* and is excluded from the AIHW measure of health research which, accordingly, is lower than the ABS measure by around 57%. Otherwise, there would be double-counting of health expenditure. To illustrate the implications, pharmaceutical R&D is regarded as embedded in the price of pharmaceuticals (and is therefore classified as expenditure on pharmaceuticals). Similarly, research undertaken in acute care institutions (hospitals) is included in the estimated gross operating expenditures of those institutions (and is therefore classified as expenditure on hospitals). In a written submission from the AIHW to this report, the AIHW notes that: '*Because we only record expenditure in terms of who ultimately provides the funding for that expenditure, we believe that there is no 'double-counting' involved*'.

The fact that the AIHW and ABS measures are different does not invalidate either. Both measures have their own purposes. From a national accounting perspective, it would make no sense to single out one intermediate input (health R&D) from any other (say, for example, electricity which itself is an intermediate input into health R&D. For the purposes of this report, the ABS measure is the more important one as we are interested in total expenditure. While the AIHW data are not used further in the analysis in this report, they are reported here for completeness of the record.

Table 2 shows that, using the AIHW methodology, total health R&D funding in 2000-01 was $973m (in constant 1999-00 prices). Of this, over two thirds ($665m) was spent by the Commonwealth, 13% ($128m) by State and local governments and 18% ($180m) by non-government bodies, remembering that 'intermediate' commercially oriented R&D undertaken or commissioned by private business is excluded, and hence is different from the ABS spit of 60%:40% in the same year (Section 1.3.1).

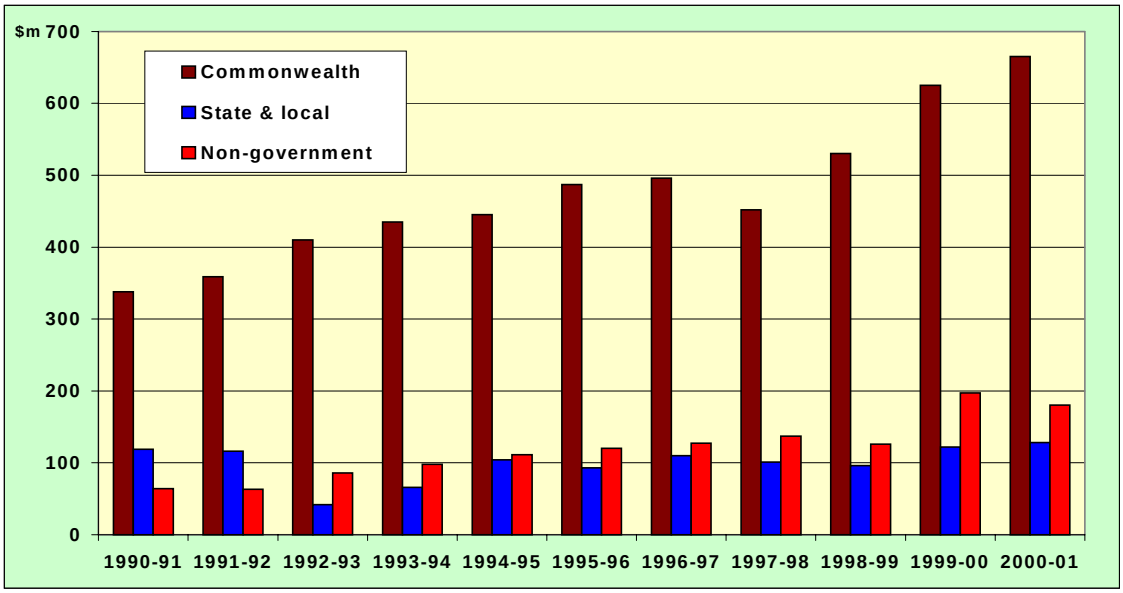
Table 2 AIHW measure of health R&D, constant prices and growth, by source of funds, 1990-91 to 2000-01*

	Commonwealth govt		State & local govt		Non-government		Total	
Year	**$m**	**% growth**	**$m**	**% growth**	**$m**	**% growth**	**$m**	**% growth**
1990-91	338	-	119	-	64	-	521	-
1991-92	359	6.1	116	-2.5	63	-0.8	538	3.3
1992-93	410	14.4	42	-63.6	86	35.5	538	-
1993-94	435	6.1	66	56.2	98	14.9	600	11.4
1994-95	445	2.2	104	57.6	111	12.8	660	10.0
1995-96	487	9.5	93	-10.7	120	7.8	700	6.0
1996-97	496	1.9	110	17.8	127	6.4	733	4.8
1997-98	452	-8.9	101	-7.6	137	7.5	690	-5.8
1998-99	530	17.2	96	-4.9	126	-7.7	753	9.0
1999-00	625	17.9	122	26.5	197	56.2	944	25.4
2000-01**	**665**	**6.4**	**128**	**4.9**	**180**	**-8.6**	**973**	**3.1**
Average annual growth rates								
1990-91 to 1992-93		10.2		-40.4		15.9		1.7
1992-93 to 1997-98		2.0		19.1		9.8		5.1
1997-98 to 2000-01		13.7		8.0		9.6		12.1
1990-91 to 2000-01		**7.0**		**0.7**		**11.0**		**6.4**

* Constant price health expenditure for 1990-91 to 2000-01 is expressed in chain volume measures, referenced to the year 1999-00.

** Based on preliminary AIHW and ABS estimates. Source: AIHW health expenditure database, reported in Table 29 AIHW (2002).

Figure 1 AIHW measure of health R&D, constant prices and growth, 1990-91 to 2000-01*



* Constant price health expenditure for 1990-91 to 2000-01 is expressed in chain volume measures, referenced to the year 1999-00.
Source: Derived from AIHW health expenditure database, reported in Table 29 AIHW (2002).

Table 2 and Figure 1 also show that health R&D spending, as measured by the AIHW, grew in real terms by 6.4% p.a. over the 1990s, with fastest growth (12.1% p.a.) over the most recent 1997-98 to 2000-01 period. The recent growth was largely driven by 13.7% Commonwealth real spending growth, although it is notable that non-government real spending growth was more consistent and higher on average (11.0% p.a. over the 1990s). This is partly because the non-government sector is generally more committed to specific project funding and less influenced by political budgetary changes. State and government spending on health R&D was the most volatile and had the lowest real growth (0.7% p.a. over the 1990s).

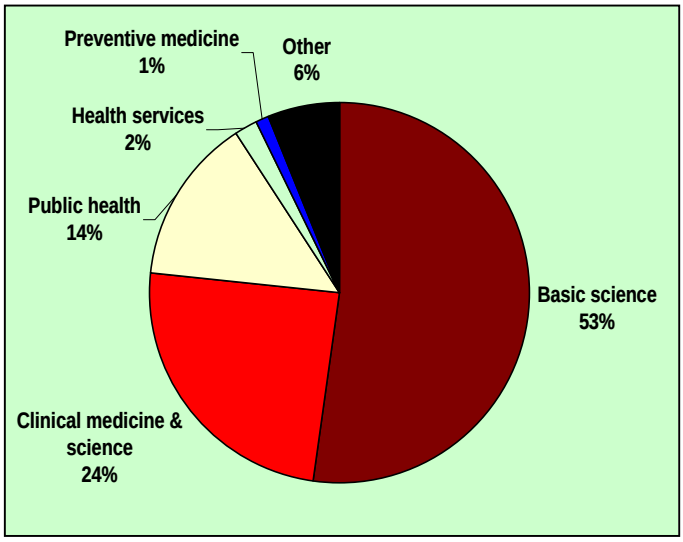
1.2.3 The National Health and Medical Research Council (NHMRC)

Since 1936, the NHMRC has promoted the development and maintenance of public health standards through the provision of evidence-based health advice, investment in high-impact health R&D, and consideration of ethical issues in health. In NHMRC (2002), Professor Alan Pettigrew (CEO) notes the recent increase in funding for the NHMRC (particularly for 2002), following from the Wills Report (which is addressed further in Section 1.2.4):

> '*The Government has recognised that the community's investment in research generates a significant return in the form of improved health and wellbeing, and has provided a further $614m over six years, more than doubling the level of funding available to the NHMRC for health and medical research by 2004-05*'.

The (real) doubling referred to here is from around $165m in 1998-99 to nearly $400m in 2004-05, an additional investment of $614m over the six years. In the year 2002, funding was $276m. Funding *committed* in 2002 totalled $369.8m, of which $139.7m (38%) was for programs, $135.8m (37%) for project grants, $69.1m (19%) for people support, $20.7m (6%) for enabling grants and $4.5m (1%) for Strategic Research Development Committee grants. Figure 2 and Figure 3 provide a broad overview of the NHMRC's investment of Commonwealth funding for health R&D. In many cases, these categories have been extracted by keyword searches from information provided by research applicants and from financial records.

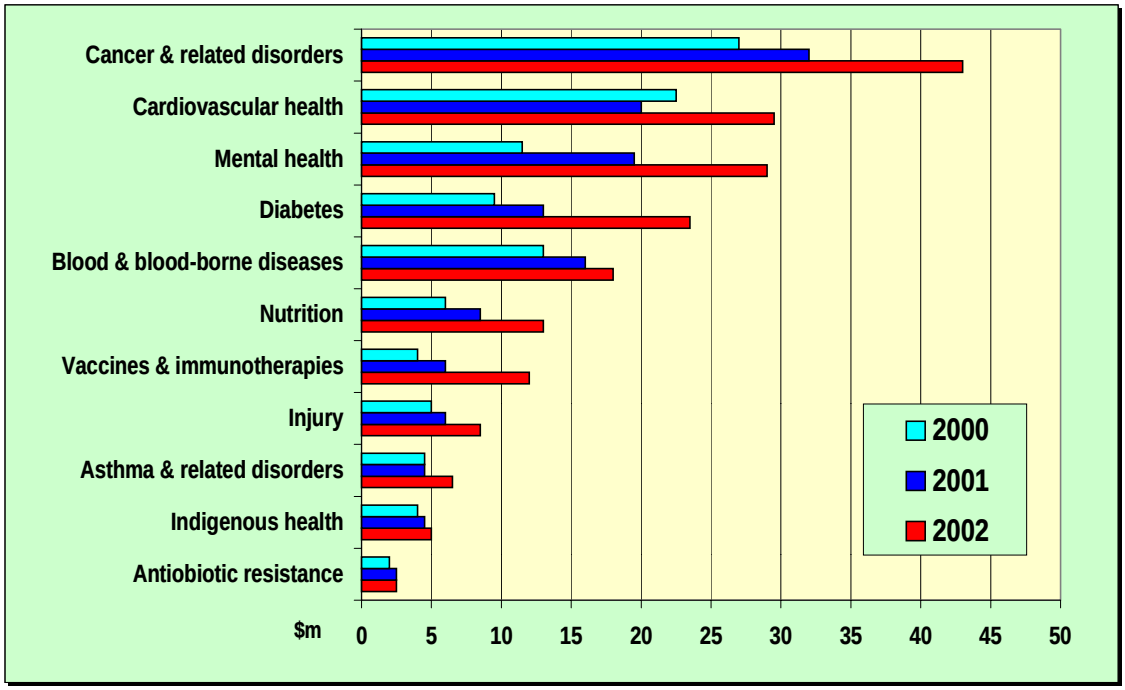
Figure 2 NHMRC research funding by broad research area, 2002



Source: NHMRC (2002), p42.

Figure 2 shows that over half of the NHMRC's funding is for basic science, reflecting its key public sector role of providing funding in areas where externalities are likely to be greatest, i.e. where the private sector is least likely to back R&D. A quarter of the $370m pie is for clinical R&D, with 14% for public health, 3% for health services and preventive medicine and 6% for other R&D.

Figure 3 Funding for indicative research areas, 2000-2002



Source: NHMRC (2002), p43.

Figure 3 shows funding in several areas of key research interest, and as such does not reflect the totality of NHMRC funding. It includes all NHMRC grant types except Block Funded Institutes, Transitional Institute Grants and Transitional Block Grants. The data reveal over $42m in funding for cancer and related disorders, nearly $30m each for cardiovascular health and mental health and over $20m for diabetes in 2002 (NHMRC, 2002).

A special data request from the NHMRC revealed the following breakdown of funding by specific institution for 2002, as shown in Table 3 and Figure 4, with the University of Melbourne receiving the most ($36.7m or 13.3% of the total). Overall, 93 institutions shared $276.4m of NHMRC institution funding in 2002. The top 15 institutions

received $227.3m (82%) of the institution funding. Funds spent through the NHMRC in 2002 are around 35% of the Commonwealth's total spend on health R&D – $800m in 2000-01 (Section 1.3.1).

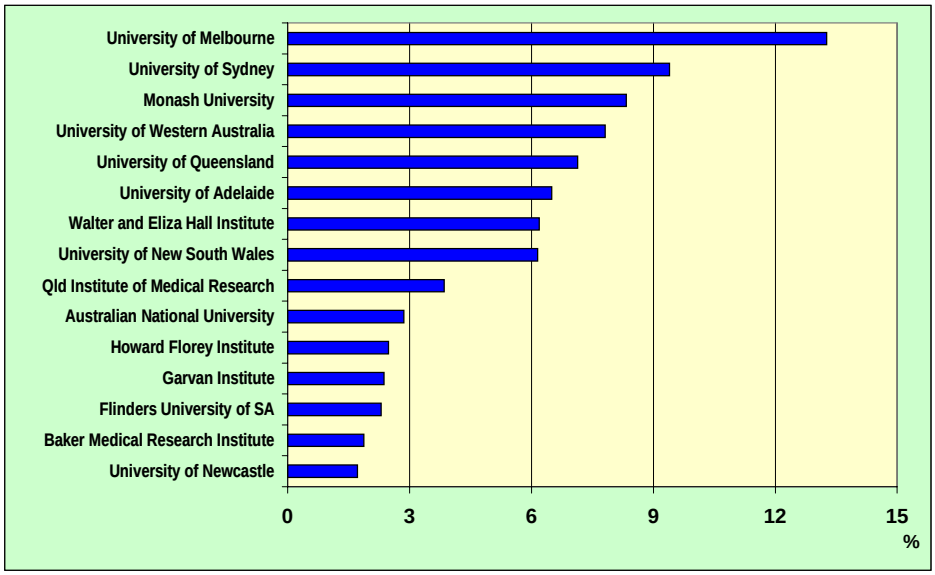
Table 3 Expenditure by the NHMRC on health R&D, by administering institution, Australia, 2002

Grand Total	**$276,406,713**	Mental Health Research Institute of Victoria	$402,169
University of Melbourne	$36,654,530	Centre for Eye Research Australia Ltd	$396,476
University of Sydney	$25,962,037	Repatriation General Hospital, Daw Park	$380,513
Monash University	$23,047,785	Mater Misericordiae Hospital / Mater Medical Research Institute	$343,281
University of Western Australia	$21,605,664	Melbourne Health	$341,154
University of Queensland	$19,725,749	University of South Australia	$338,190
University of Adelaide	$17,964,274	Peter MacCallum Cancer Institute	$332,437
Walter and Eliza Hall Institute	$17,110,850	Royal North Shore Hospital	$317,865
University of New South Wales	$16,993,159	Western Australian Institute for Medical Research	$316,717
Queensland Institute of Medical Research	$10,639,786	National Stroke Foundation	$315,262
Australian National University	$7,890,116	Edith Cowan University	$306,963
Howard Florey Institute	$6,858,631	Injury Prevention and Control (Australia) Ltd	$267,084
Garvan Institute of Medical Research	$6,546,304	NSW Cancer Council	$261,965
Flinders University of South Australia	$6,362,881	National Ageing Research Institute	$228,212
Baker Medical Research Institute	$5,174,758	Prince Charles Hospital	$225,990
University of Newcastle	$4,758,460	Alfred Hospital	$224,168
Centenary Institute	$3,732,938	The Dr Edward Koch Foundation Limited	$219,800
Prince Henry's Institute of Medical Research	$3,710,397	The Canberra Hospital	$200,351
Murdoch Childrens Research Institute	$3,472,516	University of Technology Sydney	$186,561
St. Vincent's Institute of Medical Research	$2,917,051	James Cook University	$183,901
La Trobe University	$2,206,954	Swinburne University	$142,884
Victor Chang Cardiac Research Institute	$2,204,622	Wesley Research Institute	$140,660
Children's Medical Research Institute	$2,118,621	Sir Charles Gairdner Hospital Perth	$130,207
Brain Research Institute	$1,886,535	South Western Sydney Area Health Service	$110,080
University of Tasmania	$1,729,233	Austin Hospital Medical Research Foundation	$90,440
Menzies School of Health Research	$1,627,874	Women's and Children's Hospital	$80,509
Ludwig Institute for Cancer Research	$1,327,796	Monash Medical Centre	$77,511
Griffith University	$1,271,393	Bionic Ear Institute	$75,110
Macfarlane Burnet Centre for Medical Research	$1,122,257	Institute of Dental Research	$71,000
Austin Research Institute	$1,117,279	Royal Brisbane Hospital	$60,000
Queensland University of Technology	$1,098,233	Royal Hobart Hospital	$60,000
Curtin University of Technology	$1,052,041	CSIRO ACT (Entomology)	$57,662
Westmead Hospital	$945,322	International Diabetes Institute Inc	$57,662
Deakin University	$907,233	Turning Point Alcohol and Drug Centre	$52,740
Royal Prince Alfred Hospital	$865,040	Ngaanyatjarra Health Service	$45,000
University of Wollongong	$841,523	Dental Health Services Victoria	$43,875
Heart Research Institute	$689,364	Child Health Research Institute Inc.	$40,000
Anti - Cancer Council of Victoria	$636,511	Royal Brisbane Hospital Research Foundation	$33,362
St. Vincent's Health	$588,670	Australian Institute of Criminology	$30,828
Institute of Medical and Veterinary Science	$492,381	University of New England	$30,110
Macquarie University	$478,574	Princess Alexandra Hospital	$27,793
Royal Adelaide Hospital	$474,907	The Queen Elizabeth Hospital	$27,793
The Children's Hospital Westmead	$463,466	South Eastern Sydney Area Health Service	$27,500
Royal Women's Hospital, Melbourne	$457,694	Victorian Infectious Diseases Reference Laboratory	$19,214
Victoria University of Technology	$452,259	Woorabinda Health Service	$14,520
Murdoch University	$444,531	Flinders Medical Centre	$4,088
Royal Melbourne Institute of Technology	$435,916	Royal Children's Hospital, Brisbane	$2,991

Source: NHMRC special data request.

Note: Represents funds expended by (not necessarily R&D conducted at) administering institutions.

Figure 4 Funding for NHMRC's 'top 15' research institutions, 2002 (acquitted), % total



Source: NHMRC special data request.

1.2.4 The Wills report

The Health and Medical Research Strategic Review was commissioned in March 1998 by the then Minister for Health, Dr Michael Wooldridge, to focus on the future role of health and medical research up to the year 2010. The Review was conducted by an eminent committee under the chairmanship of Mr Peter J Wills. The report of the committee, entitled '*The Virtuous Cycle: Working together for health and medical research*' provided some key findings and recommendations for policy action in Australia, many of which have been or are being implemented (Wills, 1998). Some of these are summarised below:

- Over the past 50 years, Australian researchers have made major contributions to medical breakthroughs in numerous areas, disproportionate to our relative size.
- The link between our health R&D capability and the delivery of health care is clear.
- Yet, despite the commitment of organisations such as the NHMRC, continuation of Australia's strong and long-standing international reputation may be under threat, due to a number of structural issues including:
  - *Difficulty in maintaining a skilled and motivated workforce in the face of low salary levels, job insecurity and uncertainty about the impact of research output;*
  - *A greater need for research that contributes directly to the health of the population and a well-functioning, evidence-based health system;*
  - *Barriers to Australia's ability to build an industry sector that mutually reinforces the contribution of research and government;*
  - *A lack of understanding of the returns to the community through appropriate levels of government investment in health R&D; and*
  - *The outlook of health R&D lies not only in greater government investment, but also in establishing the* links between public funding, research and the commercialisation of findings through industry. A virtuous cycle must be nurtured linking government, researchers and industry.

The final report, presented to the Minister in April 1999, contained some 120 strategic recommendations for improving Australia's health R&D workforce. Those recommendations, and the arguments in support of them, formed a compelling blueprint for change including the injection of an additional $614m for health R&D by the Federal Government, now being implemented (Section 1.2.3). This cash injection doubles the Commonwealth's contribution to health R&D channelled through the NHMRC.

Following from the Wills Report, the Government's Implementation Committee Report focuses on the strategic issues required to build the collaborations and partnerships needed to engage the States and industry in a coordinated, whole-of-government approach to health R&D. The Government referred 56 of the 120 recommendations to the NHMRC, the majority of which have now been implemented.[2] The NHMRC response has been published in the Report entitled 'Health and Medical Research Strategic Review, Implementation of the Government's Response, Final Report, October 2000' (NHMRC, 2000). In implementing the recommendations of the Review, the NHMRC has made many changes to the way it fulfils its role, including:

- **Research outcome evaluation**: a new model for performance reporting, linking outputs with inputs;
- **Funding system**: reshaping the funding and grant assessment procedures;
- **World class research capacity**: strategies to promote health R&D as a career choice, improve training opportunities, involve clinicians more, provide national facilities and encourage investment in infrastructure;
- **Priority driven research**: development of a consultative framework to identify strategic priorities;
- **Translation of research into policy and practice**: development of processes to utilise expertise of the research sector, consumer groups and government to develop policy advice, including legislative changes;
- **Effective health ethics review system**: consistent implementation and standardisation of ethical review, especially multi-centre trials and use of genetic information;
- **Community participation**: measures to attract greater community representation on committees, work programs and grant assessment procedures, especially indigenous participation;
- **Technology transfer and research commercialisation**: guidelines for intellectual property management, introduction of Development Grants and Industry Fellowships, with the possibility of Research Management Training Schemes;
- **International cooperation**: developing closer links with the Department of Industry, Science and Resources and the Australian Academy of Science to increase international researcher exchange and to build international collaborative research links;
- **Office of the NHMRC**: creation of a CEO position and more independent operation of the NHMRC.

1.2.5 Other organisations

The **Australian Research Council** (ARC) is an independent statutory authority, reporting to the Minister for Education, Science and Training. The ARC provides advice to the Government on national research investments and manages the National Competitive Grants Program. More specifically, the ARC supports high quality research and training through national competition in all fields of science, social sciences and humanity and brokers partnerships between researchers and industry, government, community organisations and international organisations.

In 2002, the ARC was budgeted to invest over $272m, which is a 10% increase on 2001. Strong future funding growth is also budgeted (Table 4) following from the Federal Government's 2001 innovation action plan, *Backing Australia's Ability,* doubling the ARC's available research funds by 2006. The ARC has been directed to allocate 33% of their funds available under the National Competitive Grants Program to four areas of priority research. These are nano-materials and bio-materials; genome/phenome research; complex/intelligent systems; and photon science and technology.

Table 4 ARC budget

	2002	2003	2004	2005
ARC Budget ($m)	272	356	404	461
Growth	10%	31%	13%	14%

Source: ARC Annual Report, 2001-02; ARC Strategic Action Plan, 2003-05.

[2] The remaining recommendations were referred to other Commonwealth agencies, including the Strategic Review Implementation Committee which was established to consider a number of recommendations that required a whole-of-government approach.

In terms of funding for the medical and health sciences, Table 5 details new ARC funding for the 2001-02 year ($103m) and that expected for the following 4 year period ($366m). Of all new funding in 2001-02, 3.9% went to the medical and health sciences discipline. This is expected to grow to 4.2% over the next few years.

Table 5 New ARC funding for medical and health sciences ($)

Program	2001-02			2002-03 to 2005-06		
	Medical & health sciences	Total funding	% Medical & health sciences	Medical & health sciences	Total funding	% Medical & health sciences
Discovery projects	1,695,572	57,291,589	3.0%	6,931,487	200,032,817	3.5%
Research/Federation fellowships	816,790	18,526,214	4.4%	4,095,372	80,461,838	5.1%
Linkage projects*	1,544,946	27,389,492	5.6%	4,492,592	85,300,871	5.3%
Total	**4,057,308**	**103,207,295**	**3.9%**	**15,519,451**	**365,795,526**	**4.2%**

* Funding for infrastructure is not included due to lack of data for 2002-06.
Note that there is likely to be funding for the health and medical area in other disciplines, in addition to that which can be separately identified as above.
Source: ARC Annual Report 2001-02

The **Commonwealth Scientific and Industrial Research Organisation** (CSIRO) is Australia's national science agency. It carries out research and development in many industries, including health. Worldwide, the CSIRO is involved in 700 current, or recently completed, research activities.

In 2001-02 the CSIRO was provided with $612m of federal government funding, of which $511m was invested in R&D. The organisation generates an additional $300m in external earnings. Planned expenditure in 2001-02 was $722m (Table 6). The three areas of work for the CSIRO are:

- Strategic R&D – which is directed toward national priority research areas. By 2005-06 the CSIRO will allocate up to 40% of allocated funding toward these programs, and 15% to emerging science areas;
- Research services/consulting/testing – the CSIRO works closely with industry;
- Licensing, patenting and other spin-offs – the CSIRO is Australia's leading patenting enterprise, holding over 3,500 granted or pending patents.

In the health area, the CSIRO has a Pharmaceuticals and Human Health division with at stated mission of 'better medicines for common illnesses'. Current research areas include biomaterials, cancer, cardiovascular disease, diabetes, diagnostics, generic pharmaceutical discovery and tissue growth and repair.

Table 6 CSIRO expenditures ($'000)

Sector	2000-01		2001-02		2002-03	
	Appropriation investment	Planned Expenditure	Appropriation investment	Planned Expenditure	Appropriation investment	Planned Expenditure
Pharmaceuticals & Human Health	19,437	30,805	20,437	32,416	21,517	33,586
All other sectors	419,896	676,925	421,350	689,513	424,550	700,860
Total all sectors	**439,333**	**707,730**	**441,787**	**721,929**	**446,067**	**734,446**

Source: CSIRO Strategic Research Plan 2000-01 to 2002-03

Cooperative Research Centres (CRCs) are funded by the Commonwealth Government and were established in 1990. CRCs bring together researchers from government agencies, private industry, universities, the CSIRO and other public sector agencies to collaborate on R&D activities. As of July 2002, there were 62 CRCs operating. Of these, 9 are in the field of medical science and technology. The average budget of a CRC is $7m, with an average funding level of $2.45m per annum.

1.3 HEALTH R&D IN AUSTRALIA

For the reasons outlined in the previous section, this analysis bases its estimates of total Australian health R&D and its composition on the ABS SEO data. Section 1.3.1 looks at the most recent year for which this data are available (2000-01), while Section 1.3.2 looks at historical trends in both aggregates and sub-components.

Health R&D was $1.7bn in 2000-01. Universities & business performed 70% of the R&D. Nearly half was Commonwealth funded.

1.3.1 2000-01

Table 7 and Figure 5 show health R&D (SEO) by sector and source of funds – $1.7bn was spent in 2000-01. Nearly half (45%) was performed by higher education facilities, while a further quarter was performed by private businesses. PNP organisations performed 15%, while State, Territory and local government bodies performed 12%. Commonwealth R&D facilities only performed 3% of the total R&D.

In terms of financing R&D, the Commonwealth provided nearly half (47%) of the funds ($800m) in 2000-01. Business provided a further quarter of the funds ($420m), mainly financing its own R&D activities – see Table 8. Other Australian sources (mainly philanthropic organisations and individuals) funded 13%, while State, Territory and local governments funded 9%. 7% of Australian health R&D was funded from overseas.

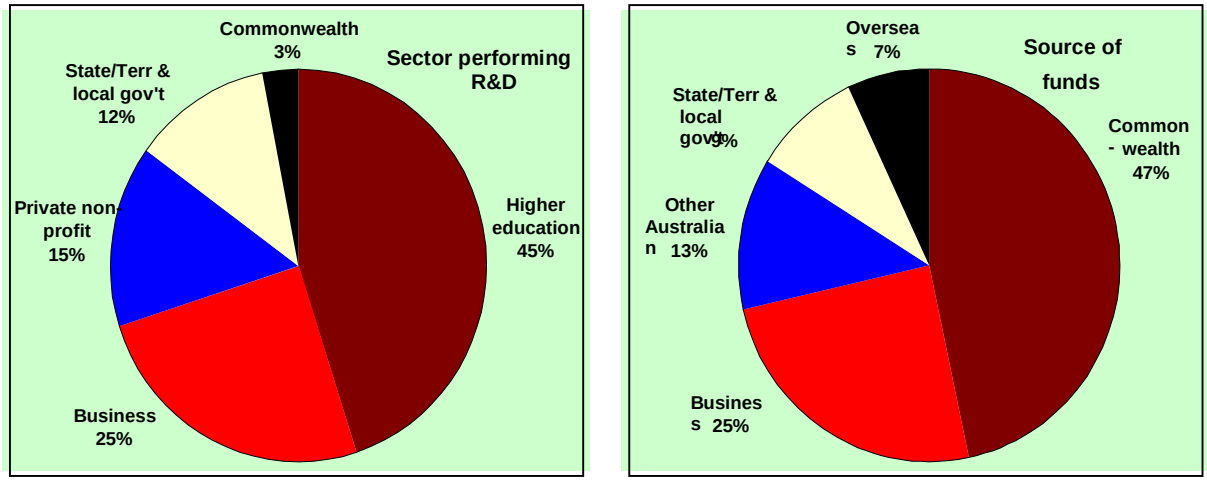
In Australia, 60% ($1.03bn in 2000-01) of health R&D activity was performed in the public sector (including universities) although that sector funded a slightly lower proportion (56% or $0.95bn). The private sector was a smaller player, funding relatively more R&D (44% or $0.76bn) than it performed (40% or $0.68bn).

Table 7 Australian health R&D (SEO), by sector and source of funds, $'000, 2000-01

	Public sector sources			Private sector sources				Total	
Sector performing the R&D	**Common-wealth**	**State/Terr & local govt**	**Total**	**Business**	**Other Aust**	**Over-seas**	**Total**	**$'000**	**% Total**
Commonwealth	43,754	941	44,696	5,551	2,191	832	8,574	**53,270**	3.1%
State/Territory/local	36,730	91,911	128,641	27,393	38,360	6,887	72,640	**201,281**	11.8%
Higher education	622,916	31,156	654,072	43,069	47,215	26,851	117,135	**771,207**	45.1%
Public Sector	**703,400**	**124,009**	**827,409**	**76,012**	**87,766**	**34,570**	**198,349**	**1,025,757**	**60.0%**
Business	28,818	3,840	32,658	327,151	-	66,060	393,211	**425,869**	24.9%
PNP	67,514	25,986	93,501	16,678	128,476	19,451	164,604	**258,105**	15.1%
Private Sector	**96,332**	**29,827**	**126,159**	**343,829**	**128,476**	**85,511**	**557,815**	**683,974**	**40.0%**
Grand Total	***799,732***	***153,835***	***953,567***	***419,841***	***216,242***	***120,081***	***756,164***	***1,709,731***	***100.0%***
% of total	46.8%	9.0%	55.8%	24.6%	12.6%	7.0%	44.2%	100.0%	

Source: Access Economics, derived from ABS special data request.

Figure 5 Australian health R&D (SEO), by sector and source of funds, %, 2000-01



Source: Access Economics, derived from ABS special data request.

Table 8 provides further detail of the financing components, looking more closely at how the financiers prefer to distribute their funds to research performers.

Table 8 Australian health R&D (SEO), % of total source of funds, 2000-01

	Public sector sources			Private sector sources				Total
Sector performing the R&D	**Common-wealth**	**State/Terr & local govt**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**% Total**
Commonwealth	**5.5%**	0.6%	4.7%	1.3%	1.0%	0.7%	1.1%	3.1%
State/Territory/local	4.6%	**59.7%**	13.5%	6.5%	17.7%	5.7%	9.6%	11.8%
Higher education	77.9%	20.3%	68.6%	10.3%	21.8%	22.4%	15.5%	45.1%
Public Sector	**88.0%**	**80.6%**	**86.8%**	**18.1%**	**40.6%**	**28.8%**	**26.2%**	**60.0%**
Business	3.6%	2.5%	3.4%	**77.9%**	0.0%	55.0%	52.0%	24.9%
PNP	8.4%	16.9%	9.8%	4.0%	**59.4%**	16.2%	21.8%	15.1%
Private Sector	**12.0%**	**19.4%**	**13.2%**	**81.9%**	**59.4%**	**71.2%**	**73.8%**	**40.0%**
Grand Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Access Economics, derived from ABS special data request. Intrasectoral investment boxed.

- As observed above, Australian businesses perform and finance one quarter of Australian health R&D. However, 22% of their finance is channelled to external R&D performers – 10.3% ($43m) to universities, 6.5% ($27m) to State, Territory and local government facilities, 4.0% (nearly $17m) to non-profit research institutions and 1.3% ($5.5m) to Commonwealth R&D bodies.
- Private philanthropic organisations tend to fund non-profit research bodies (59% or $128m). However, of the total $216m that they provided in 2000-01, $47m (21.8%) went to university R&D, and $38m (17.7%) to State, Territory and local government bodies. Only 1% went to Commonwealth R&D and none to business.
- Of all Commonwealth finance ($800m), most as expected was directed to university R&D (78% or $623m), with 5.5% ($44m) to other Commonwealth performers. Of the remaining 13%, most went to non-profit research institutes (over $67m or 8.4%), with 4.6% ($37m) to State, Territory and local government bodies and to 3.6% ($29m) to business R&D.
- Of all State, Territory and local government financed projects, nearly 60% ($92m) were intrasectoral, with a further 20% ($31m) directed to Universities. Nearly 17% ($26m) went to PNP organisations, with a very small amount invested in business R&D (under $4m or 2.5%) and almost nothing in Commonwealth projects (less than $1m or 0.6%).
- Overseas financiers directed over half ($66m or 55%) of their investment in Australian health R&D to the business sector; it is expected that a substantial proportion of these flows were direct foreign investment from multinational parent companies. Global corporations and foreign philanthropic organisations such as, for example, the Wellcome Trust, invested $27m (22%) into Australian University research and a further $19.5m (16%) into Australian not-for-profit R&D. Again only small amounts were direct to Commonwealth (under $7m or 5.7%) and State, Territory and local government R&D (under $1m or 0.7%).

Table 9 illustrates relative financing by source of funds for each sector's R&D portfolio.

Table 9 Australian health R&D (SEO), % of total sectoral finance, 2000-01

	Public sector sources			Private sector sources				Total
Sector performing the R&D	**Common-wealth**	**State/Terr & local govt**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**% Total**
Commonwealth	**82.1%**	1.8%	83.9%	10.4%	4.1%	1.6%	16.1%	100.0%
State/Territory/local	18.2%	**45.7%**	63.9%	13.6%	19.1%	3.4%	36.1%	100.0%
Higher education	80.8%	4.0%	84.8%	5.6%	6.1%	3.5%	15.2%	100.0%
Public Sector	**68.6%**	**12.1%**	**80.7%**	**7.4%**	**8.6%**	**3.4%**	**19.3%**	**100.0%**
Business	6.8%	0.9%	7.7%	**76.8%**	0.0%	15.5%	92.3%	100.0%
PNP	26.2%	10.1%	36.2%	6.5%	**49.8%**	7.5%	63.8%	100.0%
Private Sector	**14.1%**	**4.4%**	**18.4%**	**50.3%**	**18.8%**	**12.5%**	**81.6%**	**100.0%**
Grand Total	***46.8%***	***9.0%***	***55.8%***	***24.6%***	***12.6%***	***7.0%***	***44.2%***	***100.0%***

Source: Access Economics, derived from ABS special data request. Intrasectoral finance boxed.

- Universities, the biggest performers of health R&D in Australia, sourced 81% ($623m) of their finance from the Commonwealth and 4% ($31m) from State, Territory and local governments. The remaining 15% of finance was from Australian philanthropy ($47m or 6.1%), Australian business ($43m or 5.6%) and overseas sources ($27m or 3.5%).
- Australian businesses, the second largest performers of health R&D in Australia, sourced 77% ($327m) of their finance intrasectorally in Australia and 15.5% ($66m) from overseas. The remaining 8% of finance was from Commonwealth ($29m or 6.8%) and State, Territory and local governments (under $4m and less than 1%).
- The PNP R&D institutes sourced half of their funding intrasectorally in Australia ($128m) with a further 26% ($67m) from the Commonwealth government. The remaining quarter was from State, Territory and local governments ($26m or 10%), overseas ($19.5m or 7.5%) and from Australian businesses ($16.7m or 6.5%).
- Commonwealth R&D performers were overwhelmingly Commonwealth-financed (82%) with 10% from Australian businesses.
- However, State, Territory and local government R&D performers received less than half (46%) of their funding intrasectorally; 19% was from Australian philanthropy, 18% from the Commonwealth government, 13.6% from Australian business and 3.4% from overseas.

The ABS has also provided data for Australian health R&D (on a socio-economic objective basis) by broad category (Section 1.1.3 and Table 1 for methodology). Table 10 shows that, for the year 2000-01, of the total $1.7bn of health R&D in Australia, over half (57.4%) was clinical research, nearly one fifth (19.1%) was research for public health, 12.8% was for pharmaceuticals, and 10.6% was for health and support services. However these shares, as expected, varied considerably depending on who performed the research.

Table 10 Australian health R&D (SEO), by broad category, $'000 & % total, 2000-01

Sector performing the R&D	670400 Human Pharma-ceutical products		730100 Clinical (organs, disease & conditions)		730200 Public health		730300 Health and support services		Total
	$m	% Total	$m	% Total	$m	% Total	$m	% Total	$m
Commonwealth	34,037	63.9%	5,959	11.2%	9,858	18.5%	3,416	6.4%	53,270
State/Territory/ local	7,511	3.7%	130,647	64.9%	43,014	21.4%	20,109	10.0%	201,281
Higher education	26,909	3.5%	431,304	55.9%	187,056	24.3%	125,937	16.3%	771,207
Public Sector	**68,457**	**6.7%**	**567,910**	**55.4%**	**239,929**	**23.4%**	**149,462**	**14.6%**	**1,025,757**
Business	149,806	35.2%	215,742	50.7%	30,991	7.3%	29,330	6.9%	425,869
PNP	1,226	0.5%	198,258	76.8%	55,540	21.5%	3,081	1.2%	258,105
Private Sector	**151,032**	**22.1%**	**414,001**	**60.5%**	**86,531**	**12.7%**	**32,411**	**4.7%**	**683,974**
Grand Total	***219,489***	***12.8%***	***981,910***	***57.4%***	***326,459***	***19.1%***	***181,873***	***10.6%***	***1,709,731***
	% of column totals								
Commonwealth		15.5%		0.6%		3.0%		1.9%	3.1%
State/Territory/ local		3.4%		13.3%		13.2%		11.1%	11.8%
Higher education		12.3%		43.9%		57.3%		69.2%	45.1%
Public Sector		**31.2%**		**57.8%**		**73.5%**		**82.2%**	**60.0%**
Business		68.3%		22.0%		9.5%		16.1%	24.9%
PNP		0.6%		20.2%		17.0%		1.7%	15.1%
Private Sector		**68.8%**		**42.2%**		**26.5%**		**17.8%**	**40.0%**
Grand Total		***100.0%***		***100.0%***		***100.0%***		***100.0%***	***100.0%***

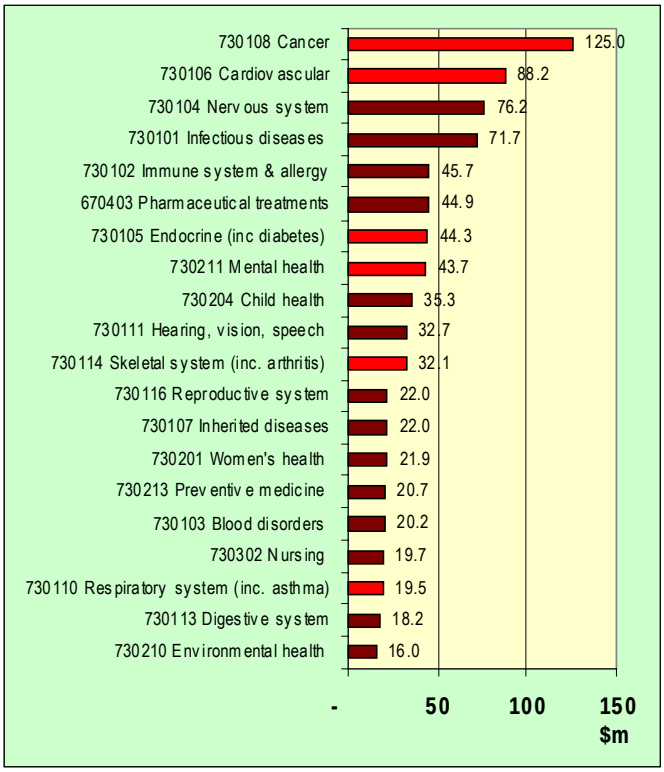
Source: Access Economics, derived from ABS special data request.

- Businesses performed $150m of pharmaceutical R&D, a larger than average proportion (35% compared with 12.8%) and 68% of all pharmaceutical R&D. However, half of business R&D was clinical ($215m).
- The Commonwealth focussed mainly on pharmaceuticals (64% or $34m) and public health (18.5% or $10m).
- PNP institutes focused about 3:1 on clinical and public health R&D, performing almost no pharmaceutical R&D.

- State, Territory and local government bodies performed mainly clinical and public health R&D (65% and 21%).
- Universities placed a relatively greater emphasis on public health and health and support services than the other sectors, performing 57% and 69% of that R&D, respectively. They maintained their share (44%) of clinical research and performed relatively less on pharmaceutical R&D (12%).
- The public sector, whose average share was 60%, performed relatively less of the pharmaceutical R&D (31%) and relatively more of public health R&D (74%) and health and support services R&D (82%), reflecting relative externalities in commercialising the different types of R&D.
- Conversely, the private sector performed relatively more R&D than its average share (40%) in areas more able to be commercialised – pharmaceuticals (69%) and clinical R&D (42%).

Detailed data for 2000-01 by class category are provided in the Appendix (Table 46 and Table 47). A summary of the top 15 class categories from the Appendix Tables is provided below in Figure 6, necessarily excluding the business sector as it is not available at class category level. Nonetheless the data reflect three quarters of Australian R&D ($1.28bn of the total $1.71bn), and a notional allocation including business sector estimates by class category is provided in Table 11.

Figure 6 Top 20 class categories for health (SEO) R&D excluding businesses, 2000-01, Australia



Source: Access Economics, derived from ABS special data request.

Major features of the data (excluding business) are:

- Cancer is the leading research area, with $125m of non-business R&D in 2000-01, nearly 10% of the total;
- Cardiovascular R&D is second, with $88m (7% of the total);
- Next is R&D relating to the nervous system and infectious diseases (each just under 6% of the total), followed by that relating to the immune system;
- National health priority areas are highlighted (red) – cancer, cardiovascular disease, diabetes, mental health, musculoskeletal disease and asthma; only R&D regarding accidents and injury do not make the 'top 20' here;
- Of the top 20 areas, 13 are clinical (including the top 5), 5 are public health areas, while there is one category each from health and support services and from human pharmaceutical products.

For interest we have estimated a notional allocation of the business sector, allocating each broad business category to class categories using the distribution of the expenditure of the other sectors as weights, to derive estimates for total R&D in Australia, all sectors, by class category, for 2000-01 (Table 11).

Table 11 Health R&D, all sectors, allocated by class category, 2000-01, Australia

Rank	Category	Allocated $'000	% Allocated Total
1	**730108 Cancer and related disorders**	**160,154**	**9.4%**
2	670403 Treatments (e.g. chemicals, antibiotics)	141,492	8.3%
3	**730106 Cardiovascular system and diseases**	**113,030**	**6.6%**
4	730104 Nervous system and disorders	97,599	5.7%
5	730101 Infectious diseases	91,952	5.4%
6	730102 Immune system and allergy	58,624	3.4%
7	**730105 Endocrine organs and diseases (inc diabetes)**	**56,780**	**3.3%**
8	**730211 Mental health**	**48,261**	**2.8%**
9	730111 Hearing, vision, speech and their disorders	41,970	2.5%
10	**730114 Skeletal system and disorders (inc arthritis)**	**41,174**	**2.4%**
11	730204 Child health	39,020	2.3%
12	670401 Prevention - biologicals (e.g. vaccines)	33,572	2.0%
13	730116 Reproductive system and disorders	28,207	1.6%
14	730107 Inherited diseases (inc gene therapy)	28,175	1.6%
15	730103 Blood disorders	25,931	1.5%
16	670402 Diagnostics	25,850	1.5%
17	**730110 Respiratory system and diseases (inc asthma)**	**24,981**	**1.5%**
18	730201 Women's health	24,228	1.4%
19	730302 Nursing	23,544	1.4%
20	730113 Digestive system and disorders	23,352	1.4%
21	730213 Preventive medicine	22,909	1.3%
22	730210 Environmental health	17,689	1.0%
23	730205 Substance abuse	16,554	1.0%
24	730303 Occupational, speech and physiotherapy	16,438	1.0%
25	730301 Health education and promotion	16,350	1.0%
26	730109 Surgical methods and procedures	15,996	0.9%
27	730118 Organs, diseases and abnormal conditions nec	15,466	0.9%
28	730203 Health related to ageing	14,640	0.9%
29	730219 Behaviour and health	13,192	0.8%
30	730206 Aboriginal and Torres Strait Islander health	13,009	0.8%
31	730306 Evaluation of health outcomes	12,384	0.7%
32	730112 Oro-dental and disorders	12,138	0.7%
33	730208 Occupational health (exc economic development aspects)	10,679	0.6%
34	730305 Diagnostic methods	9,601	0.6%
35	730115 Urogenital system and disorders	9,368	0.5%
36	730117 Skin and related disorders	8,567	0.5%
37	730215 Nutrition	8,098	0.5%
38	730212 Disease distribution and transmission	7,131	0.4%
39	730307 Health policy evaluation	7,009	0.4%
40	730308 Health policy economic outcomes	6,758	0.4%
41	730209 Rural health	6,249	0.4%
42	730216 Food safety	6,045	0.4%
43	730214 Dental health	5,659	0.3%
44	730217 Health status (e.g. indicators of well-being)	5,369	0.3%
45	730202 Men's health	5,326	0.3%
46	730304 Palliative care	3,851	0.2%
47	730218 Social structure and health	3,668	0.2%
48	730220 Injury control	3,539	0.2%
49	730207 Health related to specific ethnic groups	2,219	0.1%
	730399 Health and support services nec	72,930	4.3%
	730199 Clinical health nec	67,592	4.0%
	730100 Clinical, not allocated	60,854	3.6%
	730299 Public health nec	30,624	1.8%
	730200 Public health, not allocated	22,350	1.3%
	670499 Other pharmaceutical nec	15,044	0.9%
	730300 Health and support services, not allocated	13,009	0.8%
	670400 Human pharmaceutical products, not allocated	3,531	0.2%
	Grand total	**1,709,731**	**100.0%**

Source: Access Economics, derived from ABS special data request.

Including the business sector, we observe in the top 20:

- R&D for pharmaceutical treatments (previously 6th) has moved up to second place;
- The order of other items has not changed substantially (partially a product of the weighting assumptions in relation to clinical R&D), although the magnitude increases;
- Child health moves from 9th place to 11th, with hearing, vision and speech R&D and musculoskeletal R&D both moving up slightly;
- R&D for biological prevention (e.g. vaccines) becomes a new item in 12th place, while R&D for better diagnostics become a new item in 16th place;
- Women's health (14th to 18th) and Preventive medicine (15th to 21st) slip relatively in the order, and Environmental health R&D also slips out of the top 20.

1.3.2 Historical analysis

Two-year data for Australian health R&D are shown in Table 12, in nominal terms, highlighting annualised growth rates and changes in the relative shares of the sectors over the period. Nominal growth averaged 10.7% p.a. over the period 1992-93 to 2000-01, driven by the private sector (14.3% p.a.). Non-profit institutes were the fastest growing (14.9% p.a.), while Commonwealth growth was negative (-0.6% p.a.). As a result, the Commonwealth's share in total R&D fell from 7.5% to 3.1% over the period, along with the share of other tiers of Government (15.2% to 11.8%). Universities' share also declined very slightly (46.2% to 45.1%), resulting in an overall reduction in the public sector's share of R&D from 68.8% to 60.0%. Conversely, the private sector grew from 31.2% to 40.0%, with business increasing from one-fifth to one quarter and the non-profits increasing from 11.3% to 15.1%.

The public sector share of R&D has fallen from 69% to 60% between 1992-93 and 2000-01

Table 12 Australian health R&D (SEO) by sector, nominal, 1992-93 to 2000-01

Sector $'000	**1992-93**	**1994-95**	**1996-97**	**1998-99**	**2000-01**
Commonwealth	57,179	66,232	51,630	57,008	53,270
State/Territory/local	115,925	186,749	168,993	167,895	201,281
Higher education	352,267	404,019	537,127	647,610	771,207
Subtotal Public	**525,370**	**657,000**	**757,749**	**872,513**	**1,025,757**
Business	151,911	226,497	257,246	304,641	425,869
PNP	85,856	132,728	169,290	197,642	258,105
Subtotal Private	**237,767**	**359,225**	**426,536**	**502,284**	**683,974**
Grand Total	***763,137***	***1,016,225***	***1,184,285***	***1,374,797***	***1,709,731***
Nominal growth pa	**1992-93 to 2000-01**	**1992-93 to 1994-95**	**1994-95 to 1996-97**	**1996-97 to 1998-99**	**1998-99 to 2000-01**
Commonwealth	-0.6%	7.6%	-11.7%	5.1%	-3.3%
State/Territory/local	7.8%	26.9%	-4.9%	-0.3%	9.5%
Higher education	10.3%	7.1%	15.3%	9.8%	9.1%
Subtotal Public	**8.7%**	**11.8%**	**7.4%**	**7.3%**	**8.4%**
Business	13.9%	22.1%	6.6%	8.8%	18.2%
PNP	14.9%	24.3%	12.9%	8.1%	14.3%
Subtotal Private	**14.3%**	**22.9%**	**9.0%**	**8.5%**	**16.7%**
Grand Total	***10.7%***	***15.4%***	***8.0%***	***7.7%***	***11.5%***
% of Total	**1992-93**	**1994-95**	**1996-97**	**1998-99**	**2000-01**
Commonwealth	7.5%	6.5%	4.4%	4.1%	3.1%
State/Territory/local	15.2%	18.4%	14.3%	12.2%	11.8%
Higher education	46.2%	39.8%	45.4%	47.1%	45.1%
Subtotal Public	**68.8%**	**64.7%**	**64.0%**	**63.5%**	**60.0%**
Business	19.9%	22.3%	21.7%	22.2%	24.9%
PNP	11.3%	13.1%	14.3%	14.4%	15.1%
Subtotal Private	**31.2%**	**35.3%**	**36.0%**	**36.5%**	**40.0%**
Grand Total	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Removing the effects of inflation (using AIHW health inflation data), Table 13 shows real growth in health R&D. In real terms, R&D activity grew by 8.5% p.a. over 1992-93 to 2000-01, with 6.6% p.a. from the public sector and a healthy 12.2% p.a. from the private sector.

Table 13 Australian health R&D (SEO) by sector, real growth, 1992-93 to 2000-01

Real growth pa	1992-93 to 2000-01	1992-93 to 1994-95	1994-95 to 1996-97	1996-97 to 1998-99	1998-99 to 2000-01
Commonwealth	-2.7%	6.7%	-14.0%	3.1%	-6.6%
State/Territory/local	5.7%	26.0%	-7.1%	-2.3%	6.2%
Higher education	8.2%	6.1%	13.1%	7.8%	5.9%
Subtotal Public	**6.6%**	**10.9%**	**5.1%**	**5.3%**	**5.2%**
Business	11.8%	21.2%	4.3%	6.8%	15.0%
PNP	12.8%	23.4%	10.7%	6.1%	11.0%
Subtotal Private	**12.2%**	**22.0%**	**6.7%**	**6.5%**	**13.4%**
Grand Total	***8.5%***	***14.4%***	***5.7%***	***5.7%***	***8.3%***
Average health deflator	2.1%	1.0%	2.3%	2.0%	3.3%

Source: Access Economics, derived from ABS special data request. Average health deflator derived from AIHW (2002), Table 5.

Health R&D also increased relative to GDP over the period, from 0.18% of GDP in 1992-93 to 0.26% of GDP in 2000-01. In nominal terms, we spent $88 per person on health R&D p.a. in 2000-01, more than double the $43 per person spent in 1992-93. Table 14 provides further detail.

Table 14 Australian health R&D (SEO) by sector, %GDP and per capita, 1992-93 to 2000-01

% of GDP	1992-93	1994-95	1996-97	1998-99	2000-01
Commonwealth	0.013%	0.014%	0.010%	0.010%	0.008%
State/Territory/local	0.027%	0.040%	0.032%	0.028%	0.030%
Higher education	0.083%	0.086%	0.101%	0.109%	0.115%
Subtotal Public	**0.123%**	**0.139%**	**0.143%**	**0.147%**	**0.153%**
Business	0.036%	0.048%	0.049%	0.051%	0.064%
PNP	0.020%	0.028%	0.032%	0.033%	0.039%
Subtotal Private	**0.056%**	**0.076%**	**0.080%**	**0.085%**	**0.102%**
Grand Total	***0.179%***	***0.216%***	***0.223%***	***0.232%***	***0.255%***
$ per capita (nominal)					
Commonwealth	$3.24	$3.66	$2.79	$3.01	$2.75
State/Territory/local	$6.56	$10.33	$9.12	$8.87	$10.38
Higher education	$19.94	$22.36	$29.00	$34.20	$39.78
Subtotal Public	**$29.74**	**$36.36**	**$40.91**	**$46.07**	**$52.91**
Business	$8.60	$12.53	$13.89	$16.09	$21.97
PNP	$4.86	$7.34	$9.14	$10.44	$13.31
Subtotal Private	**$13.46**	**$19.88**	**$23.03**	**$26.52**	**$35.28**
Grand Total	***$43.20***	***$56.23***	***$63.93***	***$72.60***	***$88.19***

Source: Access Economics, derived from ABS special data request. GDP series for the years 1992-93, 1994-95, 1996-97, 1998-99, 2000-01, is 426,231, 471,349, 529,885, 591,916 and 669,307 ($m). Population series for the same years at end-June is 17,667, 18,072, 18,524, 18,937 and 19,387 ('000 people).

Turning to changes in financing of health R&D over the period, Table 15 shows trends in nominal terms, as well as nominal and real growth, relative shares of total financing, shares of GDP and per capita financing by source of funds.

- Again the diminishing importance of the public sector is evident, with its share in total finance falling from 63% in 1992-93 to 56% in 2000-01, but nonetheless with real growth of 6.7% p.a. Finance from each tier of government grew at a similar rate.
- Private sector finance grew at 13.3% p.a. (11.1% p.a. in real terms), almost all due to the marked rise in overseas finance albeit from a small base. Overseas finance grew from $13.3m (1.7%) in 1992-93 to over $120m (7.0%) in 2000-01, increasing by nearly one third each year.
- Australian business investment in health R&D was also quite strong, averaging 11.8% p.a. over the period (9.7% p.a. real growth), with a small increase in its share.

- Australian philanthropic financing grew at a similar rate – 11.2% p.a. and 9.0% p.a. respectively, to maintain its share of total R&D finance.
- Relative to GDP, public finance of R&D grew from 0.114% in 1992-93 to 0.142% in 2000-01. Private finance doubled over the period relative to GDP, from 0.065% to 0.113%.
- Public and private finance also both increased relative to the population, nearly doubling for the public sector and more than doubling for the private sector (in current prices). Overseas finance increased from 75 cents per Australian in 1992-93 to $6.19 per Australian in 2000-01. Australian business pay nearly $22 for every Australian in health R&D, while the Commonwealth pays $41.

Table 15 Australian health R&D (SEO) by source of funds, 1992-93 to 2000-01

	Public sector sources			Private sector sources				
Year Current $'000	Common-wealth	State/Terr & local	Total	Business	Other Aust	Overseas	Total	*Total*
1992-93	405,343	78,631	**483,974**	172,388	93,461	13,314	**279,164**	***763,137***
1994-95	470,372	143,136	**613,508**	234,236	130,608	37,874	**402,717**	***1,016,225***
1996-97	563,618	n.p.	**n.p.**	305,541	151,083	n.p.	**n.p.**	***1,184,285***
1998-99	660,459	138,293	**798,752**	338,913	170,281	66,851	**576,045**	***1,374,797***
2000-01	799,732	153,835	**953,567**	419,841	216,242	120,081	**756,164**	***1,709,731***
Nominal growth pa								
1992-93 to 1994-95	7.7%	34.9%	**12.6%**	16.6%	18.2%	68.7%	**20.1%**	***15.4%***
1995-96 to 1996-97	9.5%	n.p.	**n.p.**	14.2%	7.6%	n.p.	**n.p.**	***8.0%***
1997-98 to 1998-99	8.3%	n.p.	**n.p.**	5.3%	6.2%	n.p.	**n.p.**	***7.7%***
1999-00 to 2000-01	10.0%	5.5%	**9.3%**	11.3%	12.7%	34.0%	**14.6%**	***11.5%***
1992-93 to 2000-01	**8.9%**	**8.8%**	**8.8%**	**11.8%**	**11.2%**	**31.6%**	**13.3%**	***10.7%***
% of Total								
1992-93	53.1%	10.3%	**63.4%**	22.6%	12.2%	1.7%	**36.6%**	***100.0%***
1994-95	46.3%	14.1%	**60.4%**	23.0%	12.9%	3.7%	**39.6%**	***100.0%***
1996-97	47.6%	n.p.	**n.p.**	25.8%	12.8%	n.p.	**n.p.**	***100.0%***
1998-99	48.0%	10.1%	**58.1%**	24.7%	12.4%	4.9%	**41.9%**	***100.0%***
2000-01	46.8%	9.0%	**55.8%**	24.6%	12.6%	7.0%	**44.2%**	***100.0%***
Real growth pa								
1992-93 to 1994-95	6.8%	34.0%	**11.6%**	15.6%	17.3%	67.7%	**19.2%**	***14.4%***
1995-96 to 1996-97	7.2%	n.p.	**n.p.**	12.0%	5.3%	n.p.	**n.p.**	***5.7%***
1997-98 to 1998-99	6.3%	n.p.	**n.p.**	3.3%	4.2%	n.p.	**n.p.**	***5.7%***
1999-00 to 2000-01	6.8%	2.2%	**6.0%**	8.1%	9.4%	30.8%	**11.3%**	***8.3%***
1992-93 to 2000-01	**6.7%**	**6.6%**	**6.7%**	**9.7%**	**9.0%**	**29.5%**	**11.1%**	***8.5%***
% of GDP								
1992-93	0.095%	0.018%	**0.114%**	0.040%	0.022%	0.003%	**0.065%**	***0.179%***
1994-95	0.100%	0.030%	**0.130%**	0.050%	0.028%	0.008%	**0.085%**	***0.216%***
1996-97	0.106%	n.p.	**n.p.**	0.058%	0.029%	n.p.	**n.p.**	***0.223%***
1998-99	0.112%	0.023%	**0.135%**	0.057%	0.029%	0.011%	**0.097%**	***0.232%***
2000-01	0.119%	0.023%	**0.142%**	0.063%	0.032%	0.018%	**0.113%**	***0.255%***
$ per capita (nom.)								
1992-93	$22.94	$4.45	**$27.39**	$9.76	$5.29	$0.75	**$15.80**	***$43.20***
1994-95	$26.03	$7.92	**$33.95**	$12.96	$7.23	$2.10	**$22.28**	***$56.23***
1996-97	$30.43	n.p.	**n.p.**	$16.49	$8.16	n.p.	**n.p.**	***$63.93***
1998-99	$34.88	$7.30	**$42.18**	$17.90	$8.99	$3.53	**$30.42**	***$72.60***
2000-01	$41.25	$7.94	**$49.19**	$21.66	$11.15	$6.19	**$39.00**	***$88.19***

Source: Access Economics, derived from ABS special data request. See note to Table 14 re GDP and population data.

From Table 16 we see that:

- Total basic research accounted for 43.1% of R&D expenditure in 2000-01. This is the lowest level for our period of data, which starts in 1992-93.
- Generally, the share of basic research expenditure has been in decline since 1992-93, with the exception of a small increase in 1998-99. In 1992-93 the proportion of expenditure was 47%.

- 2000-01 has seen a significant decline in the public sector share of total basic research, from around 74-75% previously, to 68%.
- Both applied research and experimental development shares of R&D expenditure have fluctuated up and down since 1992-93.
- Over the 1990s, the public sector provided around two thirds to three quarters of experimental development, in accord with expectations based on consideration of risk and externalities.

Table 16 R&D expenditure by sector and type of research, Australia, SEO basis

	Sector of performance ('000)			Share of R&D by type of research (%)			Share of R&D by public/private split (%)		
Type of R&D activity	**Public**	**Private**	**Total**	**Public**	**Private**	**Total**	**Public**	**Private**	**Total**
2000-01									
Pure basic research	187,964	80,142	268,106	18.3%	11.7%	15.7%	70.1%	29.9%	100%
Strategic basic research	312,582	155,683	468,265	30.5%	22.8%	27.4%	66.8%	33.2%	100%
Total basic research	500,546	235,825	736,371	48.8%	34.5%	43.1%	68.0%	32.0%	100%
Applied research	429,953	210,915	640,868	41.9%	30.8%	37.5%	67.1%	32.9%	100%
Experimental development	95,258	237,234	332,493	9.3%	34.7%	19.4%	28.6%	71.4%	100%
Total	**1,025,757**	**683,974**	**1,709,731**	**100.0%**	**100.0%**	**100.0%**	**60.0%**	**40.0%**	**100%**
1998-99									
Pure basic research	191,239	45,298	236,537	21.9%	9.0%	17.2%	80.8%	19.2%	100%
Strategic basic research	267,033	106,527	373,560	30.6%	21.2%	27.2%	71.5%	28.5%	100%
Total basic research	458,272	151,825	610,098	52.5%	30.2%	44.4%	75.1%	24.9%	100%
Applied research	349,403	135,873	485,275	40.0%	27.1%	35.3%	72.0%	28.0%	100%
Experimental development	64,838	214,585	279,424	7.4%	42.7%	20.3%	23.2%	76.8%	100%
Total	**872,513**	**502,284**	**1,374,797**	**100.0%**	**100.0%**	**100.0%**	**63.5%**	**36.5%**	**100%**
1996-97									
Pure basic research	153,080	44,617	197,697	20.2%	10.5%	16.7%	77.4%	22.6%	100%
Strategic basic research	228,830	88,804	317,634	30.2%	20.8%	26.8%	72.0%	28.0%	100%
Total basic research	381,910	133,421	515,331	50.4%	31.3%	43.5%	74.1%	25.9%	100%
Applied research	322,278	138,203	460,481	42.5%	32.4%	38.9%	70.0%	30.0%	100%
Experimental development	53,562	154,912	208,474	7.1%	36.3%	17.6%	25.7%	74.3%	100%
Total	**757,749**	**426,536**	**1,184,285**	**100.0%**	**100.0%**	**100.0%**	**64.0%**	**36.0%**	**100%**
1994-95									
Pure basic research	124,648	43,130	167,778	19.0%	12.0%	16.5%	74.3%	25.7%	100%
Strategic basic research	222,172	79,485	301,657	33.8%	22.1%	29.7%	73.7%	26.3%	100%
Total basic research	346,820	122,615	469,435	52.8%	34.1%	46.2%	73.9%	26.1%	100%
Applied research	260,876	88,936	349,812	39.7%	24.8%	34.4%	74.6%	25.4%	100%
Experimental development	49,304	147,674	196,978	7.5%	41.1%	19.4%	25.0%	75.0%	100%
Total	**657,000**	**359,225**	**1,016,225**	**100.0%**	**100.0%**	**100.0%**	**64.7%**	**35.3%**	**100%**
1992-93									
Pure basic research	97,520	29,047	126,567	18.6%	12.2%	16.6%	77.0%	23.0%	100%
Strategic basic research	171,538	60,530	232,068	32.7%	25.5%	30.4%	73.9%	26.1%	100%
Total basic research	269,058	89,577	358,635	51.2%	37.7%	47.0%	75.0%	25.0%	100%
Applied research	206,797	68,340	275,137	39.4%	28.7%	36.1%	75.2%	24.8%	100%
Experimental development	49,515	79,850	129,365	9.4%	33.6%	17.0%	38.3%	61.7%	100%
Total	**525,370**	**237,767**	**763,137**	**100.0%**	**100.0%**	**100.0%**	**68.8%**	**31.2%**	**100%**

Source: ABS special data request.

From Table 17 we see that:

- In 2000-01, the capital expenditure component of R&D was 16.2% (mainly land and buildings, 10%), and the current expenditure component accounted for 83.8% (mainly labour 46%);
- The capital expenditure component is at its highest level since 1994-95 where it was 21.4%.
- The public sector's share of capital spending declined over the 1990s, from 72% to 54%, although it increased slightly (to 58%) in 2000-01.

Table 17 R&D expenditure by sector and type of expenditure, Australia, SEO basis

Type of expenditure	Sector of performance ('000)			Share of R&D by type of expenditure (%)			Share of R&D by public/private split (%)		
	Public Sector	Private Sector	Total	Public Sector	Private Sector	Total	Public Sector	Private Sector	Total
2000-01									
Land and buildings	50,681	30,911	81,592	17.5%	1.4%	10.0%	62.1%	37.9%	100%
Other capital expenditure	48,362	39,990	88,352	3.1%	5.1%	6.3%	54.7%	45.3%	100%
Labour costs	479,315	300,310	779,625	53.9%	44.8%	46.4%	61.5%	38.5%	100%
Other current expenditure	447,399	312,763	760,163	25.5%	48.7%	37.4%	58.9%	41.1%	100%
Total capital expenditure	***99,043***	***70,901***	***169,943***	***20.6%***	***6.5%***	***16.2%***	***58.3%***	***41.7%***	***100%***
Total current expenditure	***926,714***	***613,074***	***1,539,788***	***79.4%***	***93.5%***	***83.8%***	***60.2%***	***39.8%***	***100%***
Total	**1,025,757**	**683,974**	**1,709,731**	**100.0%**	**100.0%**	**100.0%**	**60.0%**	**40.0%**	**100%**
1998-99									
Land and buildings	14,384	15,677	30,061	2.3%	1.2%	3.2%	47.9%	52.1%	100%
Other capital expenditure	40,350	30,851	71,201	3.4%	4.6%	8.0%	56.7%	43.3%	100%
Labour costs	428,940	223,544	652,484	58.9%	46.4%	50.5%	65.7%	34.3%	100%
Other current expenditure	388,838	232,212	621,050	35.4%	47.8%	38.3%	62.6%	37.4%	100%
Total capital expenditure	***54,734***	***46,528***	***101,262***	***5.6%***	***5.8%***	***11.2%***	***54.1%***	***45.9%***	***100%***
Total current expenditure	***817,779***	***455,756***	***1,273,535***	***94.4%***	***94.2%***	***88.8%***	***64.2%***	***35.8%***	***100%***
Total	**872,513**	**502,284**	**1,374,797**	**100.0%**	**100.0%**	**100.0%**	**63.5%**	**36.5%**	**100%**
1996-97									
Land and buildings	14,724	12,567	27,291	1.5%	1.8%	4.9%	54.0%	46.0%	100%
Other capital expenditure	37,664	28,489	66,153	5.5%	4.7%	8.1%	56.9%	43.1%	100%
Labour costs	377,719	187,394	565,113	58.1%	47.1%	50.8%	66.8%	33.2%	100%
Other current expenditure	327,642	198,086	525,728	34.9%	46.4%	36.3%	62.3%	37.7%	100%
Total capital expenditure	***52,388***	***41,056***	***93,444***	***7.1%***	***6.5%***	***12.9%***	***56.1%***	***43.9%***	***100%***
Total current expenditure	***705,361***	***385,480***	***1,090,841***	***92.9%***	***93.5%***	***87.1%***	***64.7%***	***35.3%***	***100%***
Total	**757,749**	**426,536**	**1,184,285**	**100.0%**	**100.0%**	**100.0%**	**64.0%**	**36.0%**	**100%**
1994-95									
Land and buildings	38,396	19,601	57,997	13.8%	1.1%	12.0%	66.2%	33.8%	100%
Other capital expenditure	36,356	31,142	67,498	7.1%	4.9%	9.4%	53.9%	46.1%	100%
Labour costs	333,510	148,964	482,474	48.4%	53.5%	43.8%	69.1%	30.9%	100%
Other current expenditure	248,738	159,519	408,257	30.7%	40.6%	34.8%	60.9%	39.1%	100%
Total capital expenditure	***74,752***	***50,743***	***125,495***	***20.8%***	***6.0%***	***21.4%***	***59.6%***	***40.4%***	***100%***
Total current expenditure	***582,248***	***308,482***	***890,730***	***79.2%***	***94.0%***	***78.6%***	***65.4%***	***34.6%***	***100%***
Total	**657,000**	**359,225**	**1,016,225**	**100.0%**	**100.0%**	**100.0%**	**64.7%**	**35.3%**	**100%**
1992-93									
Land and buildings	16,612	4,130	20,743	2.2%	3.0%	1.9%	80.1%	19.9%	100%
Other capital expenditure	43,217	19,100	62,317	6.5%	9.0%	6.6%	69.4%	30.6%	100%
Labour costs	327,276	110,159	437,434	55.5%	67.3%	56.2%	74.8%	25.2%	100%
Other current expenditure	138,265	104,378	242,643	35.7%	20.6%	35.3%	57.0%	43.0%	100%
Total capital expenditure	***59,829***	***23,230***	***83,059***	***8.8%***	***12.1%***	***8.5%***	***72.0%***	***28.0%***	***100%***
Total current expenditure	***465,541***	***214,537***	***680,078***	***91.2%***	***87.9%***	***91.5%***	***68.5%***	***31.5%***	***100%***
Total	**525,370**	**237,767**	**763,137**	**100.0%**	**100.0%**	**100.0%**	**68.8%**	**31.2%**	**100%**

Source: ABS special data request.

There is also interesting growth in health R&D analysed by category and by sector performing the research, although trends are more difficult to precisely compare because of the series break between 1998-99 and 2000-01 due to the adoption of the new ASRC in 1998 (Section 1.1). Appendix Tables 46 to 55 show nominal expenditures by category, as well as percentage shares of the total. Table 18 provides some summary details, with highlights below.

Table 18 Australian health R&D (SEO) by category, 1992-93 to 2000-01

Broad category $'000	**1992-93**	**1994-95**	**1996-97**	**1998-99**	**2000-01**
(6)70400 Human pharmaceutical products	125,144	182,426	197,880	221,236	219,489
(7/1)30100 Clinical (organs, disease & conditions)	412,986	488,209	578,227	655,745	981,910
(7/1)30200 Public health	135,869	173,817	195,676	249,617	326,459
(7/1)30300 Health & support services	45,550	59,368	88,011	104,845	181,873
191000 Medical & health sciences	43,589	112,406	124,492	143,355	end series
Total	763,137	1,016,225	1,184,285	1,374,797	1,709,731
	1992-93 to	**1992-93 to**	**1994-95 to**	**1996-97 to**	**1998-99 to**
Nominal growth pa	**2000-01**	**1994-95**	**1996-97**	**1998-99**	**2000-01**
(6)70400 Human pharmaceutical products	7.6%	20.7%	4.1%	5.7%	-0.4%
(7/1)30100 Clinical (organs, disease & conditions)	11.6%	8.7%	8.8%	6.5%	22.4%
(7/1)30200 Public health	11.6%	13.1%	6.1%	12.9%	14.4%
(7/1)30300 Health & support services	19.2%	14.2%	21.8%	9.1%	31.7%
191000 Medical & health sciences	24.4%	60.6%	5.2%	7.3%	end series
Total	10.7%	15.4%	8.0%	7.7%	11.5%
% of Total					
(6)70400 Human pharmaceutical products	16.4%	18.0%	16.7%	16.1%	12.8%
(7/1)30100 Clinical (organs, disease & conditions)	54.1%	48.0%	48.8%	47.7%	57.4%
(7/1)30200 Public health	17.8%	17.1%	16.5%	18.2%	19.1%
(7/1)30300 Health & support services	6.0%	5.8%	7.4%	7.6%	10.6%
191000 Medical & health sciences	5.7%	11.1%	10.5%	10.4%	end series
Total	100.0%	100.0%	100.0%	100.0%	100.0%
	1992-93 to	**1992-93 to**	**1994-95 to**	**1996-97 to**	**1998-99 to**
Real growth pa	**2000-01**	**1994-95**	**1996-97**	**1998-99**	**2000-01**
(6)70400 Human pharmaceutical products	5.4%	19.8%	1.9%	3.7%	-3.6%
(7/1)30100 Clinical (organs, disease & conditions)	9.5%	7.8%	6.6%	4.5%	19.1%
(7/1)30200 Public health	9.5%	12.2%	3.9%	10.9%	11.1%
(7/1)30300 Health & support services	17.1%	13.2%	19.5%	7.1%	28.5%
191000 Medical & health sciences	22.3%	59.6%	3.0%	5.3%	end series
Total	8.5%	14.4%	5.7%	5.7%	8.3%
% of GDP					
(6)70400 Human pharmaceutical products	0.029%	0.039%	0.037%	0.037%	0.033%
(7/1)30100 Clinical (organs, disease & conditions)	0.097%	0.104%	0.109%	0.111%	0.147%
(7/1)30200 Public health	0.032%	0.037%	0.037%	0.042%	0.049%
(7/1)30300 Health & support services	0.011%	0.013%	0.017%	0.018%	0.027%
191000 Medical & health sciences	0.010%	0.024%	0.023%	0.024%	end series
Total	0.179%	0.216%	0.223%	0.232%	0.255%
$ per capita					
(6)70400 Human pharmaceutical products	$7.08	$10.09	$10.68	$11.68	$11.32
(7/1)30100 Clinical (organs, disease & conditions)	$23.38	$27.02	$31.21	$34.63	$50.65
(7/1)30200 Public health	$7.69	$9.62	$10.56	$13.18	$16.84
(7/1)30300 Health & support services	$2.58	$3.29	$4.75	$5.54	$9.38
191000 Medical & health sciences	$2.47	$6.22	$6.72	$7.57	end series
Total	$43.20	$56.23	$63.93	$72.60	$88.19

Source: Access Economics, derived from ABS special data request. See note to Table 14 re GDP and population data.

- Growth was most rapid in medical and health sciences, over 20% p.a. in real and nominal terms (noting that from 2000-01 this category has been absorbed into others, mainly clinical items).
- R&D relating to health and support services grew relatively rapidly – 19.2% p.a. nominal growth and 17.1% p.a. in real terms, resulting in an increase in its share from 5.8% of the total in 1992-93 to 10.6% in 2000-01.
- In contrast, pharmaceutical R&D was least rapid (7.6% p.a. nominally and 5.4% p.a. real), with a consequent decline in its share from 18.0% to 12.8% over the same period.
- The largest item, clinical health, grew fairly steadily, with the anomalous one-off absorption of the more basic research in 2000-01. Public health also grew fairly steadily, maintaining its share of the total.

2. INTERNATIONAL PERSPECTIVES

2.1 INTERNATIONAL COMPARISONS OF EXPENDITURE ON HEALTH R&D

There is not currently a consistent and comparable set of figures that allows a robust international comparison of country specific expenditures on health R&D.

The closest available are those collected by the OECD. OECD (2001) discusses many of the issues in collecting this type of information and highlights some of the inconsistencies that exist in the country-specific data, notably due to differences between health systems and data collection processes between countries. It also provides a framework for the collection and classification of expenditures on health R&D and, to this end, attempts to overcome some of the data inconsistencies for ten participating countries, including Australia.[3] Thus, while good comparative data are still elusive, the data provided by each country can be assessed individually taking into consideration some of these limitations.

To that end, OECD data including for Australia are presented in this chapter, comparing the following approaches and sources:

- Government budget appropriations or outlays (Federal only) for research and development (GBAORD) as a percentage of GDP – Section 2.1.1;
- Spending on health R&D as reported by government, business, higher education and not-for-profit organisations, referred to as gross domestic expenditures on R&D (GERD), with special consolidation of ten countries' data – Section 2.1.2;
- Total pharmaceutical expenditures on R&D, together with public and other non-pharmaceutical expenditures on health R&D as reported in the timely but less consistent OECD health database – Section 2.1.3; and
- Public and private non-pharmaceutical data for five countries as reported in the Wills Report, based originally on OECD data – Section 2.1.4.

2.1.1 GBAORD

This is often used as a proxy for health related R&D, even though it only includes government expenditures. Since the data are readily accessible from the OECD Health Data series and updated annually, the timeliness of this series often makes it a first choice for many commentators, although non-compatibility issues between country data render limited comparisons. The main limitations are:

- ***Excludes the private sector***: For countries that have active and extensive private sector investment in health R&D, there may be less economic rationale for its public provision, which distorts the results.
- ***Federal only***: GBAORD is collected for Federal governments only and excludes regional, provincial and State governments, as well as the private sector. For Australia in 1996, State governments financed nearly 20% of the public funds for health (OECD, 2001 p18). For Denmark, municipal and county governments supply around 90% of funding to support R&D in hospitals. If this were included, Denmark's figures would almost double.
- ***Variable content:*** Outlays are categorised as 'health, excluding pollution'. The content of this category is fairly subjective and varies across countries. Moreover, the data only cover those programs where 'health' is the primary purpose, which is also subjective and may exclude research that, while not initially directed towards health outcomes, ultimately results in (possibly serendipitous) benefits. For example, many countries do not include medical sciences for the advancement of research.

Since the quality of the data comparisons by this measure are so poor, they are not included in this report.

[3] The other nine countries were Austria, Canada, Denmark, France, Israel, Norway, Spain, the United Kingdom and the United States.

2.1.2 GERD

The second approach detailed by the OECD is through the collection of gross domestic expenditures on R&D (GERD). This approach provides more accurate figures on R&D expenditures split by four sectors:

- business enterprises;
- government;
- higher education; and
- private not-for-profit enterprises.

The problem with cross-country comparisons for GERD is that not all countries have the appropriate data to satisfy the various categories of the OECD R&D data collection. Thus some information is included and some is not. Table 19 highlights the type of information each country includes in its response to the OECD. It is possible to derive broad estimates of health-related GERD for some countries, but again comparisons are not appropriate unless the data limitations are taken into consideration.

Table 19 Summary of health related R&D expenditure from the OECD health database, 2001

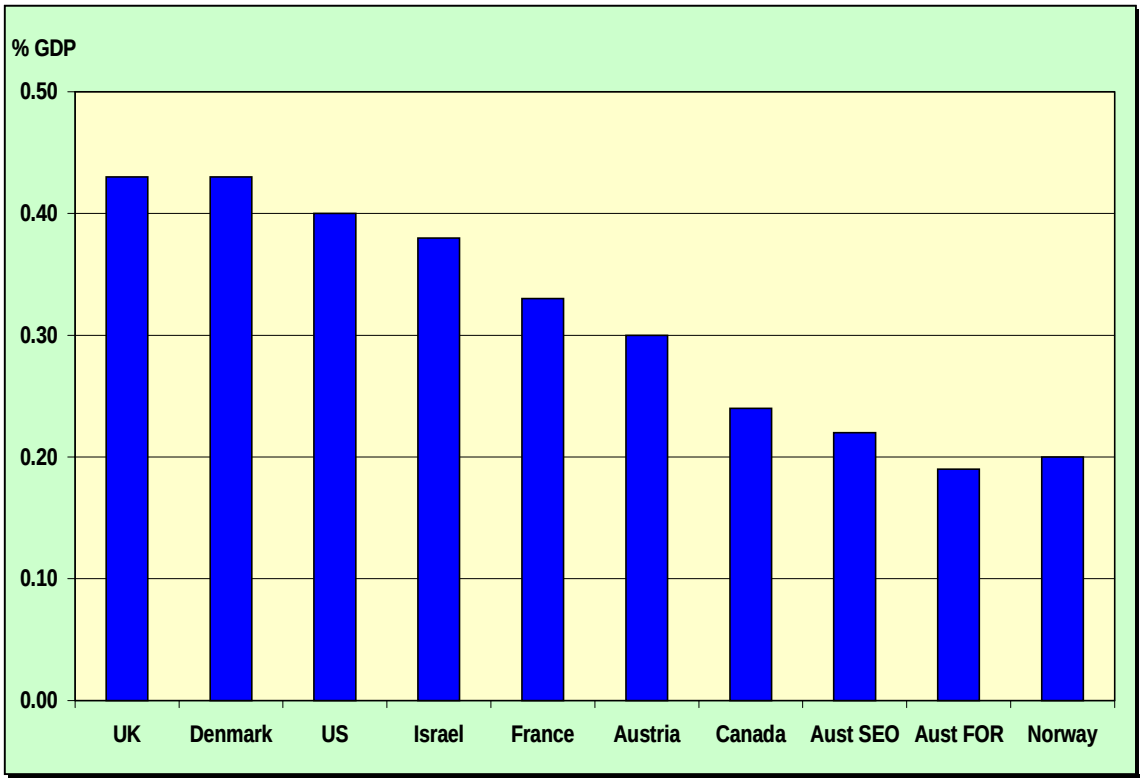
	Business Enterprises	Government	Higher Education	PNP
US	Ph, PhS			
Japan	Ph, PhS	Hobj	Medsci, MedsciS	Hobj, Medsci, MedsciS
Germany	Ph, PhS	Medsci	Medsci, MedsciS	
France	Ph, PhS			
UK	Ph, PhS			
Korea	Ph, PhS, Hobj	Hobj	Hobj, Medsci, MedsciS	Hobj
Italy	Ph	Hobj		
Canada	Ph, PhS			
Netherlands	Ph, PhS	Hobj	Hobj, MedsciS	Hobj
Australia	Ph, PhS, Hobj, Medsci	Hobj, Medsci	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS
Sweden	Ph, PhS	Hobj	Medsci, MedsciS	Hobj
Spain	Ph, PhS, Hobj, Medsci	Hobj, Medsci	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS
Switzerland	Hobj	Hobj		
Belgium	Ph		Medsci, MedsciS	Medsci, MedsciS
Austria	Ph, PhS	Hobj	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS
Finland			Medsci, MedsciS	Medsci
Denmark	Ph, PhS, Hobj	Hobj, Medsci	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS
Poland	Ph, PhS, Hobj, Medsci	Medsci	Medsci, MedsciS	
Mexico	Ph, PhS, Hobj	Hobj	Medsci, MedsciS	Medsci, MedsciS
Norway	Ph, PhS	Hobj	Hobj, Medsci, MedsciS	
Turkey	Ph, PhS	Hobj	Medsci, MedsciS	
Czech Republic	Ph, PhS, Hobj, Medsci	Hobj, Medsci	Hobj, Medsci, MedsciS	Hobj, Medsci
Portugal	Ph, PhS	Hobj	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS
Hungary	Ph, PhS	Hobj, Medsci	Hobj, Medsci, MedsciS	
New Zealand	Ph	Hobj	Medsci, MedsciS	
Greece	Ph			
Iceland	Ph, PhS, Hobj, Medsci	Hobj, Medsci	Hobj, Medsci, MedsciS	Hobj, Medsci, MedsciS

Ph Total intramural R&D in the pharmaceutical industry
PhS Sources of funds R&D in the pharmaceutical industry
Medsci Total intramural R&D in the medical sciences
MedsciS Sources of funds R&D in the medical sciences
Hobj Intramural R&D for health as a socioeconomic objective

Source: OECD R&D database, January 2001

The OECD in its report, *Measuring Expenditure of Health-related R&D* (OECD, 2001) analysed a group of ten countries to highlight and assess some of the data inconsistencies. Further work undertaken by each of these countries, combined with the data gathered by the OECD, provide enhanced results on health-related GERD, as indicated in Figure 7 below.

Figure 7 Health-related GERD, OECD countries, % GDP



Source: OECD (2001), for 1997, 1998 or nearest year. Note two methods (SEO and FOR) for Australian data.

Health-related GERD is around 0.2% to 0.45% of GDP. The OECD note that the US figure is a lower bound and the UK figure in particular is a rough estimate. Australia – with SEO at 0.22% GDP, which accords with Table 14 for 1996-97 – is at the lower end of the scale, including data from all four sectors (i.e. business enterprises, government, higher education and PNP organisations). In contrast, the UK and US only include business enterprises, and they are at the higher end of the scale.

2.1.3 OECD health data 2002

The OECD health database for 2002 provides the latest available health data for 30 countries. For R&D expenditure, three categories of information within the database are relevant:

- pharmaceutical industry R&D expenditures;
- public expenditures on health R&D (noting previous limitations); and
- total expenditures on health R&D, excluding those by the pharmaceutical industry.

Total non-pharmaceutical expenditure on health-related R&D category is somewhat of a catch-all generally including all residual items that are non-Federal and non-pharmaceutical. Country results for each of these categories are presented in Table 20, noting that the grand total is not strictly summable due to different collection years and content anomalies.

Table 20 Expenditure on health-related R&D, OECD 12-country comparison by sector

	Pharmaceutical expenditure on R&D		Public expenditure on R&D		Total non-pharmaceutical expenditure on R&D			Grand total		
Country	**Year**	**% GDP**	**Year**	**%GDP**	**Year**	**%GDP**	**Rank**	**Year**	**%GDP**	**Rank**
Switzerland	n.a.	n.a.	2000	0.29	2000	0.57	1	n.a.	n.a.	n.a.
Denmark	1999	0.38	1999	0.18	1999	0.54	2	1999	1.10	1
UK	1998	0.26	1997	0.11	1997	0.43	3	comb	0.80	2
France	1997	0.17	2000	-	2000	0.40	4	comb	0.57	4
US	1999	0.22	2000	0.23	2000	0.26	5	comb	0.71	3
Japan	1998	0.13	1997	0.16	1997	0.17	6	comb	0.46	5
Canada	1998	0.07	2001	0.10	2001	0.15	7	comb	0.32	6
Australia	**1998**	**0.03**	**1998**	**0.10**	**1998**	**0.12**	**8**	**comb**	**0.25**	**7**
Czech Republic	1996	0.03	2000	0.06	2000	0.09	9	comb	0.18	8
New Zealand	1996	0.02	1998	0.06	1998	0.06	10	comb	0.14	10
Korea	n.a.	n.a.	1998	0.03	1998	0.03	11	n.a.	n.a.	n.a.
Germany	1998	0.11	1998	0.02	1998	0.02	12	1998	0.15	9

Source: OECD (2002).

The OECD data in Table 20 for Australia are broadly consistent with our estimates – Table 15 and Table 18 show the pharmaceutical spend for 1998-99 as 0.037% of GDP (0.03% OECD), the total spend as 0.232% (0.25% OECD) and the Commonwealth spend as 0.112% (0.10% OECD), bearing in mind the OECD definition of 'public expenditure' as Federal only. Comparing the countries in Table 20 to the common countries with GERD data in Figure 7 we can see that Denmark and the UK are leaders, the US, France and Canada rank in the middle, while Australia is again at the lower end of the spectrum (last of the common countries).

Australia ranks at the lower end of the OECD spectrum for health-related R&D spending, by most indicators.

The pharmaceutical expenditures on R&D indicate a range of around 0.02% of GDP (New Zealand) up to 0.38% of GDP (Denmark). Again there is need for caution due to inconsistencies in the data. For example, in Australia around 25% of the manufacturing of pharmaceutical products is performed outside the pharmaceutical industry (OECD, 2001 p31). Furthermore, more than 20% of the R&D performed by the pharmaceutical industry in Australia is not for health reasons (OECD, 2001 p31). In Denmark, non-health related pharmaceutical R&D expenditures has doubled between 1995 and 1998 (from 9% to 18%).

2.1.4 The Wills report data

The Wills Report (Wills, 1998) used OECD data on total and public only expenditures on health-related R&D to deduce an indicative level of private health expenditure on R&D, as the residual. However, private expenditures derived in this manner do not include the pharmaceutical industry, which would alter the results as demonstrated in Chapter 1. Nonetheless, the Report concluded that, overall:

> '*Statistics show that Australian support of health and medical research is low by OECD standards. In 1995, Australia spent 0.115%*[4] *of GDP or $28 per capita on health and medical research and development. The GDP-weighted OECD average for developed nations was significantly higher at 0.174% or $66 per capita. Likewise, industry funding of health and medical research in Australia is very low by the standards of OECD countries*.' (Wills, 1998 p7).

Because of the importance of the Wills report in Australia, its findings on the split between public and private expenditure on health R&D are also included here for comparative purposes (Table 21).

[4] To reconcile this with Wills' table (Table 21) and our Table 14 in Chapter 1, Wills must be referring to Commonwealth R&D only.

Table 21 Expenditure on health-related R&D, Wills report 5-country comparison by sector

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total expenditure on health R&D (% GDP)												
Australia	0.11	0.12	0.12	0.13	0.14	0.13	0.13	0.12	0.12			
Canada	0.10	0.10	0.11	0.11	0.11	0.10	0.10	0.12	0.13	0.14	0.14	0.15
New Zealand	0.09	0.08	0.09	0.08	0.07	0.06	0.07	0.07	0.06			
UK					0.45	0.42	0.42	0.43				
US	0.22	0.23	0.24	0.23	0.24	0.24	0.23	0.23	0.24	0.25	0.26	
Public expenditure on health R&D (% GDP)												
Australia	0.10	0.11	0.11	0.12	0.11	0.11	0.11	0.09	0.10			
Canada	0.06	0.06	0.07	0.07	0.07	0.06	0.06	0.08	0.09	0.10	0.10	0.10
New Zealand	0.08	0.08	0.08	0.07	0.06	0.05	0.07	0.07	0.06			
UK					0.15	0.11	0.11	0.11				
US	0.20	0.21	0.22	0.21	0.22	0.22	0.21	0.21	0.21	0.23	0.23	
Private expenditure on health R&D (% GDP)												
Australia	0.01	0.01	0.01	0.01	0.03	0.02	0.02	0.03	0.02			
Canada	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
New Zealand	0.01	-	0.01	0.01	0.01	0.01	-	-	-			
UK					0.30	0.31	0.31	0.32				
US	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03	

Source: Wills (1998), Appendix C; OECD (2002).

The final data point in each country series in Table 21 is the 'most recent' number reported in Table 20, for public expenditures and noting that 'Total non-pharmaceutical expenditure on R&D' in Table 20 equates to 'Total expenditure on health R&D' from the Wills Report. Bearing in mind that there may be definitional changes in the series collected by each country over the years, Table 21 nonetheless reveals some interesting trends:

- Canada's total health R&D expenditure has ***increased*** since 1996 from 0.10% of GDP to 0.15% in 2001.
- In the United States, total health R&D expenditure has also ***increased*** fairly steadily from 0.22% of GDP in 1990 to 0.26% in 2000.
- For the United Kingdom, while there are insufficient data points in the series to establish a trend, the overall level of R&D spending is ***very high*** at over 0.4% of GDP.
- In contrast, although Australia's total health R&D spending ***increased*** from 0.11% of GDP to 0.14% between 1990 and 1994, it ***declined*** to 0.12% by 1998; we now spend only 80% of what Canada spends relative to GDP.
- New Zealand's spending has also ***declined***, from an even lower start point (0.09% in 1990 to 0.06% in 1998).

Although Canada and the US grew their public health R&D spending over the late '90s, and the UK was already high, Australia (like New Zealand) declined from a lower base.

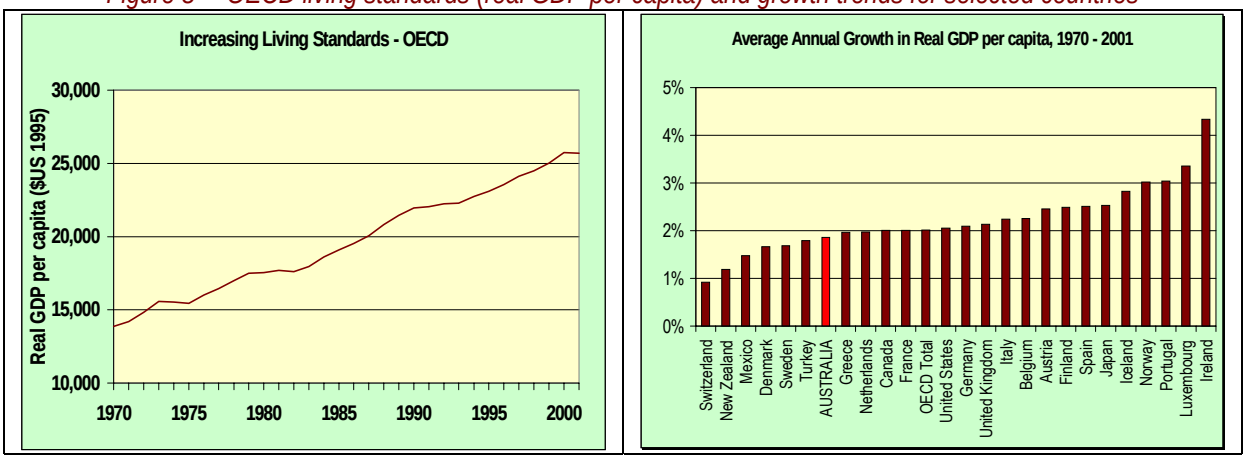
- There are similar trends in public spending as in total spending, although in terms of absolute levels relative to GDP the US dominates public spending and the UK dominates private (non-pharmaceutical) spending. There is also a healthy amount of private (non-pharmaceutical) spending in Canada – about one third of the total. In contrast there is almost no philanthropic or academic spending in New Zealand.

2.2 HISTORICAL OVERVIEW OF WORLDWIDE HEALTH ADVANCES

2.2.1 Improvements in living standards and life expectancy

Living standards in OECD countries – as measured by real GDP per capita – have steadily increased over the past 30 years by an average annual rate of 2.0%. Australian living standards have been slightly lower than the OECD average, with an average annual increase of 1.9% (Figure 8).

Figure 8 OECD living standards (real GDP per capita) and growth trends for selected countries



Source: OECD (2003), OECD (2002).

Life expectancies have also increased (Table 22). For Australia, life expectancy in 1999 was 81.8 years for females and 76.6 years for males. This compares to an average life expectancy of 73.9 for females and 67.9 for males in 1960 (OECD, 2002). Between 1960 and 1999, the gain in life expectancy for males in Australia was 8.3 years. This is higher than many other countries such as the US, UK and New Zealand, but not as high as gains in Japan and Portugal. For females the gain in life expectancy in Australia was 7.9 years. This falls more toward the middle of gains in other countries, however life expectancy is toward the upper end of the OECD spectrum.

Table 22 Life expectancy (years) for selected OECD countries, 1960 and 1999

	1960		1999		Difference	
	Females at birth	Males at birth	Females at birth	Males at birth	Females at birth	Males at birth
Japan	70.2	65.3	84.0	77.1	13.8	11.8
Switzerland	74.5	68.7	82.5	76.8	8.0	8.1
France	73.6	67.0	82.5	75.0	8.9	8.0
Spain	72.2	67.4	82.4	74.9	10.2	7.5
Sweden	74.9	71.2	81.9	77.0	7.0	5.8
Australia	***73.9***	***67.9***	***81.8***	***76.2***	***7.9***	***8.3***
Canada	n.a.	n.a.	81.7	76.3	n.a.	n.a.
Luxembourg	72.2	66.5	81.2	74.7	9.0	8.2
New Zealand	73.9	68.7	80.8	75.7	6.9	7.0
Belgium	73.5	67.7	80.8	74.4	7.3	6.7
Germany	72.4	66.9	80.7	74.7	8.3	7.8
Netherlands	75.4	71.5	80.5	75.3	5.1	3.8
United Kingdom	73.7	67.9	79.8	75.0	6.1	7.1
United States	73.1	66.6	79.4	73.9	6.3	7.3
Portugal	66.8	61.2	79.1	72.0	12.3	10.8

Source: OECD (2002).

2.2.2 The nature and value of medical advances

Over the last century, tremendous medical advances have been accomplished. These include the development of inoculations, pharmacological and surgical developments, psychosocial interventions, aetiological breakthroughs and HIV treatments. As stated in the Wills Report (Wills, 1999 p.161):

> '*We should not take for granted the improvements to our quality of life that have arisen from health and medical research over recent times. Within the last 25 years, mortality rates related to heart disease and stroke have decreased dramatically, vaccines for hepatitis A & B have been developed and Australians live almost completely free of diseases such as polio, tetanus, smallpox, measles, mumps and rubella. Death rates from cancer have started to fall, strong public health policies on tobacco promotion are in place and new antibiotics maintain our ability to cure life-threatening infections*.'

There are numerous examples of how these breakthroughs have impacted positively on our lives, through improved living standards and life expectancies. Specific studies have also looked at the savings in medical costs or reduction in lives lost that can be attributed to breakthroughs in the medical field. Some Australians case studies are highlighted below.[5]

- **Australian case study 1 – stomach ulcers:** In 1983, Dr Barry Marshall and colleague Dr Robin Warren announced that stomach ulcers were caused by the bacterium *helicobacter* and not by stress. More than half the world's population is infected by helicobacter to some degree. Prior to the discovery, around 10% of adults suffer a peptic ulcer episode in their lifetime with 4% one-year treated prevalence. Today the most common cause of ulcer is easily cured by a GP on the basis of a simple diagnostic (breath or blood) test for *H. pylori*. Drugs, mainly antibiotics, based on the Perth research now successfully combat the disease worldwide and also prevent future peptic ulcer problems, decreasing endoscopies of the stomach by 50% and saving $250m each year in Australia. Marshall's work was funded initially by the NHMRC, Pfizer and Smith-Kine, although he moved to the US to continue his research, funded by Procter and Gamble. In 1997 he was awarded a NHMRC Burnett Fellowship to return to Perth and establish the *H. pylori* research laboratory. 20 years on, one major challenge remains for Dr Marshall – to develop a vaccine to eradicate, not just treat, helicobacter.
- **Australian case study 2 – cervical cancer:** In Australia, despite extensive screening, there are around 1,000 cases and over 200 premature deaths annually from cervical cancer. Worldwide there are 200,000 deaths. This is set to change in the future if both preventive and treatment human papillomavirus (HPV) coat protein vaccines become widely available, originally discovered by Professor Ian Frazer and Dr Jian Zhou from the Centre for Immunology and Cancer Research at the University of Queensland. The vaccines are now successfully through Phase I/II trials in Brisbane hospitals and undergoing Phase III/IV trials worldwide, including at the Melbourne Royal Women's Hospital. The vaccines can prevent about 70% of cervical cancers, with applications also for other related cancers, having taken 18 years from an Australian test tube to worldwide clinical proof. The research was funded by the NHMRC, the Queensland Cancer Fund, the Princess Alexandra Hospital Foundation, the Cancer Research Institute of New York and the US NIH. Australian companies Uniquest (the Queensland University's commercial arm) and Melbourne-based pharmaceutical company CSL have licensed the preventive vaccine to global pharma Merck Sharp and Dohme, who are conducting further related research. The initial research investment is now expected to generate revenue in excess of $100m per year in Australia, and save up to $500m per year in direct health care costs.
- **Australian case study 3 – SIDS**: Research linking the impact of sleeping positions of babies to Sudden Infant Death Syndrome (SIDS) has reduced SIDS deaths in Australia by 80% from 507 in 1990 to 101 in 2001, saving over 400 babies' lives each year. Epidemiological researchers at the Menzies Centre for Population Health Research in Hobart, led by Professor Terry Dwyer, conducted extensive examinations of 10,000 Australian babies between 1988 and 1995. They found that lying babies face-down (prone) increased the risk of SIDS 450%, supporting earlier research findings at the Adelaide Children's Hospital. Other risk factors include paternal smoking, low birth-weight and overheating. The research led to multiple public awareness and education campaigns across Australia – such as 'Red Nose Day' – and the western world. The research was funded by the Tasmanian State Government, the Australian Rotary Health Research Fund, the NHMRC, the US NIH, the National SIDS Council of Australia, the Community Organisations' Support Program of Department of Human Services and Health, Zonta International, Wyeth Pharmaceuticals and the Tasmanian Sanatoria After-Care Association.

Year	Total SIDS cases pa	Rate per 1,000 live births
1988	482	1.96
1993	254	0.98
1998	139	0.56
2001	101	0.41

[5] Australian case studies in this section are derived from ASMR (2003).

Other Australian examples include:

- **Lithium**: The discovery of lithium in treating mania by Melbourne psychiatrist John Cade (Cade, 1949) is regarded as one of the major advances in the history of psychiatric pharmacotherapy. Although lithium was not used routinely until 1970, by 1985 it was estimated that Cade's discovery had saved at least $17.5 billion in hospitalisation costs around the world (Rubinstein and Rubinstein, 1996) through the successful management of bipolar disorder, which affects over 1% of people. Moreover, lithium is effective in reducing suicidality from bipolar disorder, thus saving many millions of lives (Access Economics, 2003a). An Australian play about Dr Cade, written by Neil Cole (former Victorian MP, playwright and a person with bipolar disorder) opened in Sydney and Melbourne in 2003.
- **Cochlear implant**: Professor Graeme Clark, pioneer of the cochlear implant, is known as the 'father of the bionic ear'. His research, which involved 175 scientists over 37 years and which derived initially from experimenting with a piece of grass and a seashell, has restored hearing to 50,000 people in 120 countries since the first implant in 1978 (Gooch, 2003). With demographic ageing, the number of people needing implants is forecast to grow substantially. An economic evaluation of the cochlear implant (Carter and Hailey, 1995) found that health-related quality of life improved 11% to 37% through use of the implant for profoundly deaf adults, at a cost for this group of $11,790 to $38,150 per QALY (quality adjusted life year). For partially deaf adults the cost was $14,410 to $41,000 per QALY, while for children it was $5,070 to $11,100 per QALY. These interventions rank as cost-effective to highly cost-effective by WHO standards (Section 2.3.3).
- **ResMed**: When ResMed was formed in 1989, its primary purpose was to commercialise a device for treating obstructive sleep apnea (OSA), a major subset of sleep-disordered breathing (SDB). Developed in 1981 by Professor Colin Sullivan and colleagues at the University of Sydney, nasal continuous positive airway pressure (CPAP) provided the first successful noninvasive treatment of OSA, which affects around 10% of the population (similar to asthma and diabetes) and has been linked to increased risk of hypertension, heart attack and stroke. ResMed's Ultra Mirage mask enables CPAP to keep a person's airway open while sleeping. Since 1989, OSA has gained greater public and physician awareness and ResMed, under the direction of founder and CEO Dr Peter C Farrell, has experienced meteoric growth, introducing a number of highly innovative product lines and operating directly in Australia, the US, Germany, France, Sweden, the UK, New Zealand, Singapore, Malaysia and Japan, as well as through distributors in more than 60 other countries. ResMed's principal manufacturing facilities are located in Sydney, although its business strategy from day one has been global, a key element in its successful commercialisation and growth. Committed to technological innovation, ResMed spends approximately 7-8% of net revenues on R&D. By 2002, sales were $204.1m and operating cash flow was $35.6 million. Since listing in June 1995, growth in excess of 25% pa in both revenues and net income has been achieved.
- **AGEN**: AGEN is a wholly-owned subsidiary of Agenix Ltd (formerly Biotech International Ltd), a Brisbane-based biotechnology company. AGEN Biomedical Ltd developed the first monoclonal antibody (MAb) that was specific for D-dimer. The antibody was first made at the University of Queensland some 20 years ago, and AGEN became Queensland's first biotech company to spinoff from University research. Today, AGEN's manufactured products are monoclonal antibody based immunoassays, including a new clot Imaging Agent – Thromboview –for diagnostic imaging of Deep Vein Thrombosis. AGEN's R&D in medical and veterinary diagnostics continues to flourish, developing for the global market simple and rapid blood testing products, with a focus on medical conditions arising from cardiovascular disorders and infectious diseases. AGEN now has an international network of distributors for its medical and veterinary diagnostic products with direct sales and marketing in Australia and New Zealand. Sales in FY2001-02 exceeded $40m, 40% up on FY2000-01.
- **Gradipore**: Gradipore Limited is another success story of Australian biotechnology excellence emerging from humble R&D beginnings. This Sydney-based company now researches, develops, manufactures and markets separation technologies for the life sciences market (including *Gradiflow,* for example for blood purification), blood clotting tests for genetic disorders for the health industry and biological products to detect disease and to manufacture pharmaceuticals. Gradipore is now well-known around the world, with cash reserves of around $30m.

More recently, human genome mapping is offering a multitude of possibilities for medical advances.

'*The human genome project is now well advanced, and involves an international cooperative program and several billion dollars of public and private investment. High density genetic and physical maps of all chromosomes have been constructed and it is expected that a complete DNA sequence (3.3 billion bases) and identification of all genes in the human genome (estimated to be about 70,000) will have been completed by 2005. This is just the first phase. These genes and their protein products become candidates for structural and functional analysis by a variety of computational and experimental means, and can be cross-referenced by genetic mapping to genetic loci with known phenotypic consequences.*

Advances in molecular genetic science and technology will have an enormous impact on all biologically based industries, especially on health and clinical services. This impact will be felt increasingly via the development of new pharmaceuticals and other goods and services, such as clinical diagnostics and prognostics, but in the end and most importantly the characterisation of all of the genetic components of human biology and health, and therefore also of the intersecting environmental influences and variables.' (Mattick, 1999).

It is interesting to note the origins of the genetic/biotechnology industry. Working at the Australian National University in Canberra, in 1974 Professor John Shine and his PhD supervisor discovered a messaging sequence inside cells that explained how those cells recognised the information encoded in genes and translated a gene sequence into functional proteins. The Shine-Dalgarno sequence 'broke the code' of intra-cellular communication, enabling the initiation and termination of such signals – turning a gene 'on' and 'off'. The research led to an understanding of how protein synthesis is terminated in all species and showed how bacteria start the synthesis of different proteins.

In 1975 Professor Shine progressed his research by moving to the University of California, where he stayed till 1978, during which time he became the first to clone a human hormone gene. This breakthrough catalysed the first biotech company, Genentech, who commercialized Shine's discovery to manufacture growth hormone and insulin and conduct clinical trials. The result was a streamlined process to produce biopharmaceutical products and today Genentech employs over 5,000 people and has a market capitalization of $US17bn. Recombinant pharmaceutical products incorporating Professor Shine's research now account for 50% of the top ten selling biopharmaceutical products, worth more than $US3bn per annum.

Shine and Dalgarno's original research was funded by an Australian Postgraduate Research Scholarship and research support from the Australian National University worth $51,000 over three years. Shine's gene cloning research was funded by a CSIRO Postdoctoral Fellowship (approximately $14,000) with $15,000 per annum from the US NIH. Today pioneer Professor Shine is head of the Garvan Institute, chair of the NHMRC and known as Australia's father of biotech. He says:

'*Like all researchers, I have been driven by the excitement of fundamental science, the thrill of discovery. I hope Australia will always be a place where such adventurous research is encouraged. Fundamental new knowledge is at the core of social and economic benefit*.'

An example of the importance of current genetic research is provided in Section 2.4.1 in relation to cystic fibrosis R&D in the US.

OECD data show that the potential years of life lost due to diseases and other injuries are currently around 3,700 per 100,000 of the Australian population. This has improved significantly since 1960 when the rate was around 8,700 per 100,000 (Table 22), although there are still further gains to be made.

One area of greatest improvement has been in the reduction of premature deaths due to cardiovascular disease (CVD) – the rate has dropped to one-quarter of the 1960 value. Similarly, the rate for respiratory diseases has dropped to one-fifth of its 1960 value. CVD remains the leading cause of death in Australia, accounting for 40% of all deaths (over 50,000 deaths each year). The large-scale Australia-New Zealand LIPID study, led from 1994 by Professor Andrew Tonkin and supported by an unrestricted research grant from Bristol-Myers Squibb, provided trial evidence that pravastatin, a cholesterol lowering drug, reduced the risk of death by 22% and reduced the need for heart surgery by 20%.

Table 23 Potential years of life lost by cause, under the age of 70 (rate per 100,000)

	Australia		United States		Canada		Japan	
Selected causes	**1960**	**1999**	**1960**	**1999**	**1960**	**1999**	**1960**	**1999**
Diseases of the circulatory system	2,036	472	1,452	602	1,079	322	1,476	281
External causes	1,787	1,160	925	749	878	505	1,210	462
Malignant neoplasms	1,169	848	1,330	907	1,313	890	1,255	674
Congenital abnormalities	564	220	504	219	1,416	229	252	165
Diseases of the respiratory system	534	107	572	187	608	97	1,145	111
Diseases of the digestive system	351	95	379	125	362	76	809	52
Diseases of the genitourinary system	200	15	152	40	121	19	248	18
Diseases of the nervous system	186	122	163	98	186	92	221	61
Infectious, parasitic diseases	181	47	179	90	200	35	1,019	51
Endocrine, metabolic diseases	157	111	207	201	161	87	204	32
Mental disorders	73	101	31	32	37	21	63	9
Diseases of the skin/subcutaneous tissue	38	3	31	4	33	1	54	1
Symptoms and ill-defined conditions	35	105	134	137	45	184	279	44
Diseases of the blood	18	18	31	23	23	11	37	16
Diseases of the musculoskeletal system	12	13	9	31	11	14	20	19
All causes	**8,716**	**3,723**	**7,686**	**3,813**	**7,176**	**2,780**	**9,975**	**2,133**

Source: OECD (2002).

Table 23 shows for Australia, the US, Canada and Japan, the impressive gains that have been made in reducing the number of years of life lost to certain diseases. A large part of this is due to advances in medical technology and breakthroughs in medical research.

2.3 RETURNS TO INVESTMENT – METHODS OF EVALUATION

2.3.1 International methodologies to calculate the value of improvements in health

Economic performance is usually measured in terms of national output and income levels. This approach however poorly reflects improvements in living standards in terms of the health status of the population. Therefore, estimating the return on health R&D expenditure can be problematic. As such, there are very few international studies that have assessed the rate of return on spending in the health field. There are a few studies that have addressed the burden of disease (i.e. estimating the direct, indirect and intangible costs of illness) and how this has changed, but the link to savings made through R&D expenditures has not been significantly assessed.

The one major exception to this is the work carried out by the *Lasker Foundation* and *Funding First* (Hatfield et al, 2000) in the US. This was a comprehensive study that commissioned research from economists at the University of Chicago, Harvard University, Yale University, Stanford University and Columbia University. A number of papers were developed aimed at calculating the economic value of life and the returns to investments in the medical research area.

Broadly speaking, there are two aspects to the measurement of returns to investment as described in these papers:

- Determining the **value of longer life and better health** (using mortality and morbidity measures); and
- **Attributing medical research** to this improvement, as distinct from other factors not related to research and development. For example increased advertising of health risks associated with smoking.

There are difficulties with linking medical breakthroughs to gains in life expectancy. While it is obvious that medical advances have increased our life expectancy, total gains in life expectancy cannot be solely attributed to medical research. The knowledge gained from research interacts with other factors, such as better access to health care, public education and awareness, policy regulations, and improvements in safety (such as air bags in cars, smoke detectors in houses, and on-the-job safety procedures), to result in a greater life expectancy. Hatfield et al (2000) uses the example of smoking. Fatalities due to cardiovascular diseases have dropped

dramatically in recent years. Smoking was understood to be dangerous even in the 1960s prior to this drop. However, medical research has helped to reduce smoking, along with public information campaigns, the growing tendency for the more affluent to spend more on health, higher taxes on cigarettes and regulations against smoking in many public places. Disentangling the impact of increased longevity from medical research alone is therefore very difficult. One argument is that the information campaigns, taxes and regulation have all eventuated due to the results of medical research in the area.

Research by Cutler and Kadiyala[6], who looked into cardiovascular disease in the US, indicates that roughly one-third of the total gain in reduced mortality from cardiovascular disease, can be directly attributed to medical research that led to new drugs and treatment options. For the US, Murphy and Topel (1999) estimate that the total economic value of reduced mortality from cardiovascular diseases is around $US1.5 trillion per year. One-third of this value results in a return on medical research investments of $US500bn per year – 20 times total annual spending on medical research in the US.

More generally, returns to investment in health R&D lead to medical advances and savings that can be classified into three broad areas – direct savings, indirect savings and healthspan gains. A broad description with some international examples are provided here.

1. **Direct savings** – are related to the costs of the health care system. Through reduced illness, savings can be achieved by reduced hospitalisations, fewer surgeries, reduced dependence on nursing homes and lower health care costs. Improvements in health generally and through advances in medical technology and drug treatments reduce pressures placed on the national health budget. For example, in the US heart disease costs $US128bn per year (Table 24). Even a slight improvement in treatment costs would save considerable dollars.

Table 24 Prevalence and cost of uncured diseases in the US

	Prevalence (m people)	Economic cost ($USbn pa)
Heart disease	56	128
Cancer	10	104
Alzheimer's disease	4	100
Diabetes	16	92
Arthritis	40	65
Depression	17.4	44
Stroke	3	30
Osteoporosis	28	10

Source: Hatfield et al (2000)

2. **Indirect savings** – are savings due to the 'wellness' of the population. Through lowered morbidity, savings can be made by improved worker productivity, reduced sick days and higher employment rates. For children, improved health enhances learning, with multiplier effects on productivity in later life. Lowered mortality also increases the number of productive work years. Lower health care costs, reduced burden on carers and lower welfare payments would also be classified as indirect savings.

> '*We cannot be a strong nation unless we are a healthy nation.*'
> Franklin D Roosevelt

Medical inventions from research, innovations and technological advancement can have considerable (indirect) returns for the economy also through greater knowledge spin-offs and patents. Patents allow drug manufacturers to recover their costs of R&D and return a profit. Without patents, costs would not be recoverable in many instances. This provides little incentive for innovation and development of new pharmaceuticals. Hughes et al (2002) estimate that if patents for prescription drugs were eliminated, consumers would be better off in the short-term due to a more immediate access to generic drugs through

6 As quoted in Hatfield et al (2000).

lower prices. Yet in the longer-term, manufacturers would have less incentive to innovate and consumers would become worse off. In fact, the long-term losses are estimated at three times the size of the short-term gains.

3. **Quality of life** gains are typically measured by disability-adjusted life years (or DALYs). Putting a value on the gain in life-years or DALYs is however more difficult. Recently however some work has been done in this area, which is discussed below.

Estimating the returns to investment in health R&D is complex and is relatively new in terms of the attention it is starting to receive. Earlier studies tended to focus on the direct costs of illness, health care cost savings (due, for example, to reduced hospitalisation) or an assessment of the financial burden of a particular disease. More recently, work has focussed on determining the value of extending the quantity and quality of life, emphasising the value of **reduced mortality** (Section 2.3.2) and **reduced morbidity** (Section 2.3.3)

2.3.2 The value of reduced mortality

Two methodologies for valuing improvements in health status based on reduced mortality are provided by:

- Nordhaus (1999), and
- Murphy and Topel (1999).

Nordhaus – Yale University

Nordhaus (1999) documents two approaches to assessing the value of improved health status: the mortality approach and the life-years approach. The basic question in Nordhaus' approach is how much an individual is willing to pay to trade-off consumption for health. The basis for his analysis is a life-cycle model and it is assumed that there is a trade-off between health and consumption (or expenditure). An individual is assumed to value health and consumption according to a lifetime utility (or preference) function. These preferences are a function of the future consumption of the individual, which will in part depend upon their probability of survival.

- Under the ***mortality approach***, the value of improved health status is determined by the change in the mortality rate (weighted by the share of the population experiencing lower mortality) multiplied by the estimated value of lower mortality.
- Under the ***life-years approach***, the value of improved health status is determined by the increase in life expectancy (weighted by the share of the population experiencing greater life expectancy) multiplied by the estimated value of an additional year of life.

The critical aspect of these approaches lies in the estimation of the value of either lower mortality or an additional life year. Most studies determine the value of a life year by assessing the value of a 'fatality prevented', with the 'willingness to pay' approach being the most generally accepted method of assessing this value.

There are three approaches to assessing the willingness to pay in order to reduce mortality risks:

- labour market studies – which look at the risk-wage tradeoff;
- consumer purchase decisions – which look at the risk-price tradeoff e.g. the amount people pay for smoke alarms or airbags in cars, or the discount in rent demanded to live near chemical factories (Hatfield et al, 2000); and
- contingent valuation studies – which determine individual preferences by examining stated preferences.

Labour market studies are the most commonly used as they reflect actual behaviour and are easily undertaken across different industry sectors and countries. These studies compare an income risk per year against a mortality risk per year to calculate the price of an extra year of life.

Figures on the price of a life vary considerably. In the US, figures can be found within the range of $US0.6m to $US13.5m per fatality prevented (or, value of a statistical life), yet the commonly quoted range is $US3m to $US7m. Nordhaus uses $US2.66m for his calculations, as an average value of a statistical life. A meta-analysis by Viscusi (1993) showed a very broad range from $US1,400 to $US40,000 (see Box below).

Estimating the Economic Value of an Extra Year of Life

A number of labour market studies have reviewed the wage premium demanded by workers who undertake more hazardous jobs. In the mining industry in the early 1980s, the fatality rate amongst workers in the US was 35.4 per 100,000. In the services sector the fatality rate was a mere 2.4 per 100,000 workers. All else being equal, the higher wages demanded by those in the mining industry could be used to reflect the implied economic value that workers place on life and the associated risk of working in such an industry.

Viscusi (1993) reviewed 24 such studies to reveal that the economic value of life ranged from $US500,000 to $US16m. Over this period the average life expectancy was 72 years, implying that the value of a single year of life was within the range of $US7,000 to $US200,000. With longevity rising during this period by around 1 year in every 5, it was argued that the annual economic value of the gain in life expectancy equals one-fifth of the value of a life year – around $US1,400 to $US40,000.

Federal Reserve Bank of San Francisco (2001)

Under the *mortality approach*, Nordhaus calculates that between 1975 and 1995, the decline in the mortality rate was 2,249 per million persons. This is multiplied by the average value of avoiding death for that period of $US2.66m, giving a value of $US5,980. This represents the value of a decline in mortality for one person. This is then compared with the average consumption expenditure for that person in that period, of $US14,700. Nordhaus concluded that the '*economic value of improvements in living standards due to reduced mortality is estimated at 40% of consumption … or about 2% per year*' (p15).

Under the *life-years approach*, the calculation is more complex and incorporates discounting of future values. Once a figure is determined for the prevention of a fatality (in this case $US2.66m), Nordhaus uses actual survival rates to determine that the value of a life-year lies between $2,600 per life-year gained (at a 0% discount rate) and $7,600 per life-year gained (at a 3% discount rate). Thus over the defined period, the increase in the population weighted life expectancy (of 2.1 years) multiplied by the value of an additional life-year, returns a total gain in health income of $US5,400. Compared with consumption expenditure, this relates to around 1.6% per year.

Table 25 Growth in living standards from consumption and health improvements – per capita p.a. (%)

	1900-1925	1925-1950	1950-1975	1975-1995
Growth in living standards from consumption expenditure				
Consumption	2.0	1.8	2.4	2.0
Growth in living standards from health improvements				
Mortality approach	3.2	4.0	2.6	2.0
Life years approach				
0% discount rate	2.3	3.3	1.9	1.7
3% discount rate	2.3	3.2	1.8	1.6

Source: Nordhaus (1999)

Murphy and Topel – University of Chicago

The approach undertaken by Murphy and Topel (1999) assesses the present value of the future income from an individual under different life expectancies, to determine the value of increased life. The approach is similar to Nordhaus in that it uses a life-cycle model and incorporates survival functions and value of life calculations. As with the Nordhaus approach, willingness to pay for improvements in health and medical knowledge is the driving force behind the modelling. Willingness to pay in the Murphy and Topel model is determined by the expected discounted present value of a lifetime utility function.

To value changes in mortality, Murphy and Topel incorporate information on changes in survival rates across age groups, estimates of lifecycle patterns of income and consumption, and estimates of the value of a statistical life. The value of a statistical life is taken from the literature on labour market studies that assess the trade-off between income and job-related mortality. They use an estimate of $US5m as a representative amount for an

individual statistical life. The value of changed mortality is calculated as the change in the discounted present value of income/wealth expected at a particular age per unit of change in the probability of survival to that age.

The Nordhaus approach assumes that decreased mortality is uniform across age groups. Murphy and Topel note that this is not the case, and as such calculate values for different age cohorts. Murphy and Topel do not attempt to isolate life expectancy improvements with specific advances in medical knowledge; rather, they assume all life expectancy advances are due to health research. As such they also do not attempt to directly link research with health outcomes. Nevertheless, their figures are astounding. They indicate that historical gains from increased longevity in the US have been worth around $US2.8 trillion annually between 1970 and 1990. The reduction in mortality from heart disease is calculated to have increased the value of life by around $US1.5 trillion per year over the same period.

A number of interesting points are concluded by Murphy and Topel:

- The 'willingness to pay for changes in survival do not depend on the level of health' (p10).
- Willingness to pay rises with wealth.
- Value of life calculations that focus only on earned income will understate the willingness to pay as non-market time is unaccounted for.
- The value of progress against a disease is greater, the closer an individual is to the onset of that disease. This is due to the discounting of future life years.
- Reduced mortality is worth more, the greater the probability of survival. For example '*progress against Alzheimer's is of little value in Guinea Bissau because relatively few of its citizens reach old age, but it may be of great value in advanced countries where expected lifetimes are longer*' (p15).
- The social value of increased life expectancy is proportional to the size of the population.

Murphy and Topel apply their methodology to determine the economic value of eliminating deaths from selected diseases (Table 26). Eliminating cancer would be worth $US47 trillion to the US. This means that one spared cancer death in one thousand would be worth $US47bn.

Table 26 Economic value of reducing deaths, measured as the increase in the value of life ($USbn)

	Men	Women	Total
Heart disease	28,636	19,712	48,348
Cancer	24,235	22,212	46,537
Digestive organs	5,469	4,160	9,629
Breast	25	4,617	4,642
Genital/urinary	1,810	2,334	4,145
AIDS	6,278	1,263	7,540
Stroke	3,473	4,156	7,629
Circulatory disease	3,085	2,654	5,739
Flu	1,841	1,591	3,432

Source: Murphy and Topel (1999)

2.3.3 The value of reduced morbidity

Both the Nordhaus and Murphy and Topel measures are mortality based measures and do not include improvements to the quality of life, or morbidity aspect.

Generally, morbidity has been falling as life expectancies have grown. However evidence of the economic value of reduced morbidity is limited. According to Hatfield et al (2000) even simple approaches to valuing the quality of life return inconsistent answers. Two approaches are outlined below:

- Cutler and Richardson (1998); and
- the World Health Organisation.

Cutler and Richardson

Cutler and Richardson (1998) assess the value of life using quality-adjusted life years (QALYs). It is assumed that an individual's quality of life can be ranked on a scale of 0 to 1 from death to perfect health. Living with a disease will fall between these two values. One QALY refers to one year of perfect health. By multiplying the expected number of QALYs for an individual by the value of a year in perfect health, a measure of the total value of health for an individual is obtained, which can be discounted back to present values. Summing over all individuals in a population gives a measure of 'health capital' of a population.

The value of a healthy life was again taken as a consensus from the literature regarding the worth of a statistical life, which lies in the range of $US3 to $US7m (as stated earlier). Cutler and Richardson indicate that this is equivalent to $US75,000 to $US150,000 for a year of life gained. They use an intermediate value of $US100,000 for a year of healthy life and a discount rate of 3%.

Measuring the health capital of the population however, is still not representative of the quality of life. Cutler and Richardson discuss the use of survival rates that are adjusted by the prevalence of disease, with ten disease groups identified. For each disease group, a quality of life weight is attached.

How the quality of life weight is determined is debatable and there is no consensus in the literature as to what these weights should be. One approach is through the use of surveys, asking questions such as how many perfect health years an individual would trade for increased longevity. Yet these types of surveys have produced wide-ranging results. The box below identifies some of the more common methods for valuing health status.

Methods of Determining the Value of Health Status

Rating Scales – a chart displays two health states with the most preferred rated at 100 and the least preferred rated at 0. Individuals must indicate on the chart where other health states would fall.

Standard Gamble – Individuals must consider two alternatives. In the first, their health state is certain. In the other, there are two possible health states, one better than the certain state (i.e. ideal health) and one worse (i.e. death). The probability that the best state occurs is varied until the subject is indifferent to their health state being certain. This probability, or point of indifference, is the 'utility' of the health state under consideration.

Time trade-off – Individuals are asked to choose between a longer life, or a shorter life but in good health. The length of the shorter life is varied until the individual is indifferent between the two.

Person trade-off – An individual must choose between a lesser health benefit for a larger number of people, or a larger health benefit for a smaller number of people. For example, saving a larger number of lives but having less than ideal health, and saving a smaller number of lives but with ideal health.

Mathers et al (1999), p10.

Cutler and Richardson suggest an alternative approach. An ordered probit model is used to determine the reduction in quality of life associated with each disease group. It is assumed that a person's underlying health is related to their demographics and health conditions. Health conditions come from the US Health Interview Survey where people were asked to rate their health as either excellent, very good, good, fair or poor.

Combining the QALY weights, the prevalence of disease and the share of people alive provides a measure of the quality of life. Cutler and Richardson estimate that in the US, health has improved by $US100,000 to $US200,000 per person between 1970 and 1990.

Table 27 Prevalence of disease and quality of life, US, 1970 and 1990

	Prevalence per 1000		QALY weight	
Condition	**1970**	**1990**	**1970**	**1990**
Orthopaedic	102.1	135.0	0.70	0.88
Arthritis	111.8	127.8	0.69	0.79
Cardiovascular disease	64.7	99.3	0.57	0.71
Hearing	80.0	91.2	0.91	0.93
Diabetes	45.9	54.3	0.65	0.66
Other vision	48.0	30.2	0.84	0.93
Cancer	11.1	18.7	0.70	0.70
Paralysis	7.4	7.1	0.62	0.68
Amputee	6.1	6.0	0.87	0.89
Blindness	8.6	2.0	0.73	0.87

Source: Cutler and Richardson (1998)

World Health Organisation – Global Burden of Disease Study

The disability adjusted life years (DALY) indicator was developed in the Global Burden of Disease (GBD) study undertaken by the Harvard School of Public Health together with the World Bank and World Health Organisation, to quantify the burden of disease (Murray and Lopez, 1996; Mathers et al, 2002). DALYs are used to estimate gains in healthspan, extending the approaches of measuring years of life lost to disease, to include quality of life measures. The DALY can be calculated for any disease or health condition by summing the years of life lost due to premature mortality (YLL) and the years lost due to disability (YLD), across a population: DALY = YLL + YLD.

YLD requires an estimate of the incidence of health conditions and the duration of that condition (to either remission or death). The number of years of healthy life lost is calculated by multiplying the average duration of a particular condition with a severity weight. The severity weight quantifies the equivalent loss of healthy years due to living with the health condition, and is equivalent to the QALY weights discussed above.

The Australian Institute of Health and Welfare (AIHW) has used this approach for assessing the burden of disease in Australia (Section 3.1.3). Disability weights determined in a Dutch study were used in some instances and the Gross Burden of Disease rates and other extrapolations or estimations in other instances (Table 28).

Table 28 Examples of disability weights used by AIHW, taken from a Dutch study

0.00-0.01	Gingivitis, dental caries
0.01-0.05	Mild asthma, mild vision loss, mild hearing loss, basal cell skin cancer
0.05-0.10	Low back pain, uncomplicated diabetes, mild stable angina
0.10-0.15	Mild depression, osteoarthritis of hip or knee, epilepsy
0.15-0.20	Mild/moderate panic disorder, spina bifida, HIV seropositive
0.20-0.30	Non-invasive breast cancer or tumour, anorexia, mild/moderate obsessive-compulsive disorder
0.30-0.40	Moderate depression, multiple sclerosis in relapsin-remitting phase, severe asthma, chronic hepatitis B infection with active viral replication, deafness
0.40-0.50	Severe vision loss, medium-level spina bifida, osteoarthritis, operable small cell lung cancer, moderate intellectual disability
0.50-0.65	Paraplegia, AIDS (first stage), severe chronic bronchitis or emphysema
0.65-0.80	Disseminated breast cancer, severe depression, moderately severe brain injury resulting in permanent impairments, extreme intellectual disability
0.80-1.00	Severe schizophrenia, disseminated colorectal cancer, severe dementia, alcoholic psychosis, quadriplegia, stroke with multiple permanent impairments, end-stage Parkinson's disease

Source: Stouthard et al (1997) as presented in Mathers et al (1999)

These weights indicate, that on average, society judges a year with mild depression preferable to a year with a mild/moderate panic disorder. DALYs thus measure the future stream of healthy years of life lost due to each case of disease or injury (Mathers et al, 1999, p12). A 3% time discount rate is applied to determine a net present value of years of life lost. Thus a year of life gained in ten years' time, is worth 24% less than a year of life gained now or, more generally:

$Yn = (1-r)^n$ where r= discount rate and Yn = value of a year of life gained n years in the future

WHO added an extra step in their calculations, weighting a year of healthy life by age, reflecting a preference to value a year of healthy life as a young adult more highly than a year lived as a child or at older ages. The Australian study used uniform age weights indicating that healthy life is valued equally across all age groups.

WHO provides a database of DALYs by disease category, which is summarised in Table 29.

Table 29 Burden of disease ('000 DALYs) for WHO member countries, 2001

Cause	Africa	The Americas	Eastern Mediterranean	Europe	South-East Asia	Western Pacific	TOTAL	% total
I. Communicable diseases, maternal and perinatal conditions and nutritional deficiencies	**261,456**	**27,116**	**67**	**14,607**	**188,152**	**57,269**	**615,737**	**42.0**
Infectious and parasitic diseases	189,047	12,555	35	5,876	93,995	23,163	359,377	24.5
Respiratory infections	29,873	3,528	12	3,626	32,904	12,378	94,037	6.4
Maternal conditions	11,328	1,843	4	751	10,027	2,864	30,943	2.1
Perinatal conditions	21,920	7,096	12	2,866	39,495	14,581	98,422	6.7
Nutritional deficiencies	9,288	2,093	4	1,489	11,731	4,283	32,958	2.2
II. Non-communicable conditions	**66,105**	**97,402**	**53**	**115,902**	**176,569**	**164,276**	**672,865**	**45.9**
Malignant neoplasms	6,837	10,952	4	17,371	13,657	23,991	76,716	5.2
Other neoplasms	75	262	0	279	604	327	1,773	0.1
Diabetes mellitus	818	3,412	1	2,291	4,515	3,160	15,446	1.1
Nutritional/endocrine disorders	1,651	2,235	1	998	939	1,539	8,232	0.6
Neuropsychiatric disorders	17,280	35,370	15	30,601	48,091	45,131	191,260	13.0
Sense organ disorders	4,320	3,782	3	5,077	13,579	8,648	38,742	2.6
Cardiovascular diseases	11,364	15,144	12	34,136	41,531	30,506	144,471	9.8
Respiratory diseases	7,271	8,594	4	7,043	16,408	19,727	62,842	4.3
Diseases of the genitourinary system	2,780	1,915	1	1,838	3,552	3,462	15,010	1.0
Skin diseases	759	285	0	258	551	152	2,171	0.1
Musculoskeletal diseases	2,181	4,404	2	5,818	6,649	9,059	29,798	2.0
Congenital abnormalities	3,877	3,483	4	1,942	8,807	5,891	28,083	1.9
Oral diseases	525	1,319	1	1,093	2,373	1,764	8,148	0.6
III. Injuries	**30,323**	**20,699**	**16**	**20,714**	**54,123**	**36,323**	**178,656**	**12.2**
Unintentional	20,288	12,020	12	14,107	43,932	27,177	129,853	8.9
Intentional	10,034	8,679	4	6,608	10,192	9,146	48,802	3.3
TOTAL DALYs	**357,883**	**145,217**	**136**	**151,224**	**418,844**	**257,868**	**1,467,257**	**100**

Source: WHO (2002). Note: These figures were produced by WHO using the best available evidence. They are not necessarily the official statistics of Member States. Estimates for specific causes may not sum to broader totals due to the omission of residual categories.

In the World Health Report (WHO, 2002), it is suggested that '*substantial health gains can be made for relatively modest expenditures…People of the most industrialized countries, such as the United States, Western Europe and the Asia Pacific, stand to gain another five years of healthy life*' (p7). For the less developed nations, up to 10 years of healthy life could be gained through effective preventative strategies.

WHO (2002) describes a method for evaluating the cost effectiveness of strategies to reduce risks attributable to certain diseases and illnesses. They assess what is likely to have happened if a set of interventions had not been undertaken and compare this against what is likely to have happened if they were implemented. The number of healthy years of life is estimated using rates of mortality, disease incidence and remission. Costs of interventions typically include running costs such as administration, training and media contact, and costs to the individual.

WHO indicates the following guidelines for assessing the effectiveness of interventions:

- Very cost effective interventions are those where 1 DALY averted costs less than the GDP per capita; and
- Cost effective interventions are where 1 DALY averted costs between 1 and 3 times the GDP per capita.

2.4 RETURNS TO INVESTMENT – COUNTRY STUDIES

2.4.1 United States

The United States is an important comparator for Australia in terms of what can be achieved with research dollars spent and the estimated returns from that research.

Worldwide, the US is considered to be at the forefront of spending on medical research and as such, a number of papers have been recently written looking at the returns of that investment (Rosenberg, 2002; Hatfield et al, 2000; NIH, 2000; Cutler and Richardson, 1998; Murphy and Topel, 1999; Nordhaus, 1999; Federal Reserve Bank of San Francisco, 2001).

Spending on health research by the US government has really only taken off in the last fifty years. Before the second world war, the US government invested only small amounts into medical research. In fact, over 90% of all funding came from industry and philanthropic sources. This however improved during the 1950s with the help of advocacy and lobbying efforts urging a greater involvement.

Since then an impressive escalation in funding has occurred. Firstly, public funds went towards basic scientific research in academia, where discoveries were made. This fuelled further investments in research and development by the pharmaceutical industry, which then led to the birth and growth of the biotechnology industry.

The US now invests around $57bn on medical and health research per year (Rosenberg, 2002). This equates to $US250 per capita and about 0.6% of GDP (which compares to 0.255% of GDP for Australian spending). Over half of this is sponsored by the biopharmaceutical industry (Table 30). Figures indicate that roughly 39% of funding is through public sources and 61% through private funding sources[7].

Table 30 Funding of health research in the US by funding source, 1999

	$USbn	% of total
Biopharmaceutical industry	31.4	55%
Federal government expenditures	18.8	33%
State and local governments	3.2	6%
University institutional funds	2.0	4%
Voluntary health associations and philanthropy	1.0	2%
Independent research institutes	0.7	1%
Total	**57**	**100%**

Source: Rosenberg (2002).

Yet the investment of $US57bn on medical and health research is less than 2% of the economic (direct and indirect) cost of illness in the US. The direct cost of health care expenditures is estimated at $US1.3 trillion for the year 2000 (14% of GDP), with an additional $US1.7 trillion (18% of GDP) indirect costs from premature deaths and the reduction in the ability to work (NIH, 2000). Direct costs are thus calculated at around 44% of total direct and indirect costs, with the indirect costs at around 56% of the total.

Table 31 details a breakdown of direct and indirect costs of a number of specific illnesses in the US. It is a compilation of figures derived from numerous studies over numerous years and therefore does not necessarily match the total figures quoted above from the NIH.

[7] Public funds included those from the federal, state and local governments. All others are included in the private funds.

Table 31 Economic costs of major illnesses ($USbn)

Illness	Year	Direct costs	Indirect costs	Total costs	Ratio indirect: total
Injury	1995	89.0	248.0	337.0	74%
Heart diseases	1999	101.8	81.3	183.1	44%
Disability	1986	82.1	87.3	169.4	52%
Mental disorders	1992	66.8	94.0	160.8	58%
Cancer	1994	41.4	68.7	110.1	62%
Alzheimer's disease	1997	15.0	85.0	100.0	85%
Diabetes	1997	44.1	54.1	98.2	55%
Chronic pain conditions	1986	45.0	34.0	79.0	43%
Arthritis	1992	15.2	49.6	64.8	77%
Digestive diseases	1985	41.5	14.7	56.2	26%
Stroke	1998	28.3	15.0	43.3	35%
Kidney and urological diseases	1985	26.2	14.1	40.3	35%
Eye diseases	1991	22.3	16.1	38.4	42%
Pulmonary disease	1998	21.6	16.2	37.8	43%
HIV/AIDS	1999	13.4	15.5	28.9	54%
Other (10 further illnesses)	various	53.4	23.9	77.3	31%
Total		**707.1**	**917.5**	**1,624.6**	**56%**

Source: NIH (2000). Note: All costs are in selected year unadjusted US dollars.

Table 31 shows the large variation in the ratio of direct to indirect costs depending on the type of illness/disease and where health expenditures are directed. For example, injuries have a very high indirect component (74%) due to reduced work ability. Strokes on the other hand have a large direct component (65%) but a relatively small indirect component (35%) probably due to the fact that strokes tend to occur later in life where the relative impact on work ability is lower.

The rate of return on publicly funded research is documented to be in the order of 25-40% per annum (NIH, 2000). This is based on a number of econometric studies undertaken in the US and it is noted that it is very difficult to quantify these types of numbers. It is also state that this rate of return '*agrees with estimates of privately funded research and development*' (NIH, 2000 p9). Examples in the box below alone total some $82bn per annum in savings, 16% of annual direct health expenditure and 1.4 times annual US research expenditure. It is notable that two of these major savings singled out by the US NIH are Australian – lithium and ulcers.

Examples of Direct Cost Savings in the US

- ***Tuberculosis.*** Before antibiotics were developed, tuberculosis patients often spent years in sanatoriums and had a high chance of death. Today, patients typically recover within a year with antibiotic treatments. As a result, the US health care system saves about $5bn annually in institutional care costs for the 300,000 or so patients who would have had this disease.
- ***Polio.*** For years, the best the medical profession could offer polio sufferers was management of the disease by the use of expensive iron lungs. With the discovery of the polio vaccine, the disease has been eliminated in the United States: no new cases have been reported since 1991. If a vaccine had not been found, US health care costs would have been about $30bn a year higher, according to one estimate.
- ***Peptic ulcers.*** Operations for peptic ulcers plunged 80% between the late 1970s and late 1980s as new pharmaceuticals were introduced to replace surgery. Further research found that ulcers can be complicated by a bacterium. The bacterium can now be treated with antibiotics. This discovery resulted in cost savings of about $600m annually.
- ***Clinical depression***. New drugs developed during the past two decades have dramatically cut treatment costs for the approximately 6 million Americans with clinical depression. Antidepression drugs save the health care system about $6.5bn annually.

- ***Other mental illnesses.*** Mental hospitals used to hold about 400,000 schizophrenia patients and other mental patients, but new drugs enabled 95% of patients to be treated on an outpatient basis by the late 1980s, saving up to $25bn annually. Lithium treatment for manic depression is saving over $0bn per year in hospital costs since being introduced about 30 years ago.
- ***Chronic disability.*** Long-term disability rates among the elderly have been falling as new treatments have become available, thus reducing the need for nursing homes. One study found that reduced nursing home usage saved $17bn from 1980 to 1994.

Directly reproduced from NIH (2000), p14.

Other direct and indirect benefits linked to research and development include:

- **New drugs**: Large savings have been made in the US (and elsewhere) through the development of new drugs[8]. In 1996, a statistical study examined the impact of new drugs on US health care costs. The study concluded that on average, a $US1 increase in spending on drugs reduced hospital care expenditures by $US3.65 (NIH 2000 p15).
- **Jobs created**: Major gains have been made in disease-oriented and patient-oriented research, through jobs created. It is estimated that in the biopharmaceutical industry, over 500,000 jobs have been created due to commitments in research and development (Rosenberg, 2002).
- **Life expectancy gains**: Between 1960 and 1997, mortality rates in the US have declined significantly, with the average life expectancy rising from 73.1 to 79.4 years for females and from 66.6 to 73.6 for males (OECD, 2002). A large part of this is due to significantly reduced mortality rates from cardiovascular disease. The NIH (2000) document a study which suggests that pharmacological innovations have increased life expectancy by 0.75-1% per year.
- **Reduced mortality and morbidity**: It is very difficult to disentangle the impact of R&D on improved health. The Wisconsin Association for Biomedical Research and Education (WABRE, 1995) assume that 30% of improvements in mortality and morbidity are due to advances in medical research as opposed to other factors, such as population programs and higher incomes.

Hope for Children with Cystic Fibrosis

"*My dream is to one day be able to tell parents that their child will live a long life and that they should plan for the future,*'" says Dr Robert J Fink, a paediatric pulmonologist at Children's National Medical Center in Washington DC. "*We are getting closer to that. Twenty years ago, children with cystic fibrosis (CF) rarely survived into adulthood. Now survival to mid-adulthood is expected. Half of my patients have the medical option of having children of their own some day. This was unheard of 20 years ago.*"

Cystic fibrosis, an inherited disorder, affects about 1 in 2,500 Caucasian children worldwide. Dr Fink attributes the longer survival of his patients to a combination of better antibiotics and anti-inflammatory drugs and well-tested and standardized treatment approaches. New aerosol-based drugs have the prospect of radically extending the lives of 5-year-old children today with CF. And it's not just longer lives these children can expect says Fink, it's better lives. New therapies have decreased hospitalizations by as much as 40%.

In 1989, the gene for CF was found. Prior to the discovery of the gene, notes Fink, there was money available for research, but treatment approaches were limited by the science. "*We didn't know where to go. We had hit a wall.*" After the gene was found, whole new avenues opened up for understanding the development and progression of the disease. Now the rate-limiting step is insufficient funding to follow those research paths.

Lasker/Funding First (1998, p2)

[8] Savings from antidepressant drugs primarily derive from reduced inpatient expenditures.

Benefits of improved healthspan are typically more difficult to measure than the direct and indirect costs associated with illness and disease. Methods for estimating the value of lives saved through research have been documented in Section 2.3. The following points summarise the outcomes of the work commissioned by Funding First in the US:

- Murphy and Topel (1999) indicate that increased longevity between 1970 and 1990 has led to net annual gains to the US economy worth $US2.4 trillion (in 1992 dollars). They also calculate the worth of curing specific diseases. For example, curing cancer would be worth $US47 trillion and heart disease, $US48 trillion (see Table 26 earlier).
- Nordhaus (1999) shows that the economic value of improvements in living standards for an individual (due to reduced mortality) is worth approximately 40% of their consumption expenditure. He also shows that health care spending per person has increased by $US1,200 per annum between 1980 and 1990. This compares to a value of improved longevity of $US2,300 to $US3,100 per person per annum (over the same time period). Thus the benefits of increased longevity are more than twice the size of direct health costs. Note that this does not include the value of reduced morbidity.
- Cutler and Kadiyala (1999) look at cost savings in cardiovascular disease, which have fallen by 60% in the US in the past three decades. They attribute one third of this to medical advances (such as better acute management and new drugs). They estimate that in the US, the average value of increased longevity from medical advances in heart disease is around $US85,000. This has cost around $US35,000 per person in research dollars, giving a gross investment return of 240% on the direct costs of the disease.

Summary of US work

- Around $US57bn is spent annually on medical and health research. This represents about 0.6% of GDP (Rosenberg, 2002). In comparison, Australia's spending on health R&D was 0.255% of GDP in 2000-01.
- Public sources of funds account for 39% of that spent, and private sources account for 61% (Rosenberg, 2002).
- The direct and indirect costs of illness are worth around $US3 trillion per year (or about 32% of GDP). Direct costs account for 44% of the total and indirect for 56% (NIH, 2000).
- The rate of return on publicly funded research (i.e. in terms of direct and indirect cost savings) is in the order of 25-40% per annum (NIH, 2000).
- About one-third of improvements in mortality and morbidity can be attributed to medical advances (WABRE, 1995).

2.4.2 Canada

Living standards in Canada have been increasing at a similar rate to the average for OECD nations, at around 2.0% per annum[9]. This is slightly above Australia's rate of 1.9% per annum. In 1999, Canadian females could expect to live to 81.7 years, and males to 76.3 years. These figures are very similar to those for Australia.

In a move that confirms an increasing commitment to health research, in 2000 a new organisation, the Canadian Institutes of Health Research (CIHR), was set up to coordinate research efforts and to provide an avenue for federal funding of health-related R&D. The CIHR is headed by Alan Bernstein and funds over 6,000 researchers in universities, teaching hospitals and research institutes. For 2002-03, CAD$650million from the federal government has been provided to the CIHR. More than 80% of this goes to research grants and awards. This level of funding has grown considerably since its inception in 2000 where CAD$360m was allocated from the federal budget.

[9] Using the average annual real GDP per capita growth between 1970 and 2001.

Yet the Canadian federal government provides only 16% of total health related R&D expenditures (Table 32). This proportion is lower than it was 10 years earlier, and it has only been since 1999 that funding levels have been growing at a more significant rate. Even though the provincial governments have the primary responsibility for providing health care services, their involvement in research is also small, accounting for around 7% of total health related R&D funding. Business enterprises and higher education facilities provide the majority of funds.

Table 32 Gross domestic expenditures on R&D in the health field, CAD$m

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Funding Sector												
Federal government	334	322	329	364	368	388	364	373	397	498	606	674
Provincial governments	145	147	152	148	152	159	149	172	179	201	249	279
Business enterprises	333	367	475	545	594	677	750	835	929	955	1,059	1,149
Higher education	558	620	689	687	689	762	776	791	874	871	1,072	1,233
PNP	152	173	162	203	231	234	268	287	295	304	353	395
Foreign	29	40	67	86	104	174	266	286	340	434	472	507
Total	1,551	1,669	1,874	2,033	2,138	2,394	2,573	2,744	3,014	3,263	3,811	4,237
Proportion of funds provided by:												
Federal government	22%	19%	18%	18%	17%	16%	14%	14%	13%	15%	16%	16%
Provincial governments	9%	9%	8%	7%	7%	7%	6%	6%	6%	6%	7%	7%
Business enterprises	21%	22%	25%	27%	28%	28%	29%	30%	31%	29%	28%	27%
Higher education	36%	37%	37%	34%	32%	32%	30%	29%	29%	27%	28%	29%
PNP	10%	10%	9%	10%	11%	10%	10%	10%	10%	9%	9%	9%
Foreign	2%	2%	4%	4%	5%	7%	10%	10%	11%	13%	12%	12%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Growth in Funding Sector Expenditures on R&D												
Federal government		-3.6%	2.2%	10.6%	1.1%	5.4%	-6.2%	2.5%	6.4%	25.4%	21.7%	11.2%
Provincial governments		1.4%	3.4%	-2.6%	2.7%	4.6%	-6.3%	15.4%	4.1%	12.3%	23.9%	12.0%
Business enterprises		10.2%	29.4%	14.7%	9.0%	14.0%	10.8%	11.3%	11.3%	2.8%	10.9%	8.5%
Higher education		11.1%	11.1%	-0.3%	0.3%	10.6%	1.8%	1.9%	10.5%	-0.3%	23.1%	15.0%
PNP		13.8%	-6.4%	25.3%	13.8%	1.3%	14.5%	7.1%	2.8%	3.1%	16.1%	11.9%
Foreign		37.9%	67.5%	28.4%	20.9%	67.3%	52.9%	7.5%	18.9%	27.6%	8.8%	7.4%
Total		7.6%	12.3%	8.5%	5.2%	12.0%	7.5%	6.6%	9.8%	8.3%	16.8%	11.2%

Source: Statistics Canada (2002).

In 2001, Canada spent a total of CAD$4.2bn on health related R&D. This represents 0.4% of GDP (which compares to 0.255% of GDP for Australia). The figures also indicate that in 2001, public funds accounted for 23% of total R&D expenditures in the health field, and private funds accounted for 77%[10].

Table 33 Proportion of R&D expenditure by diagnostic category (CAD$1998m)

Diagnostic category	% of total R&D expenditure	CAD$1998	CAD$2001
Cancer	7.5%	226.1	317.8
Cardiovascular diseases	5.7%	171.8	241.5
Nervous system/sense organ diseases	3.3%	99.5	139.8
Endocrine and related diseases	3.2%	96.4	135.6
Infectious diseases	2.1%	63.3	89.0
Mental disorders	1.9%	57.3	80.5
All other diagnostic categories	7.6%	229.1	322.0
Others	8.4%	253.2	355.9
Unattributable	60.2%	1,814.4	2,550.7

Source: Health Canada (2002). Note: 2001 figures assume that the 1998 percentages apply for 2001.
'All other diagnostic categories' sums other diagnostic categories not identified above, while 'other' is a catch-all for items not coded to a diagnostic category. 'Unattributable' are items unable to be allocated to any category.

[10] Public funds included those from the federal and provincial governments. All others are included in the private funds.

Health Canada has now prepared three reports on the economic burden of illness in Canada, the latest being released in 2002 (Health Canada, 2002). The report provides an analysis of the direct and indirect costs of illness in 1998, as determined by the opportunity costs to society of illness or injury. This provides a measure of the potential savings that could be gained if illness and injury were prevented, but it does not address savings due to improvements in healthspan. Findings from the report include the following:

- The total cost of illness in Canada in 1998 was CAD$159bn. This equates to around 18% of GDP.
- Direct costs (described as those costs directly measurable such as hospital care, drug expenditures, physician care and direct health expenditures on public health and research) account for 53% of total costs – or CAD$84bn.
- Indirect costs (described as the value of economic output lost due to illness and injury, disabilities and premature death) account for 47% of the total cost of illness – or CAD$75bn.
- Of the total indirect costs, 44% are due to premature mortality and 56% are due to morbidity.

Table 34 details the economic burden of illness by diagnostic category for Canada. It also breaks down the indirect costs between mortality-related costs and morbidity-related costs. Cardiovascular diseases, musculoskeletal diseases and cancer were the most costly illnesses, accounting for 31% of the total direct and indirect costs.

Table 34 Economic burden of illness, Canada, 1998 (CAD$million)

		Indirect Costs				
Diagnostic Category	**Direct costs**	**Mortality costs**	**Morbidity costs**	**Total**	**Total costs**	**Ratio of indirect to total costs**
Blood diseases	213.4	93.1	152.0	245.1	458.5	53%
Perinatal conditions	305.8	298.4	0.0	298.4	604.2	49%
Birth defects	175.8	357.8	172.4	530.2	706.0	75%
Skin and related diseases	1,474.3	18.7	169.6	188.3	1,662.6	11%
Pregnancy	1,297.1	12.3	378.5	390.8	1,687.9	23%
Infections & parasitic diseases	909.0	755.2	457.1	1,212.3	2,121.3	57%
Endocrine & related diseases	1,584.6	1,012.3	867.4	1,879.7	3,464.3	54%
Genitourinary diseases	2,597.3	319.7	596.8	916.5	3,513.8	26%
Others	3,221.5	0.0	683.8	683.8	3,905.3	18%
Well-patient care	2,623.3	0.0	2,374.9	2,374.9	4,998.2	48%
Ill-defined conditions	1,760.3	1,595.7	2,321.3	3,917.0	5,677.3	69%
Digestive diseases	3,540.0	1,134.3	1,179.9	2,314.2	5,854.2	40%
Mental disorders	4,680.8	479.9	2,710.8	3,190.7	7,871.5	41%
Nervous system/sense organ diseases	2,822.5	833.9	4,644.3	5,478.2	8,300.7	66%
Respiratory diseases	3,461.4	1,646.8	3,422.9	5,069.7	8,531.1	59%
Injuries	3,224.8	5,925.6	3,586.7	9,512.3	12,737.1	75%
Cancer	2,462.4	10,622.1	1,135.9	11,758.0	14,220.4	83%
Musculoskeletal diseases	2,648.4	125.7	13,607.1	13,732.8	16,381.2	84%
Cardiovascular diseases	6,818.1	8,250.0	3,404.8	11,654.8	18,472.9	63%
Unattributable	38,134.1	0.0	131.9	131.9	38,266.0	0%
Total	83,954.9	33,481.5	41,998.1	75,479.6	159,434.5	47%

Source: Health Canada (2002).

Health Canada uses a human capital approach to measuring the mortality and morbidity costs. Future production losses due to premature mortality or morbidity are discounted back to present values using a discount rate of 5%. The potential lifetime production lost takes account of factors such as life expectancy, average annual earnings, workforce participation rates, the value of unpaid work and labour productivity growth. For the morbidity measure, weights are assigned based on the severity of the illness/injury[11].

[11] For example 0.8 for a severe disability, 0.4 for moderate disability, and 0.1 for a mild disability.

Canada has not undertaken any specific work to determine the rate of return of expenditures on health R&D.

Summary of Canadian work

- Around CAD$4.2bn is spent annually on medical and health research. This represents about 0.4% of GDP (Statistics Canada, 2002). In comparison, Australia's spending on health R&D was 0.255% of GDP in 2000-01.
- Public sources of funds account for 23% of that spent, and private sources account for 79% (Statistics Canada, 2002).
- The direct and indirect costs of illness are worth around $US159bn per year (or about 18% of GDP). Direct costs account for 53% of the total and indirect for 47% (Health Canada, 2002).
- No rate of return work has been undertaken.

2.4.3 Singapore

There is very little information available on R&D spending in the health and medical field for Singapore, and no studies were found that discussed costs of illnesses or rates of return on investments dollars spent[12]. As such, this study briefly outlines what information is available.

In Singapore, there is a dual system of healthcare delivery – the public system (managed by the Government) and the private system (provided by private hospitals and general practitioners). 80% of hospital care is provided by the public sector and the remaining 20% by the private sector. For primary care, the reverse holds.

The Government heavily subsidises medical services at the public hospitals and government medical clinics. A combination of taxes, employee medical benefits, compulsory savings, insurance and out-of-pocket payments are used to finance the system. In 1999, the Singapore Government spent about S$4.3bn or 3.0% of GDP on healthcare, compared to 8.5% in Australia. Per capita healthcare spending was S$1,347. Government subsidy on the public healthcare services was 0.8% of GDP in 1998.

Singapore has a population of 4.1 million people, and a resident population of 3.3 million. It is a young population with only 7.4% above the age of 65, compared to 12.5% currently in Australia. The average life expectancy for Singaporeans is 78.4 years (76.4 years for males and 80.4 years for females).

The leading causes of morbidity and mortality are currently the major non-communicable diseases such as cancer, coronary heart disease, strokes, diabetes, hypertension and injuries. Cancer and cardiovascular diseases together account for approximately 62% of the total causes of death.

The Agency for Science, Technology and Research (A*STAR) is a branch of the Ministry of Health in Singapore, and they collect statistics relating to R&D (A*STAR, 2001). One category of information relates to the biomedical sciences[13], which provides us with an indication of R&D expenditure in the health field.

In 2001, a total of S$3.2bn ($US1.8bn) was spent on all R&D in Singapore. 9.2% of this was in the biomedical sciences field (or S$298m, $US166m).

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12 Most of the information in this section is obtained from the Singaporean Ministry of Health. Accessed on April 30, 2003 from http://app.moh.gov.sg

13 This includes basic medicine (anatomy, pharmacology, physiology), clinical medicine (anaesthesiology, dentistry, internal medicine, gynaecology, paediatrics, surgery), health sciences (public health services, epidemiology), biological sciences (bacteriology, biochemistry, biology, biophysics, genetics, microbiology) and related sciences.

The split of R&D expenditures across the private sector, higher education sector and public research institutes is fairly even, each accounting for around 26% to 28% of the total R&D funds in biomedical sciences (Table 35). The government accounts for slightly less of the total, at 19%.

Table 35 R&D expenditure, Singapore, $US, 2001

	Private Sector	Higher Education	Government	Public Research Institutes	Total
Biomedical Sciences	46	45	32	43	166
% of total R&D	12%	12%	8%	11%	5%
% of total biomedical sciences R&D	28%	27%	19%	26%	100%

Source: A*STAR (2001). Note: Singapore dollars converted to US dollars at an average annual exchange rate of 0.588 for 2001.

The higher education sector and public research institutes spend a relatively high proportion of their total R&D dollars in the biomedical sciences area (i.e. between 19% and 22%). In 2001, the private sector only spent 4% of their R&D dollars in the health area, although this rose from 1.5% the previous year.

2.4.4 Where mistakes have been made

New Zealand

In a recent review of New Zealand health R&D capacity (Health Research Council of New Zealand, 2002), the Chair of the HRC concluded that:

> *"The evidence compiled in this Report highlights some key areas of concern for the Ministry and for the HRC. The under-investment in health research, and health research infrastructure in this country compared with other firs-world nations threatens the sustainability of evidence-based care, and reduces incentives for clinicians to practice in New Zealand. The small number of clinicians engaged in high quality research limits the ability to take up research findings and extrapolate the results of research conducted overseas to New Zealand."*

The Report found that, of 19 OECD countries, New Zealand ranked fifth lowest in funding health R&D as a percentage of GDP and as a percentage of health expenditure. In 1998, health R&D in New Zealand relative to health spending was 0.9%, compared to between 1-2% in most OECD countries. Moreover, since 1998 a number of OECD countries were found to have increased their budgets for health R&D, resulting in an even greater disparity between New Zealand's health R&D funding and that of other countries (p2).

The tide of graduates leaving New Zealand for opportunities was highlighted in the report, which concluded that 'the ultimate costs of failing to foster and support a research workforce can be measured in inappropriate standards of care and the failure of services to be cost-effective' (p1). The report advocated that research be viewed as 'an investment rather than a cost, with the potential to relieve the burden of illness, and the burden of cost placed on the health system.'

Related to the low and relatively declining levels of funding, but also a result of regulatory frameworks, New Zealand has a relatively unfavourable environment for the biotechnology industry, which the Researched Medicines Industry Association of New Zealand (RMIANZ or RMI) describes in a discussion paper entitled *The Knowledge Economy, Health Research and the Pharmaceutical Industry in New Zealand* as 'in dire risk of becoming a victim of policy dysfunction" and "as fragile as the level of research funds available'. This paper concludes that:

> *"The knowledge and investment developed here in biomedical research remain in grave danger of melting away as research funds reduce… In the space of a few years, New Zealand had built a reputation for having the western world's most hostile operating environments for the pharmaceutical industry." (RMI, 2000).*

The paper attributes this demise to a number of policies and outlooks, including:

- government policies that restricted intellectual property protection;
- medicine purchasing that was driven by a system focussing on short-term cost-reduction for the tax payer, at the expense of longer term economic development; and
- an absence of commercial protection, through the exclusion of the industry from anti-competitive provisions in the Commerce Act.

Government pressure to control health expenditures on the pharmaceutical budget, along with restrictions placed on pharmaceutical companies that restrict their ability to compete for a share in either the public or private market for medicines in the country, impacted on the industry. This has ultimately resulted in many companies reconsidering their position within the New Zealand market. For example, GlaxoSmithKline is one of the world's largest pharmaceutical companies and originated in New Zealand. Yet diminishing research funds in New Zealand are driving investments down, and the country is in danger of losing GSK presence, among others. In 2000, New Zealand's R&D investment by the pharmaceutical industry was NZ$13m and falling. Staffing numbers have fallen, R&D funds have been withdrawn, products have been removed and there has been a reluctance to introduce new innovative medicines to the market.

3. ECONOMIC RETURNS TO AUSTRALIAN INVESTMENT IN HEALTH R&D

The previous two chapters have demonstrated that, although Australia currently invests over $1.7bn per annum (around one quarter of one % of GDP) in health R&D, funding remains at the low end of the OECD spectrum. Moreover, although private sector investment is showing strong growth, public sector investment has been declining over the 1990s, as identified also in the Wills Report, which advocated an increase in publicly financed research. Increased Commonwealth funds are now being channelled through the NHMRC, although not yet reflected in the published ABS data.

This chapter will look at the economic returns to investment in health R&D, applying the international methodologies identified in the previous chapter to derive returns within the Australian health sector, across the economy, and also to every Australian in terms of increased 'healthspan' (healthy lifespan). Returns to investment in R&D are known to be exceptional, but the purpose of this chapter is to put a more defined range on these returns in the health sector.

3.1 TYPES OF RETURNS IN AUSTRALIA

In general, when quantifying returns to investment, it is important to distinguish where those returns accrue. The direct or 'private' returns are those accruing directly to the research organisation, including the profits resulting from marketing of any products, as well as royalties and license fees from any patents. Intra-industry returns accrue to other organisations within the same industry (health in this case - for example, if one pharmaceutical company produces a generic brand drug after expiry of the original patent) while inter-industry returns accrue to other industries (e.g. if a miniaturisation process in the IT industry is applied to produce miniature bionic ears for the health industry). The social benefits that accrue indirectly (not to the originating research body) are called *spillovers* or 'positive externalities'. Spillover benefits may also cross international boundaries.

- **Spillover**: Refers to any unpaid benefit or unrecompensed cost that flows to any agent other than the organisation undertaking the R&D. It is the difference between the private and social rates of return.
- **Rate of return**: The flow of benefits expressed as the average annual benefit accruing in perpetuity as a proportion of the cost of the asset (the stock of knowledge) generating the benefit.

The Industry Commission (1995), in Appendix QA, 'Quantifying the Returns to R&D: The Evidence to Date', outlined a variety of approaches to measuring R&D returns in Australia across industries, including:

- **production functions**, where the output of the firm, industry or economy is econometrically estimated as a function of the quantity of materials, labour and capital used in production, as well as the own R&D of the firm, industry or economy and the R&D spillover pool;
- **cost functions**, where the total cost of production is econometrically estimated as a function of the price of the materials, labour and capital used in production, as well as the own R&D of the firm and the R&D spillover pool;
- **total factor productivity (TFP),** where growth in labour productivity or, more strictly, TFP (the residual of output over the labour and physical capital used in production) is estimated econometrically as a function of R&D intensity – the ratio of R&D expenditure to value added (output) or sales; and
- **case studies**, where the benefits and costs that accrue to the firm and to society of a particular innovation are identified and compared. Case studies have been a useful complement to econometric studies.

Key methodological issues identified in measuring returns were:

- difficulties valuing the benefits and costs to the firm undertaking the R&D, and to society;
- the complementary nature of R&D;
- attributing benefits over time;

- identifying other growth factors (e.g. structural changes may also result in greater productivity or lower costs); and
- data issues – availability of consistent data, measuring changes in quality, measuring and depreciating the stock of knowledge, identifying and valuing spillover pools, avoiding double-counting and potential econometric problems.

The Industry Commission found econometrically estimated returns from R&D of between 10% and 55%. Average industry rates of return were little different from firm rates indicating that average intra-industry spillovers were relatively small (2 to 15%), although there was a wide spread of rates of return (-66% to 285%, most 0 to 130%). There was some evidence that inter-industry spillovers may actually erode private returns. Differences were noted between countries, between industries, between different types of R&D (basic cf. applied) and over time. Country of ownership was also an issue affecting rates of return, with foreign R&D investment having greater domestic benefits the more open the economy to international trade. Importantly, public returns (returns to publicly financed R&D) were found to be significantly lower than private returns, suggesting perhaps that not all the social benefits were being captured, or that private benefits are indeed more than half the total benefits.

Health R&D has a relatively high proportion of spillover benefits that are difficult to capture within the private sector (e.g. the benefits of lower absenteeism to the employer of someone able to be treated for a condition previously not treatable). Moreover, for social equity reasons, there is a need to ensure access to new health technologies for all Australians, which represents a constraint on the operation of private returns alone. Sections 3.1.1 to 3.1.3 below attempt to quantify the types and scale of returns to health R&D (broadly defined as in Section 2.3.1) and identify whether they accrue in the private or public sector. Attempts to measure the benefits of commercialisation within Australia have not been made, although this issue is qualitatively addressed in Section 4.

A final point is that the sections below do not attempt to evaluate the effectiveness of particular types of research at a micro level, although such cost effectiveness analysis and evaluation is performed routinely by funding bodies. Methods that funding bodies use are quite different, including peer review techniques, bibliometric and patent analyses, user surveys, technometrics and human capital approaches (Centre for Research Policy and Innovation Studies, 2000).

3.1.1 Direct returns in the health sector

Returns in the health sector accrue to both the public and private sector. Table 36 shows that the public sector finances 70% of the Australian health industry, while the private sector finances 30%. However, the shares vary between areas of expenditure, with large areas such as medical services and public hospitals having high shares of public finance, while private hospitals and other professional services have the highest private shares.

Table 36 Health expenditure by source of funds and area of expenditure, 2000-01

Total expenditure, current prices	**$m**	**% Total**	*Recurrent expenditure, constant prices*	**Public**	**Private**	**Total**
Commonwealth	28,845	47.5%	Public hospitals	91.4%	8.6%	27.1%
State/ Terr & local	13,678	22.5%	Medical services	81.8%	18.2%	17.8%
Total public sector	**42,523**	**70%**	Pharmaceuticals	58.0%	42.0%	13.2%
Private health insurance funds	4,349	7.2%	Private hospitals	34.2%	65.8%	8.3%
Individuals	10,534	17.3%	High level residential aged care	77.1%	22.9%	7.9%
Other non-government	3,378	5.6%	Other professional services	16.7%	83.3%	4.4%
Total private sector	**18,257**	**30%**	Other	60.0%	40.0%	21.2%
Grand total	***60,779***	***100.0%***	***Total***	***70%***	***30%***	100.0%

Source: AIHW (2002), Tables 12, 13, 14, 15 and 19.

The sector investing may not be the sector that reaps the rewards. R&D by pharmaceutical companies, for example, may result in new drugs that reduce hospitalisations and high level care institutionalisations, saving mainly public sector dollars. Access to those drugs may be gained through the PBS (Pharmaceutical Benefits Scheme), resulting in public finance for the drugs themselves (in contrast to the R&D). Separating out the individual effects can be complex. In this report, however, we assume that overall the direct health sector

benefits are distributed in line with the financing – 70% public and 30% private, reflecting a judgement that overall there is no reason to expect that publicly and privately financed R&D are likely to result in different productivity gains across each area of expenditure. The potential direct health system benefits of R&D are thus currently around $43bn in the public sector and $18bn in the private sector, totalling $61bn overall.

Table 37 shows health expenditure by broad area, based on 1993-94 figures derived by Mathers and Penm (1999) at the AIHW. Cardiovascular and digestive disorders each accounted for nearly 12% of health system costs, while musculoskeletal disorders accounted for a further 10%. Updated top-down cost data are due to be released by the AIHW later this year – in the absence of more recent compositional data, an approximation of the 2000-01 dollar amounts is made by extrapolating the 1993-94 shares to the 2000-01 total cost ($60.8bn). Similarly, the number of deaths in 1993-94 is crudely extrapolated to 2000-01 assuming the shares remain constant and using ABS data for the total number of deaths in that year[14]. 43% of Australian deaths were attributed to cardiovascular events, while 27% were attributed to cancers.

Table 37 Direct health system costs ($m) and deaths by health area, 1993-94 and 2000-01

	Expenditure			Deaths		
	1993-94 ($m)	**2000-01* ($bn)**	**% share**	**1993-94**	**2000-01***	**% share**
Cardiovascular	3,719	7.2	11.8%	54,888	55,634	43.3%
Digestive	3,715	7.2	11.8%	3,859	3,911	3.0%
Musculoskeletal	3,002	5.8	9.6%	775	786	0.6%
Injury	2,601	5.0	8.3%	7,189	7,287	5.7%
Mental	2,586	5.0	8.2%	2,985	3,026	2.4%
Respiratory	2,521	4.9	8.0%	9,958	10,093	7.9%
Nervous system	2,334	4.5	7.4%	2,944	2,984	2.3%
Cancer	1,904	3.7	6.1%	34,206	34,671	27.0%
Genitourinary	1,662	3.2	5.3%	2,110	2,139	1.7%
Symptoms	1,334	2.6	4.2%	547	554	0.4%
Complications of pregnancy	1,051	2.0	3.3%	16	16	0.0%
Endocrine	966	1.9	3.1%	4,112	4,168	3.2%
Skin	956	1.9	3.0%	211	214	0.2%
Infectious	849	1.6	2.7%	1,042	1,056	0.8%
Perinatal	239	0.5	0.8%	695	704	0.5%
Blood	192	0.4	0.6%	401	406	0.3%
Congenital	159	0.3	0.5%	754	764	0.6%
Other	1,607	3.1	5.1%	-	-	0.0%
Total	**31,397**	**60.8**	**100.0%**	**126,692**	**128,415**	**100.0%**

* Approximations only. Source: Access Economics derived from Mathers and Penm (1999), Table 1 and AIHW (2002).

3.1.2 Indirect financial returns

In addition to direct health system costs, there are a number of indirect financial costs of illness. Measurement of indirect costs remains a matter of some debate and controversy. The World Health Organization and most cost of illness studies typically have classed indirect costs as all financial costs that are not health system costs, although different studies include different elements (most include productivity and carer costs) and there can be differences in definitions (e.g. the incorporation of low level residential care costs or community health and aged care costs). This area of study is very much an emerging science so making comparisons needs to be done with caution and with attention to methodologies adopted. Two distinctions are important.

- The first is the distinction between *real* indirect costs and *transfer payments*, where the latter do not represent real goods and services but, rather, monetary transfers from one economic unit to another through the government. Illness incurs public sector transfer payments such as lost taxation revenue, carer payments and welfare payments (such as unemployment benefits or the disability pension)[15]. Only real

[14] A simple average of deaths for 2000 (128,290) and 2001 (128,540) from ABS (2002) *Deaths, Australia,* Cat No. 3302.0, December.

[15] It should be noted that R&D that results in improved health thus has spillover benefits on the fiscal balance, although the multiplier effects of such distant macroeconomic spillovers (lower interest rates, improved external balance and so on) are not estimated here.

indirect costs are included in this report, so estimates of potential returns are conservative since, if we were not spending money on the real transactions costs associated with transfer payments, we could spend even more on health R&D and produce even better health outcomes for the nation.

- The second is the distinction between real costs in the public sector and those in the private sector. Most of the indirect costs of illness tend to be borne in large part by private individuals, either as a direct result of the disability from their illness or by caring for someone who is not well.

Access Economics has undertaken a number of studies in recent years to estimate the indirect costs of various illnesses and conditions in Australia including arthritis, osteoporosis and associated fractures, dementia, schizophrenia and bipolar disorder. An Australian estimate of the indirect costs of cardiovascular diseases will be released in 2004. In these reports (Access Economic 2003a, 2003b, 2002, 2001a, 2001b), indirect cost estimates have included both real and transfer cost elements itemised separately. In this report, however, as noted above, only real costs are included, with the elements outlined below.

- Earnings forfeited due to the disabling nature of the illness causing **premature retirement and absenteeism**[16] – almost all real costs borne by the private individual, some by their employer (public or private) and some by the public sector in providing employment services. The splits between public and private are estimated here as 3% and 97% respectively.
- Earnings forfeited due to **premature mortality** – this reflects that, in the absence of illness, people who would otherwise die prematurely would instead be well and participate in the labour force similarly to average Australians, and for the same expected duration. Their net present value (NPV) of their average future income stream based on a discount rate of 0.81%[17]. The entire cost is borne privately.
- Earnings forfeited by **carers** (the value of informal sector care) - for many illnesses, the patient is supported and cared for by a spouse, parent, family member or significant other.

Informal care

Carers Australia estimates there are at least 2.3 million Australians (one in every five households) providing care for family members or friends with a disability, chronic condition or who are frail aged. Nearly 20% (450,900) of these are 'primary' carers, of whom 70% are female. The 'invisible workforce' saves the economy around $16bn annually and is the major provider of community care services, delivering 74% of all services to people needing care and support. The Home and Community Care (HACC) Program, worth over $1.1bn nationally, meets only 9% of this need. 78% of primary carers are of workforce age (15 to 64 years) yet 59% are not attached to the workforce. Over one-half of all full-time carers reported incomes of less than $200 per week, while also experiencing the increased expenses of looking after another person. 40% of primary carers have been providing care for a decade or more, and 68% for more than 5 years. Care is mostly for a partner (43%), child (25%) or parent (21%), and most primary carers (54%) said that they provided care either because alternative care was unavailable or too costly, or because they consider they have no choice. Carers suffer from generally worse physical health, tiredness, stress, back/muscle problems, depression, anxiety and lack of respite.

- Placing a value on the cost of volunteer care is difficult but nonetheless very important, and becoming more so as, in Australia, we increasingly cap hospital inpatient beds, discharge patients earlier, and move people with disabilities out of institutionalised settings. Greater emphasis is being placed on partnerships with community organisations, such as through the Home and Community Care (HACC) program, on 'ageing in place' and on a proliferation of paid home help and domiciliary care services. These costs of illness are not included in direct costs. A comprehensive assessment of carer costs in Australia would require detailed survey work to assess care needs across the spectrum—personal hygiene, cleaning, cooking, washing,

[16] The loss of production or earnings associated with illness assumes that, in the absence of illness, people would participate in the labour force and obtain employment at the same rate as other Australians, and earn the same average weekly earnings. The implicit economic assumption is that the numbers would not be of sufficient magnitude to substantially influence the overall clearing of the labour market.

[17] 0.81% is the 30-year average growth of real average weekly earnings (AWE) with the Consumer Price Index as the deflator for the period 1981-92 to 2011-12, including forecasts from the Access Economics Macroeconomic Model. Then NPV = $\Sigma Y/(1+r)i$ where Y=annual income of those who would participate, r=0.81% and i=0,1,2……n and n= years to retirement.

shopping and house/garden maintenance, as well as nursing care. Wherever these tasks are outsourced (to hired assistants, home services and most often volunteer carers), ideally the cost should be attributed as disease cost, although there is a need to distinguish between costs of illness and cost of ageing per se. A conservative approach has been adopted by Access Economics in that none of the cost of (paid) community care has been included, only an estimate of the 'opportunity' cost of voluntary carers' sacrificed income or alternate 'replacement' value of their care. As such, the entire cost is private.

- **Aids and modifications** required because of illness and its associated disability, such as mobility/transport aids (e.g. walking frames, wheelchairs), aids for lifting/transfers (e.g. adjustable beds, hoists and mechanical lifters), communication aids (e.g. hearing aids), nursing aids (e.g. pressure-relief mattresses, daily pill-boxes), adapted cutlery and common items (e.g. clothing with Velcro, spectacles), bathing and toileting aids (e.g. shower accessories, commodes, incontinence pads, special taps), safety aids, and home modifications such as grab rails, ramps, special lighting, continence, leisure and recreation, mobility, seating and transport. Most of the cost of such items is paid for privately, although a number of government programs are available to assist with these costs.
- **Other costs**: Where other costs are significant these have also been included, for example, forensic costs (criminality, legal and prison costs) that can be associated with under treated mental illnesses. Forensic costs tend to be borne mainly by the public sector, although some of the costs (e.g. legal fees, damages) are borne by private individuals and insurance companies (and ultimately insurance policy consumers).

Table 38 outlines indirect cost estimates of major health areas in Australia. The first five of these, 'above the line' are based on the previous Access Economics reports (2003a, 2003b, 2002, 2001a, 2001b), which attributed the prevalence of the condition, the impacts of demographic ageing and other factors important in estimating costs. 'Below the line' estimates in Table 38 are very crude, as in Table 37 attributing the direct cost as a straight extrapolation of the 1993-94 AIHW cost estimates and attributing indirect costs in the same proportions as the US estimates (see Table 31 earlier).

Table 38 Indirect costs of uncured disease, Australia ($bn)

Illness	Year	Direct costs	Real indirect costs	Total costs	Ratio indirect: total
Arthritis	2000	2.2	4.9	7.1	68%
Osteoporosis (& related fractures)	2000-01	1.9	4.5	6.3	71%
Dementia	2002	3.2	2.2	5.4	40%
Schizophrenia	2001	0.7	0.7	1.4	52%
Bipolar disorder	2003	0.3	0.8	1.1	74%
Cardiovascular*	2000-01	7.2	5.7	12.9	44%
Digestive diseases*	2000-01	7.2	2.5	9.7	26%
Injury*	2000-01	5.0	14.3	19.4	74%
Cancer*	2000-01	3.7	6.0	9.7	62%
Genitourinary*	2000-01	3.2	1.7	4.9	35%
Endocrine (inc diabetes)*	2000-01	1.9	2.3	4.2	55%
Other*	2000-01	24.3	31.7	56.0	57%
Total*		**60.8**	**77.4**	**138.1**	**56%**

* Approximations only. Source: Access Economics (2003a, 2003b, 2002, 2001a, 2001b); Extrapolations from Mathers and Penm (1999), Table 1 and AIHW (2002); NIH (2000) for ratios 'below the line'.

Table 38 shows that overall, the real indirect costs of illness in Australia are around $77bn, more than the direct costs. Like the US, and because most of the shares were based on US shares, indirect costs overall were 56% of total real costs. The total cost of illness in Australia was around $138bn in 2000-01.

The previous work of Access Economics is also used to derive the public and private components of these indirect costs. Table 39 shows the various components derived for earnings (66% of the total overall), mortality (1.9%), carers (30%), aids and modifications (2.3%) and other costs (0.6%). The indirect costs of other diseases are then assumed to be distributed in the same proportions, which may well introduce bias, since the five conditions studied represent only 14% of total direct costs and particularly since the mortality component of cardiovascular disease and cancer is likely to be higher than for these five. However, the bias should be small since the mortality component is wholly private, so the final result – 97% private and 3% public for indirect costs –

should not be greatly affected. For direct and indirect costs overall then, the private and public shares are 32% ($45bn) and 68% ($93bn) respectively.

Table 39 Indirect cost components of uncured disease, with public and private shares, Australia ($bn)

	Earnings foregone	Mortality burden	Carers	Aids & modifi-cations	Other (e.g. Forensic)	Total Indirect	Direct	Grand Total
Arthritis (2000)	4,468	n.a.	300	99	n.a.	4,867	2,240	7,107
Osteoporosis (2000-01)	2,795	n.a.	1,573	82	n.a.	4,450	1,858	6,308
Dementia (2002)	355	9	1,713	120	n.a.	2,197	3,236	5,433
Schizophrenia (2001)	488	94	88	n.a.	52	722	661	1,382
Bipolar (2003)	464	145	199	n.a.	25	833	298	1,131
Subtotal '5' Indirect	8,570	248	3,873	301	77	13,069	8,293	21,361
% Total	*65.6%*	*1.9%*	*29.6%*	*2.3%*	*0.6%*	*100.0%*	14%	
Other Diseases (2000-01)*	42,156	1,220	19,053	1,480	378	64,286	52,487	116,773
Total	***50,725***	***1,469***	***22,926***	***1,780***	***455***	***77,355***	**60,779**	**138,134**
Public Share	3%	0%	0%	25%	75%	**3%**	**70%**	**32%**
Private Share	97%	100%	100%	75%	25%	**97%**	**30%**	**68%**
Public Total	1,522	-	-	445	341	2,308	42,523	44,831
Private Total	49,204	1,469	22,926	1,335	114	75,047	18,257	93,304

* Approximations only. Source: Access Economics (2003a, 2003b, 2002, 2001a, 2001b); Extrapolations from Mathers and Penm (1999), Table 1, AIHW (2002) and NIH (2000).

3.1.3 Quality of life

Disease imposes burdens on patients that go well beyond the financial costs. The internationally developed 'Burden of Disease' approach (Section 2.3.3) has earned recognition in Australia and overseas as a useful way of estimating the pain, suffering and premature death in terms of the years of healthy life lost due to a disease. This method uses DALYs—or 'disability adjusted life years'—as the measuring stick. DALYs have two components:

- the years of life lost (YLL) due to premature death—the mortality burden; and
- the years of healthy life lost due to disability (YLD)—the morbidity burden.

Investment in health R&D and its consequences – new health technologies and methods – ultimately buys years of healthy life (DALYs). This section looks at the DALYs currently lost in Australia, as estimated by the AIHW (Mathers, Vos and Stevenson, 1999) for the year 1996. In that year the total burden of disease and injury in Australia was 2.51 million DALYs, equivalent to 137 DALYs lost per 1,000 people or 13.7% of total life years lived. A revised enumeration of DALYs by disease area is to be released by the AIHW during 2004. Figure 9 over the page shows the DALYs by major health area and their share of the total.

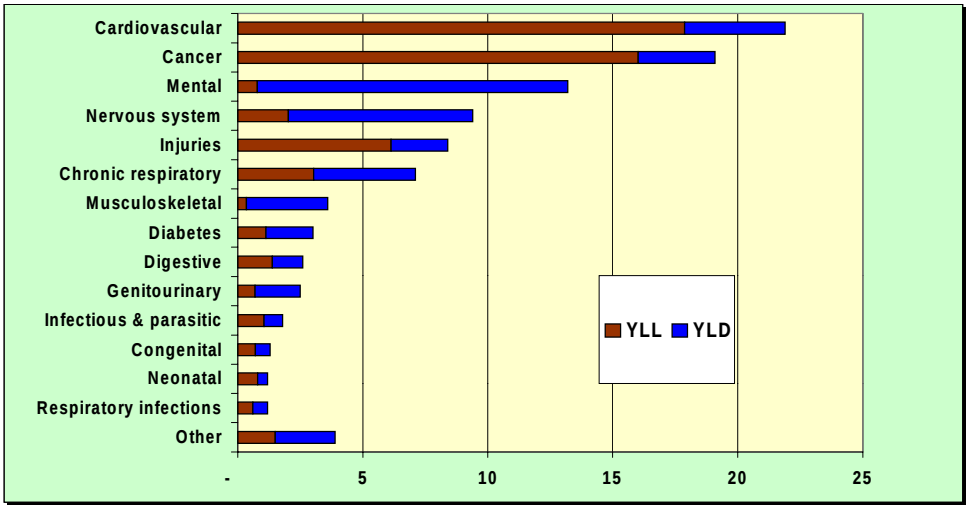
Cardiovascular disease is the greatest cause of lost DALYs (22% of the Australian total), followed by cancers (19%) and then mental illness (13%). Mental illnesses, nervous system disorders (mainly dementia) and musculoskeletal conditions have a relatively high proportion of morbidity burden (YLD) compared to mortality burden (YLL). Injuries (7.4%) contain a surprisingly high component of intentional injuries (2.7% of total DALYs), partly reflecting Australia's relatively high suicide rates. Mathers, Vos and Stevenson (1999) also observe that the male disease burden in Australia is 13% higher than the female disease burden due to 26% higher male mortality burden (YLD are 1% lower for males than females).

A final and important point is that of the total burden of disease and injury, 1.348 million DALYs (54%) were lost due to premature mortality (YLL) while 1.162 million (46%) were lost due to disability (YLD), a ratio of 1.16:1.

As noted earlier by the World Health Organization, at least five more years of healthy life per person can be gained by industrialised nations such as Australia through cost-effective interventions, i.e. those costing less that three times GDP per capita to avert one lost DALY – for Australia, less that A$112,000. Very cost-effective

interventions cost less than GDP per capita to avert one lost DALY – for Australia less than A$37,000. This represents another emerging evaluation criterion for health R&D projects.

Figure 9 Disability adjusted life years (DALYs) of major health areas, % total, Australia, 1996



Source: Derived from Mathers, Vos and Stevenson (1999), p 69 Table 5.5.

3.2 LINKING RESEARCH TO RETURNS IN AUSTRALIA

Section 2.3.1 observed that in linking health R&D to returns there are two key issues – first, valuing longer life and better health, and second, attributing R&D to a proportion of the improvement. In developing an Australian application, we have also encountered particular issues for Australia – notably how much of the gains in 'healthspan' are attributable to Australian (rather than foreign) R&D, as well as more general issues of accounting for time lags, 'serendipitous' gains and attribution to particular diseases. These issues are addressed in this section, culminating with a description of our methodology for Section 3.3.

3.2.1 Valuing improved Australian healthspan

Table 22 presented the improvements in Australian longevity over 1960-1999, noting that females gained 7.9 years of lifespan while males gained 8.3 years over the 30-year period. Table 23 presented the reductions in years of life lost by cause, noting that in 1999 only 37.2 years of life were lost per 1,000 compared with 87.2 in 1960, for Australians under 70. Section 3.1.3 above implies that, for all Australians, and including morbidity as well as mortality, in 1996 137 healthy years were lost per 1,000 people – 73.6 due to premature death and 62.4 due to pain and suffering.

In valuing these improvements in healthspan for Australia, we have adopted an eclectic 'blend and extend' version of the American economic experts. One concern was to value the improvements in quality as well as quantity of life. For mortality, we have relied on the extensive studies on valuation of human life, summarised in the meta-analyses by Viscusi (1993) and Tolley et al (1994) reported by Nordhaus (1999) and Cutler and Richardson, (1998) to estimate the value of a statistical life. These studies are colourfully summarised in Hatfield et al (2000, p4-5):

> *'Let's say that moving from a factory line to outdoor construction increases a worker's chance of a fatal accident by one in 10,000 each year. In other words, if 10,000 workers made the shift, expected on-the-job fatalities would rise by one per year. Suppose further that to induce 10,000 workers to play this death lottery voluntarily, an employer would have to pay an extra $500 annually to each worker for a total of $5m. One of these new construction workers is likely to die in return for the group gaining $5m. Thus the value of one life in this example is said to be $5m. In theory, the value of life could be revealed in other 'natural' experiments: the amount people are prepared to pay for smoke alarms, airbags and safety equipment; the discount in rent that people demand to live near chemical factories spewing toxic chemicals, and so forth. In practice, however, labour market models are less problematic. And,*

strikingly, estimates from the dozen or so sophisticated work-related studies since the mid-1970s put the value of a statistical life in the relatively narrow $3m to $7m range.'

It is important to remember that this 'value of a statistical life' measure does not bear a relationship to the value of foregone earnings (as in our indirect cost measures above and in assessing damages from death in civil liability suits), but goes beyond this to reflect personal risk and utility functions. Thus extending years of leisure in retirement is considered very valuable, even though it does not increase lifetime wages. Indeed, it is interesting that the valuation of life far exceeds average lifetime earning power.

Like Murphy and Topel, we used $US5m (the midpoint) as the value, with sensitivity analyses for the end-points ($US3m and $US7m), as per Cutler and Richardson. This is in contrast to Nordhaus, who used the $US3m low-point (which discounted to $US2.66m). With an average exchange rate of $A1= $US0.6667, the Australian equivalent values are A$4.5m to A$10.5m, with the midpoint at A$7.5m. Since all three of the key methodologies utilised a real discount rate of 3%, which is robust in the literature (Cutler and Richardson, p2) we employed this too. For our analysis then, the value of a life year in Australia was $150,000, with lower and upper bounds in the sensitivity analysis of $112,500 and $225,000.

The 'extension' to the methodology was then introduced to account for improvements in the *quality* of Australian life, as well as the improvements in longevity. The analysis of DALYs in Australia revealed that, overall, for each YLL lost due to premature mortality there was a further 86% of a DALY lost due to disability (YLD). This translated to around $129,000 as the value of a year of improved wellness, with lower and upper bounds in the sensitivity analysis of $97,000, and $194,000.[18]

Table 40 below shows the starting point – the gains in longevity (or quantity of lifespan) between 1960 and 1999 by cause, derived from Table 23.

Table 40 Gains in lifespan by cause, Australia, 1960-1999

Selected causes	**1960***	**1999***	**Gain***	**% total**
Cardiovascular	2,036	472	1,564	31.3%
External causes (injury)	1,787	1,160	627	12.6%
Cancer	1,169	848	321	6.4%
Congenital	564	220	344	6.9%
Respiratory	534	107	427	8.6%
Digestive	351	95	256	5.1%
Genitourinary	200	15	185	3.7%
Nervous system	186	122	64	1.3%
Infectious & parasitic diseases	181	47	134	2.7%
Endocrine, metabolic	157	111	46	0.9%
Mental	73	101	(28)	-0.6%
Skin	38	3	35	0.7%
Symptoms, ill-defined conditions	35	105	(70)	-1.4%
Blood	18	18	-	0.0%
Musculoskeletal	12	13	(1)	0.0%
Other	1,375	286	1,089	21.8%
All causes	**8,716**	**3,723**	**4,993**	100.0%

*Under the age of 70 (rate per 100,000, in years). Source: Access Economics derived from OECD (2002).

The methodology described above was applied to these gains, as itemised in Table 40, to derive the base case value of improved healthspan in Australia, in terms of both greater longevity and greater wellness. Straight line growth was assumed for the gains in healthspan over the period.[19] Low and high sensitivity analysis, ranging from

[18] Due to the lack of data for this time period on the allocation of improved wellness by disease, the assumption was made that this distribution was proportional to that of improved longevity. This is a weak point in the methodology that may be able to be improved over time if a data time series becomes available for YLD by disease, as per Mathers, Vos and Stevenson (1999).

[19] This differs from the American approach where the gains were concentrated in the 1970s. However, Australian data constraints prohibited this refinement, and it is considered unlikely to substantially alter the overall results.

$4.1 to $8.1 trillion for the overall gains, are shown in the Appendix (Tables 63 and 64 respectively) reflecting the alternative lower and upper bounds of statistical value of a life ($3m and $7m).

Table 41 shows that, for the base case, the value of improved healthspan over the 40-year period in Australia was worth $5.4 trillion, of which longevity was worth $2.9 trillion and improved quality of life was worth $2.5 trillion. The longevity component was 46% of final consumption expenditure over the period ($6.3 trillion), which compares well with the 40% finding of Nordhaus for the US. By 1999, the annual gains of better and longer life relative to 1960 were worth $264bn p.a., including $142bn due to greater longevity.

Improved Australian healthspan over 1960-1999 was worth $5.4 trillion, with $2.9 trillion from longer life (46% of consumption and $142bn p.a. by 1999).

Table 41 Gains in longevity, wellness and healthspan by cause, base case, Australia, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
Selected causes	1999 $m	1960-1999 $bn	1999 $m	1960-1999 $bn	1999 $m	1960-1999 $bn
Cardiovascular	44,427	911	38,291	785	82,718	1,696
External causes (injury)	17,810	365	15,351	315	33,161	680
Cancer	9,118	187	7,859	161	16,977	348
Congenital	9,772	200	8,422	173	18,194	373
Respiratory	12,129	249	10,454	214	22,583	463
Digestive	7,272	149	6,268	128	13,539	278
Genitourinary	5,255	108	4,529	93	9,784	201
Nervous system	1,818	37	1,567	32	3,385	69
Infectious & parasitic	3,806	78	3,281	67	7,087	145
Endocrine, metabolic	1,307	27	1,126	23	2,433	50
Mental	(795)	(16)	(686)	(14)	(1,481)	(30)
Skin	994	20	857	18	1,851	38
Symptoms etc	(1,988)	(41)	(1,714)	(35)	(3,702)	(76)
Blood	-	-	-	-	-	-
Musculoskeletal	(28)	(1)	(24)	(1)	(53)	(1)
Other	30,934	634	26,662	547	57,596	1,181
All causes	**141,830**	**2,908**	**122,243**	**2,506**	**264,073**	**5,413**

Source: Access Economics.

Improvements in the treatment of cardiovascular disease were very significant contributors to these gains – worth $1.7 trillion over the 40-year period and by 1999, worth $82.7bn per year.

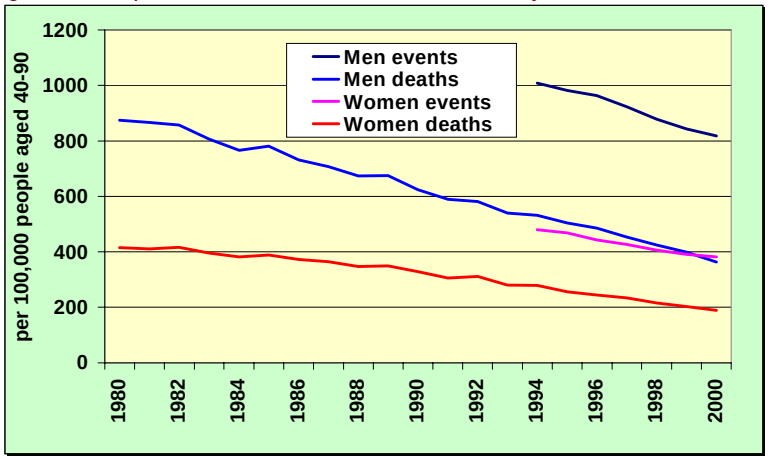
Cardiovascular improvements accounted for one third of the gains – $1.7 trillion.

Figure 10 over the page depicts the decline in mortality from cardiovascular disease in Australia, which is the primary source of the gain ($44.4bn) although there is of course also a substantial benefit also from the healthier life that can now be lived as a result of event-reducing interventions such as heart surgery, antihypertensive and lipid-lowering drugs, salt-reduced food products and so on ($38.3 trillion).

Injury prevention was worth $680bn over the period ($33bn p.a. by 1999); improvements in treatments for chronic respiratory conditions were worth $463bn (23bn p.a. by 1999); and improved screening and treatments for cancer were worth $373bn ($18bn p.a. by 1999), in particular screening for cervical cancer, breast cancer and colorectal cancer in latter decades (Peipert, 2002). Control of infectious diseases also brought $145bn of improved healthspan over the period, with most of this likely to have been gained through immunisation programs of earlier decades, although geriatric vaccination against pneumococcal continues to reduce mortality and morbidity.

Declines, rather than gains, were notable for mental illnesses, with a net human cost of $30bn over the period, or $1.5bn p.a. by 1999, excluding suicides or suicide attempts. Musculoskeletal disorders also show a small net cost, similarly due to higher mortality rates now from these conditions. Undiagnosed symptoms or ill-defined conditions showed the largest loss ($76bn over the period and $3.7bn p.a. by 1999), pointing in part to the need for research to improve our understanding of the causes of mortality and morbidity from such events.

Figure 10 Improvements in cardiovascular mortality, Australia, 1980-2000



Source: Access Economics derived from AIHW data.

3.2.2 Attributing Australian R&D to the improvements in healthspan

The second task is to attribute Australian R&D to these improvements in healthspan. As noted earlier (Section 2.3.1) a major issue is disentangling the effects of other factors such as improved diet, sanitation, housing and education that, along with effective antibiotics, were possibly the major causes of improved health in Australia prior to 1950. In the period 1960-1999, under-nutrition, poor sanitation or housing and low literacy were much less important contributors to poor health in Australia. Today's major risk factors are tobacco usage, physical inactivity, high blood pressure, alcohol abuse, overweight and obesity, high blood cholesterol, lack of fruit and vegetables in diet, illicit drug use, occupation and unsafe sex (Mathers, Vos and Stevenson, 1999).

With the information age, the public and consumer sectors have more opportunity to influence behaviour, including health actions, through their interventions aimed at addressing these and other risk factors. Notable Australian examples are the 'slip, slop, slap' campaign aimed at reducing the incidence of skin cancer, banning of smoking in many public places, the 'red healthy heart tick' on food products, compulsory wearing of seatbelts, the central pap smear register and a plethora of other initiatives. It is true that public awareness and information campaigns, regulatory and other disincentives are all ultimately based on original research that has linked the intervention to improved health outcomes, as well as in many cases, further public health research on how to most effectively target such interventions. However, knowledge of causes and taking action against them are both important, and the budgets for such interventions are indeed justified in terms of altering overall health outcomes. Hatfield et al (2000, p8) make the following comments:

> '*Changes in survival rates in the immediate aftermath of acute events – heart attacks and strokes – are almost entirely a result of new technology, which puts a lower bound on the likely benefits from medical research at 20% of the reduction in mortality… Another 13% is tied to new drug therapies that reduce blood cholesterol. Thus roughly one-third of the total gain is apparently the result of medical research that led to new drugs and treatment protocols. However, some fraction of the credit for the other two-thirds also should go to research since gains attributed to public policy and individual behaviour depend on research-driven information*.'

In the absence of robust Australian or international econometric evidence which separates out these effects, noting that the eminent American economists were also not willing to hazard a guess, and with the recommendation that such investigation is warranted in the future, the view here is that health R&D has directly, indirectly or serendipitously accounted for at least half of the gains in healthspan. We have thus modelled 50%

as our base case, which is thought to err on the conservative side, and surrounded the assumption with sensitivity analyses at the 30% and 70% levels.

The next major issue is how much Australian R&D has contributed to our own health gains, as opposed to the R&D pool of the rest of the world. Early in the 40-year period, it is likely that most of the Australian gains in healthspan were derived from European research, while later on that has gradually changed to favour North American discoveries. However, as noted in the Wills Report (see Section 1.2.4), for a country of Australia's size we have made enormous achievements in health R&D. With 0.3% of the world's population, Australia produces about 2.5% of the world's health R&D output. Australian scientists have received four Nobel prizes for Medicine or Physiology[20] and both our clinical and public health research continues to deliver high average publication (5% of the world total) and citation rates. The impact of Australian research ranks consistently in the top eight countries across a range of fields (Wills, 1999 p10-11).

The Australian case studies in Chapter 2 bear further witness to the major contributions and medical breakthroughs in areas as diverse as lithium, penicillin, bionic ears, SIDS, melanoma, AIDS testing and the origins of the biotechnology industry and genomic medicine. Moreover, in some areas, such as income from licenses and start-up company formation, our commercialisation performance is above that of either the US or Canada, relative to expenditure on research and the size of the national economy (ARC et al, 2002).

For this report, the assumption is made that Australia benefits in direct proportion to our research efforts, i.e. that 2.5% of the benefits in Australian healthspan have derived from Australian research. Once again this may be conservative, given the bibliometric and other evidence that gains from Australian research may indeed be higher than our global contribution, suggesting Australia has a comparative advantage in health R&D.

From these two assumptions, we present the results of the gains in healthspan attributable to Australian R&D, for the base case (1.25% of total gains) in Table 42 below. This table shows that Australian R&D alone is responsible for improved healthspan valued at $67.7bn over 1960-1999, including $3.3bn in 1999. The lower sensitivity (0.75%) and the higher sensitivity (1.75%) results are presented in Appendix (Tables 63 and 64 respectively). These show a lower case of $30.5bn over the forty year period (reaching $1.5bn in 1999) and an upper case of $142.5bn (reaching $6.9bn in 1999).

Distribution of gains among causes is necessarily the same as for Table 41, with of course 1.25% the order of magnitude. Australian data paucity currently precludes any other distribution linking research in and it is justifiable on two bases, each related to spillovers. The first of these we will call '**critical mass**'. This concept is widely acknowledged, reflecting the principle that it is easier to apply new discoveries, technology and innovation in an area where there is already expertise, and this is particularly true when the rate of advance is high.

[20] Peter Doherty 1996, Immunology; John Eccles 1963, Neuroscience; MacFarlane Burnet 1960, Immunology; Howard Florey 1945, Penicillin. Other distinguished prize-winners include Gus Nossal, Immunology; Don Metcalf, Haematology; Jack Martin, Bone research and endocrinology; Jacques Miller, Immunology; and (focusing on the 1990s) Vicki Sara, Endocinology; Barry Marshall, Gastroenterology; Colin Johnston, Hypertension; John Chalmers, Hypertension; Rob Baxter, Endocrinology; Suzanne Cory, Elizabeth Blackburn and Grant Sutherland, Molecular genetics; and Graeme Laver, Peter Colman and Mark von Itzstein, Pharmaceutical design.

Table 42 Gains in longevity, wellness and healthspan from Australian R&D, base case, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
Selected causes	1999 $m	1960-1999 $bn	1999 $m	1960-1999 $bn	1999 $m	1960-1999 $bn
Cardiovascular	555.3	11.4	478.6	9.8	1,034.0	21.2
External causes (injury)	222.6	4.6	191.9	3.9	414.5	8.5
Cancer	114.0	2.3	98.2	2.0	212.2	4.4
Congenital	122.1	2.5	105.3	2.2	227.4	4.7
Respiratory	151.6	3.1	130.7	2.7	282.3	5.8
Digestive	90.9	1.9	78.3	1.6	169.2	3.5
Genitourinary	65.7	1.3	56.6	1.2	122.3	2.5
Nervous system	22.7	0.5	19.6	0.4	42.3	0.9
Infectious & parasitic	47.6	1.0	41.0	0.8	88.6	1.8
Endocrine, metabolic	16.3	0.3	14.1	0.3	30.4	0.6
Mental	(9.9)	(0.2)	(8.6)	(0.2)	(18.5)	(0.4)
Skin	12.4	0.3	10.7	0.2	23.1	0.5
Symptoms etc	(24.9)	(0.5)	(21.4)	(0.4)	(46.3)	(0.9)
Blood	-	-	-	-	-	-
Musculoskeletal	(0.4)	(0.0)	(0.3)	(0.0)	(0.7)	(0.0)
Other	386.7	7.9	333.3	6.8	719.9	14.8
All causes	**1,772.9**	**36.3**	**1,528.0**	**31.3**	**3,300.9**	**67.7**

Source: Access Economics.

> Currently health care is going through dramatic change, due to rapid advances in our understanding of human physiology, particularly at the molecular level. Thus, in the current boom in biomedical understanding, R&D efforts are driving the health care system to advance at a rate that is arguably much faster than at any other time in history. The burgeoning information technology industry, while facilitating the dissemination of information, does not facilitate the ability to interpret new findings in the field of medicine. The ability to interpret and implement the major advances in biomedical understanding can only be achieved through direct experience in the research that leads to those advances. Research experience for Australia's health care workers enables them to put into practice new diagnostic, therapeutic and management techniques many years before they are available as off-the-shelf technology. Australians deserve to have access to the best of health care as it evolves.
>
> **ASMR (2000)**

Hence there is a need to maintain research endeavour across a range of areas in order to apply new results as they emerge; although 'breakthroughs' may not come equally in all areas, it is the critical mass that catalyses applications. Moreover, the gain in life expectancy in one area increases the *value* of breakthroughs in another area.

> '*Progress against one disease – say breast cancer – actually increases the value of progress against another – say diabetes – since it increases the average gain in life expectancy from successful diabetes treatment*.'
>
> (Hatfield et al, 2000), p7.

Critical mass is one reason why it would be difficult to argue that, for example, Australia has had more breakthroughs in cancer research than in cardiovascular research, so a relatively higher share of the gains should be attributed in Table 42 to the former relative to the latter.

A second reason that complicates the attribution of research endeavour to health gains is the role of **serendipity** in research. Scientific progress frequently has unforeseen of unanticipated benefits. An example might be the early concepts of gene therapy, which focused on replacing a gene that was defective in a specific well-defined genetic disease. However, this technology has potential spillover benefits in non-genetic disease such as pancreatic cancer and sarcoma, where tumour necrosis factor is directed into the cancer cells, as well as end-

stage coronary artery disease, where vascular growth factors may be life-saving, and macular degeneration, where sight loss may be prevented. Some such applications are now moving towards Phase III trials, with significant implications for healthspan, although not the intent of the original research. Serendipitous spillovers also thus complicate the attribution of returns from any investment in one particular research area.

A final issue that needs to be addressed before moving on to Section 3.3 is the treatment of **time lags** in estimating returns. The very nature of scientific investigation is that its results and timeframes are uncertain, and successes are cumulative. In pharmacological research, timeframes are somewhat more predictable, but this developmental research tends to build on public sector basic research that involves greater risks and externalities. As noted in Chapter 2, the fundamental research of Professor Shine and others conducted 30 years ago profoundly changed the methods of medical research and today's biotech industry continues to build in these early breakthroughs. How can such lags be captured?

The American economists take a simple approach, effectively ignoring lags and comparing gains with the research spend over the same period (20 or 25 years, depending on the study). At the same time, none of the US authors claim that the spectacular returns to research on cardiovascular disease guarantees that future research on these or any other disease would be high. However, Murphy and Topel point out that: '*the economic value of extending life is so large that research generating even modest advances against major killer diseases is bound to be a superb investment*.' (cited in Hatfield et al, 2000, p8).

Access Economics (2003b) estimates, among other more probable scenarios, the long run returns from investing in a $49m p.a. Australian research program that, 40 years from now, results in a 'magic bullet cure' for dementia, postulating a complete immunological eradication of this condition similar to the eradication of polio. The magnitude of direct and indirect cost savings alone in 2003 dollars is around A$4 trillion, excluding the benefits of increased healthspan.

Pushing the envelope even further, we can imagine a world where successful interventions that substantially prevent or defer neurodegenerative diseases, together with organ transplants, cancer treatments and other life-prolonging and life-enhancing interventions, continue to enhance healthspan possibly by decades. How can we relate the potential benefits from such future discoveries to the research that today is forming the foundation of the knowledge pool for our children's and grandchildren's healthspan? In economic terms, we cannot forecast this objectively although, like the Americans, we can retrospectively compare the gains in any year with the research spend in that same year, and assume that the future returns will be, in absolute terms, at least as large as previous returns. This is thus the approach we adopt in the next section, comparing the gains estimated from the year 1999 with the R&D investment in 1998-99.

3.3 RATES OF RETURN IN AUSTRALIA

Annual rates of return were between 1 and 5 times R&D expenditures, 2.4 times in the 1999 base case.

Australian health R&D data (SEO basis) in 1998-99 from Chapter 1 was $1.375bn. The returns from improved healthspan as derived in Section 3.2 in 1999 were $3.3bn in the base case. Thus the rate of return in that year was 240%, with a 129% longevity return and a 111% wellness return.

Our sensitivity analysis shows that, even in the low case, the returns are over 100% – suggesting that Australian R&D expenditures are at least recouped by health gains resulting from that Australian R&D. In the high case scenario, annual returns are over five times initial expenditures (Table 43).

Table 43 also provides an indication of rates of return by broad clinical health area. This was derived by, first, attributing private sector R&D expenditures by category in 1998-99 (see Table 65) in the same manner as for 2000-01 (Chapter 1), and then consolidating and aligning the clinical categories to relate to those for the gains in healthspan from Australian R&D, which involved condensing some categories and aggregating others. Non-clinical R&D was allocated on a proportional basis.

Table 43 Rates of return by major health area from Australian R&D, 1999

	Base			Low			High		
	Longevity	**Wellness**	**Healthspan**	**Longevity**	**Wellness**	**Healthspan**	**Longevity**	**Wellness**	**Healthspan**
Cardiovascular	423%	365%	788%	191%	164%	355%	889%	766%	1656%
Cancer	56%	48%	104%	25%	22%	47%	118%	102%	219%
Congenital	193%	167%	360%	87%	75%	162%	406%	350%	756%
Respiratory	320%	275%	595%	144%	124%	268%	671%	578%	1250%
Digestive	275%	237%	511%	124%	107%	230%	577%	497%	1074%
Genitourinary	95%	82%	177%	43%	37%	79%	199%	172%	371%
Nervous system & mental	12%	11%	23%	5%	5%	10%	26%	22%	48%
Infectious & parasitic	44%	38%	82%	20%	17%	37%	92%	79%	171%
Endocrine, metabolic	18%	16%	34%	8%	7%	15%	39%	33%	72%
Skin	52%	45%	98%	24%	20%	44%	110%	95%	205%
Blood	0%	0%	0%	0%	0%	0%	0%	0%	0%
Musculoskeletal	-1%	-1%	-1%	0%	0%	-1%	-1%	-1%	-3%
Other	140%	120%	260%	63%	54%	117%	293%	253%	546%
Total	**129%**	**111%**	**240%**	**58%**	**50%**	**108%**	**271%**	**233%**	**504%**

Source: Access Economics

Reflecting the significant falls in mortality and morbidity from cardiovascular diseases, R&D advances in this area unsurprisingly showed the highest historical rates of return, nearly 8 times annual R&D investment in this area. Returns to investment in respiratory system R&D were second highest, nearly 6 times R&D investment, while returns to R&D relating to digestive disorders were third at over 5 times the annual investment. Returns to R&D in genitourinary conditions and in cancer areas were also over 100%. Returns were significantly lower in relation to nervous system and mental disorders, although still a healthy 23%. Only R&D into blood and musculoskeletal disorders did not generate positive returns.

It is also interesting to assess the returns for the public and private sectors. Public and private gains to healthspan were attributed in the same proportions as the gains that would accrue through aversion of direct and indirect costs of illness – namely 32% public and 68% private (refer Table 39). In the base case, this suggests that, of the $3.3bn of total gains, $1.1bn would accrue to the public sector and $2.2 to the private sector.

Comparing the gains to the investments of the public and private sectors (in terms of financing health R&D, not performing it), the returns are nearly three times higher in the private sector (387%) than the public sector (134%). Our sensitivity analysis suggests a range for public returns from 60% to 282%, and for private returns from 174% to 813%. Table 44 also illustrates the division of returns from longevity and wellness.

Table 44 Rates of return by source of funds, 1999

Returns ($m)	Base			Low			High		
	Longevity	**Wellness**	**Healthspan**	**Longevity**	**Wellness**	**Healthspan**	**Longevity**	**Wellness**	**Healthspan**
Public	575	496	1,071	259	223	482	1,208	1,041	2,250
Private	1,198	1,032	2,230	539	464	1,003	2,515	2,167	4,682
Total	**1,773**	**1,528**	**3,301**	**798**	**688**	**1,485**	**3,723**	**3,209**	**6,932**
Public	72%	62%	134%	32%	28%	60%	151%	130%	282%
Private	208%	179%	387%	94%	81%	174%	437%	376%	813%
Total	**129%**	**111%**	**240%**	**58%**	**50%**	**108%**	**271%**	**233%**	**504%**

Source: Access Economics.

Table 45 derives the economic value of potentially addressing current (1999) mortality and associated morbidity.

Table 45 Economic value of potential improved healthspan, Australia (A$bn), 1999

Gains remaining $bn	Longevity	Wellness	Total
External causes (injury)	675	582	1,258
Cancer	494	426	919
Cardiovascular	275	237	512
Other	167	144	310
Congenital	128	110	239
Nervous system	71	61	132
Endocrine, metabolic	65	56	120
Respiratory	62	54	116
Symptoms, ill-defined conditions	61	53	114
Mental	59	51	110
Digestive	55	48	103
Infectious & parasitic diseases	27	24	51
Blood	10	9	20
Genitourinary	9	8	16
Musculoskeletal	8	7	14
Skin	2	2	3

Source: Access Economics

Future R&D gains, even relatively small, have potentially stunning impacts.

- There are still $1.3 trillion of potential health gains to be made from reducing intentional and unintentional injuries. Reducing these by 30% would save over $370bn, greater than Australia's total net foreign debt.
- R&D that reduced deaths from cancer by one fifth would be worth $184bn to Australians, more than total forecast Commonwealth spending in the current fiscal year.
- Reducing cardiovascular event s by 15% would be worth $34bn – exceeding our total federal health budget.

'*What we take for granted in the clinical literature today was considered basic science only a decade or two ago. And one can be confident that we are only at the beginning of reaping the benefits of the truly impressive scientific progress achieved over the past 50 years. As a nation we must, however, support the continued funding of this research, both basic and clinical, as well as the training of physician-scientists, who are most critical to conducting the necessary translational research*' (Kelley, 2003, p604).

4. CONCLUSIONS AND RECOMMENDATIONS

Section 4.1 summarises the findings of the previous chapters, while Section 4.2 draws together the key messages with recommendations for areas of application.

4.1 SUMMARY OF FINDINGS

Chapter One: Expenditure on health R&D in Australia

Australia spent $1.7bn on health R&D in 2000-01.

- Of this, universities performed 45%, businesses 25%, PNP organisations 15%, and government institutions 15%.
- Nearly half was funded by the Commonwealth (47%), 9% by State, Territory and local governments, 25% by businesses and 13% by other Australian sources, while 7% was from overseas.
- 87% of health R&D performed in the public sector was financed publicly, while 74% of private health R&D was financed privately.
- Over half was clinical R&D, nearly one fifth for public health, 13% for pharmaceuticals and 11% for health and support services.
- The private sector focused relatively more on clinical research and pharmaceuticals (businesses for the latter, not PNPs), while the public sector (especially universities) focused relatively more on public health and support services.
- Cancer was the leading area of research ($160m or 9% of the total), followed by pharmaceutical treatments (over $140m or 8%), cardiovascular disease (7%), the nervous system (6%) and infectious diseases (5%). The immune system, endocrine R&D and mental health were each around 3% of the total.

Looking at historical trends over 1992-93 to 2000-01:

- The public sector share of R&D activity fell from 69% to 60% (although the universities maintained their share), with real growth averaging 6.6% p.a.. The public sector also reduced its share of health R&D financing, from 63% to 56% (6.7% real growth pa).
- The private sector grew strongly, activity by 12.2% in real terms and finance by 11.1%.
- As a nation, Australia invested 0.255% of GDP in health R&D in 2000-01, compared to 0.179% in 1992-93. Our per capita spending has more than doubled from $43 to $88 per Australian.
- Growth was most rapid in the health and medical sciences (over 20% p.a.), while pharmacological R&D grew most slowly (5% p.a. real).
- In line with the relative decline in public sector R&D, there was also a relative decline in basic R&D from 47% to 43% of the total.
- The public sector funded a fairly steady two thirds to three quarters of basic and applied health R&D, while the private sector funded two thirds to three quarters of experimental development, in line with expectations based on consideration of risk ad externalities.
- The public sector's share of capital spending on health R&D fell from 72% to 54% over the 1990s, increasing to 58% in 2000-01. Capital expenditure is now 16% of total health R&D – mainly land and buildings (10%), while current expenditure is 84% – mainly labour (46%).

These findings are based on robust ABS estimates of Australian expenditure on R&D by the socio-economic objective (SEO) of 'health', rather than using the Field of Research (FOR) classification – the latter generates estimates of R&D around 85% of SEO.

- ABS data are also used in contrast to AIHW data which measure R&D expenditure as an input into total health spending, and hence have totals only some 57% of the ABS SEO totals.

About 35% of federal investment in health R&D is channelled through the NHMRC ($276m in 2002) – largely concentrated on the major institutes. Following from the Wills Report recommendations, NHMRC funding is set to double from around $165m in 1998-99 to nearly $400m in 2004-05, an investment of $614m over six years.

- The recommendations of this important review are largely being implemented by government, addressing key constraints to Australia's health R&D capacity in areas such as workforce recruitment and retention; collaboration between research bodies, government and business; priority-driven research; commercialisation of R&D; international cooperation; funding; and evaluation.

Other organisations such as the ARC and CSIRO are also key public delivery vehicles for R&D, although only 4-5% ($30 to $40m) of their R&D is in health areas.

- Nine of Australia's 62 CRCs focus on medical science and technology.

Chapter Two: International perspectives

Australia ranks at the lower end of the OECD spectrum for health R&D spending.

- While we spend around 0.25% of GDP, Canada spends 0.32%-0.4%, Japan 0.46%, France 0.57%, the US 0.6 to 0.71%, the UK 0.80% and Denmark 1.1%. Switzerland spends 0.86% of GDP without even counting its pharmaceutical industry spending.[21]
- The Wills Report also noted that Australia's public health R&D spending is low by OECD standards, and trending in the wrong direction over the late 1990s. Although Canada and the US grew their public health R&D spending over the late '90s, and the UK was already high, Australia (like New Zealand) declined from a low base.

However, Australia has benefited substantially from global investments in health R&D. Life expectancy at birth increased over 1960 to 1999 by 8 years – from 74 to 82 years for females and from 68 to 76 years for males, giving us the fourth highest lifespan in the world – equal with Canada and behind Sweden, Switzerland and Japan.

- These gains have derived largely from reduced death rates from cardiovascular diseases, one fifth their 1960 values, together with almost complete eradication of deaths from infectious diseases such as polio, tetanus, smallpox, measles, mumps and rubella, as well as reductions in morbidity and mortality from respiratory diseases, cancer and other causes.

Australia has contributed significantly to these advances, including through breakthroughs in treatments for stomach ulcers (saving $250m p.a. in Australian health costs), development of vaccines against cervical cancer (now through Phase III/IV trials), 450% reductions in SIDS deaths, discovery of lithium for the treatment of bipolar disorder saving some $35 billion in hospitalisation costs internationally, development of cochlear implants restoring hearing to over 50,000 people worldwide and the development and global marketing of treatments for obstructive sleep apnea (OSD) by ResMed.

- Our eminent health scientists, such as Professor John Shine – a father of the global biotechnology industry – produce 4.8% of global publications with citation rates disproportionately high relative to our national size.

International methodologies for measuring these improvements in healthspan are relatively new. New health technologies can generate direct savings to the health system (such as fewer and shorter hospitalisations) as well as indirect savings through wellness – improved labour productivity, reduced absenteeism, more years of employment, lower welfare payments and reduced burden on carers. However, the utility value to the consumer

[21] Based on OECD 2002 Health Data for pervious recent years; for the US and Canada, the 0.6% and 0.4% estimates respectively were based on internal country estimates for different recent years.

of improved life quantity (reduced mortality) and quality (reduced morbidity) is far greater even than these direct and indirect benefits, and usually far greater than individual income or even assets.

- Eminent US economists from Harvard, Yale, Stanford, Columbia and the University of Chicago – commissioned by the Mary Woodward Lasker Charitable Trust's 'Funding First' initiative – have developed surprisingly consistent methodologies to determine the value of longer life.
- To assess the value of reduced mortality, Nordhaus (at Yale) used labour market studies, consumer purchase decisions and contingent valuation studies from various meta-analyses to estimate the value of a statistical life as between $US3m and $US7m. With a real discount rate of 3%, he estimated that the gains over 1975-1995 were worth $US5,400 p.a. per person, or 40% of consumption expenditure.
- Murphy and Topel (University of Chicago) used a similar methodology – expected discounted present value of a lifetime utility function – and $US5m for a statistical life, to estimate that greater longevity in the US was worth $US2.8 trillion p.a. between 1970 and 1990 ($US57 trillion over the two decades). They applied this methodology to specific diseases to show that even small benefits from R&D could generate potentially huge gains – for example, estimating that one spared cancer death in 1000 would be worth $US47billion, and hence a 20% reduction would be worth nearly $US10 trillion.
- To assess the value of both reduced mortality and morbidity, Cutler and Richardson used the same range for the value of a statistical life and the same discount rate, as well as Quality Adjusted Life Year (QALY) weights, to estimate gains from improved healthspan of $US100,000 to $US200,000 per person between 1970 and 1990 ($5,000 to $10,000 pa), very comparable with Nordhaus and suggesting that living standards improved as much due to health gains as to consumption gains.
- The World Health Organization developed the use of Disability Adjusted Life Years (DALYs) in the 1990s, with disaggregated mortality (Years of Life Lost or YLL) and morbidity (Years of healthy Life lost due to Disability of YLD), to measure the health impact of different disease over time. Without overtly attributing a value to a human life, WHO suggests that, as a guideline, very cost effective interventions are those where 1 DALY averted costs less than GDP per capita, and cost-effective interventions are where 1 DALY averted costs between 1 and 3 times per capita GDP. WHO concludes in its 2002 Report that most industrialised countries stand to gain at least another five years of healthy life per person through investing in cost-effective interventions.

Country experiences relevant to Australia include:

- The US – important to show what can be achieved with research dollars and the estimated returns; the US spends around $US57bn p.a. and its studies conclude that at least one third of the historical value of health gains are due to investment in R&D. Hence the NIH conservatively estimates annual public sector returns at 25-40% p.a., which it believes are on par with private sector returns. Cutler and Kadiyala put the returns to investment in R&D for cardiovascular disease over the past three decades as 240%.
- Canada – a similar country to Australia in many respects, Canada has recently established the Canadian Institutes of Health Research, headed by Alan Bernstein, and generally refocussed and reprioritised public attention towards health R&D as a critical investment in future wellbeing. Like the US, Canada now has official estimates of both the direct and indirect national costs of diseases. However, it has not calculated specific rates of return to health R&D.
- Singapore – no studies were found identifying either total costs of illnesses or rates or return to R&D.
- New Zealand – an example of the negative impacts of policies that are hostile to health R&D investment. Restrictive practices in the late 1990s resulted in many companies reconsidering their position in New Zealand, falling staff numbers, removal of products and withdrawal of R&D funds.

Chapter Three: Economic returns to Australian investment in health R&D

To our knowledge, the returns to investment in health R&D in Australia have not previously been estimated.

- The Industry Commission (now Productivity Commission) estimated in 1995 that returns to all-sector R&D were around 10% to 55%. Health R&D, however, has high spillover externalities that necessitate public investment especially in the basic science end of the research spectrum.

Types of returns are direct health returns, indirect savings and overall healthspan gains.

- Direct health expenditures in Australian totalled $60.8bn in 2000-01, with 30% of these in the private sector and 70% in the public sector. It is thus assumed that any direct health savings accruing from successful health R&D are shared in these proportions.
- Cardiovascular diseases account for nearly 12% of these costs and over 40% of deaths in Australia. Digestive diseases rank a very close second in cost terms while cancer ranks second in mortality terms (27% of all deaths).

There is no official data on indirect costs of illness in Australia. Access Economics has provided estimates in recent years of the indirect costs of a number of illnesses including arthritis, osteoporosis, dementia, schizophrenia and bipolar disorder.

- Utilising these and other data relating to indirect shares of total costs from the US, the indirect costs of illness in Australia are estimated as $77bn in 2000-01, 27% higher than the direct costs.
- These include only the real indirect costs – not transfer payments – for earnings foregone due to morbidity and premature mortality as well as the costs of carers, of aids and modifications and of other costs (such as forensic costs).
- Weighted averages of indirect costs suggest that public sector bears only 3%.
- Overall, therefore, the public share of total direct and indirect costs is estimated to be 32% and the private share 68%.

In terms of DALYs, Australia lost 13.7% of total life-years lived (as measured by the AIHW in 1996), with 54% of these lost due to premature mortality (YLL) and 46% lost due to morbidity (YLD).

- Cardiovascular disease was the greatest cause of lost DALYs (22% of the total), followed by cancers (19%) and then mental illnesses (13%).
- Cost effective interventions in Australia are those that purchase a DALY for less than $112,000; very cost-effective interventions purchase a DALY for less than $37,000.

Valuing the improvements in Australian healthspan over 1960-1999 utilised an eclectic 'blend and extend' version of the American experts' methodology, based on overall improvements in Australian lifespan including reductions in specific mortality rates for a range of illnesses.

- The statistical value of a life was $US5m, with sensitivity analysis of $US3m and $US7m. With a real discount rate of 3%pa, this generated the value of a life year as A$150,000 (A$1=$US0.6667), with lower and upper bounds of $112,000 and $225,000.
- Quality of life was accounted for using the proportionality of YLD to YLL in the AIHW DALY analysis. This translated to around $129,000 as the value of a year of improved wellness, with lower and upper bounds of $97,000 and $194,000.
- Application of public and private returns was based on the proportionality in total direct and indirect costs (32% and 68% respectively).
- Possible improvements in the methodology could be achieved if real rather than straight line growth rates in longevity were able to be used, and if a YLD longitudinal series by disease became available.

Improved healthspan over 1960-99 was valued at $5.4 trillion – 46% of Australian consumption.

- $2.9 trillion of the gain was from longer life and $2.5 trillion from greater wellness.
- Healthspan gains were worth $142bn p.a. by 1999.

- Sensitivity analysis varying each of the key assumptions showed bounds of $4.1 to $8.1 trillion.
- Cardiovascular improvements accounted for one third of the gains – $1.7 trillion.
- Injury prevention was worth $680bn, improvements in treatments for chronic respiratory conditions were worth $463bn and improved screening and treatments for cancer were worth $373bn.
- Declines were notable for mental illnesses, with a net human cost of $30bn (excluding suicidality), musculoskeletal disorders and undiagnosed symptoms.

Attributing Australian R&D to these improvements in healthspan involved further key assumptions.

- The base case assumed that R&D was responsible for 50% of the improvements in healthspan, with upper and lower bounds at 30% and 70%, with the remainder of the gains due to the application of R&D knowledge through public awareness and prevention campaigns, regulatory changes and other interventions aimed at reducing health risk factors. Australian examples include the 'slip, slop, slap' campaign, banning of smoking in public places, the red healthy heart tick on food products, compulsory wearing of seatbelts and the central pap smear register.
- The base case also assumed that Australian R&D contributed 2.5% to the total R&D gains, a conservative estimate derived from our contribution to global R&D output, although there is some evidence that suggests our output may be of more than average efficacy.
- Distribution of gains to causes were linked uniformly on the basis of the principles of critical mass and of serendipity, as well as the lack of evidence for any other distribution.
- Time lags were treated (as by the Americans) retrospectively, with the implicit assumption that, although future gains are unknown, past gains from the R&D of the previous 40 years were likely to be of equal or lower value than those of the future gains built on the current investment in the knowledge pool. Hence the healthspan gains estimated from the year 1999 were compared with the R&D investment in 1998-99.

Rates of return to health R&D in Australia are exceptional.

- Annual rates of return lie between 1 and 5 times R&D expenditures, 2.4 times in the 1999 base case.
- The longevity returns were estimated as 129%, and the wellness returns as 111%.
- Public sector returns were 72% for longevity and 62% for wellness, while private sector returns were 208% for longevity and 179% for wellness.
- Even in the low case, returns were 32% and 28% (public) and 94% and 81% (private) for longevity and wellness respectively.
- Cardiovascular disease showed returns nearly 8 times annual R&D investment in this area. Returns to investment in respiratory system R&D were second highest nearly 6 times R&D investment, while returns to R&D relating to digestive disorders were third at over 500%.

Future R&D gains, even relatively small, have potentially stunning impacts.

- Reducing intentional and unintentional injuries by 30% would save over $370bn, greater than Australia's total net foreign debt.
- R&D that reduced deaths from cancer by one fifth would be worth $184bn to Australians, more than total forecast Commonwealth spending in the current fiscal year.
- Reducing cardiovascular event s by 15% would be worth $34bn – exceeding our total federal health budget.

4.2 IMPLICATIONS AND RECOMMENDATIONS

This report has confirmed that returns to investment in health R&D, measured in terms of the value of life and wellness gained, are remarkable. What does this imply for Australian policy responses?

Already, Federal government initiatives flowing from the Wills Review are stepping up Commonwealth investment in health R&D, in particular through the NHMRC, with a view to reversing its previous decline. Many initiatives have been put in place that aim to make smarter health R&D investments primarily through collaboration and workforce improvements.

However, some key issues remain.

- State, Territory and local governments need to match and stay in line with the Commonwealth effort.
- Care needs to be taken that the erosion of basic research and of capital investment that accompanied the public sector decline of the 1990s are adequately reversed also.
- Continued boosts to investment in health R&D relative to GDP are still warranted given Australia's poor relative ranking relative to other OECD countries.
- Moreover, Australia appears to have comparative advantage in health R&D given our levels of discovery, publications, citations and other evaluative criteria relative to our size in the global market. In addition to the 'good international citizen' arguments, there are therefore weighty economic reasons for enhancing our health R&D investment (see Box below).

> Australia currently has a growing deficit in the balance of trade in pharmaceuticals, medical equipment and other health and medical industries, of around $1bn per year (a quadrupling of the deficit 10 years earlier). Given our aging population and increasing demand for medical treatments, this is not likely to improve on its own. One way of reducing the deficit is to develop Australian intellectual property through biotechnology companies and market this in the international marketplace. Licensing intellectual property for royalties would also help. Yet '*Australia has traditionally been very good at research, but deplorably bad at capturing the value of its intellectual property*' (Wills, 1999, p124). Sweden provides an excellent example of what can be achieved in the pharmaceutical industry. In the early 1980s, Sweden had a pharmaceutical trade deficit. Now, following policies in the 1960s and '70s, which saw governments supporting basic research, the Swedish pharmaceutical industry has thrived and turned a trade deficit into a significant trade surplus. More than 80% of their sales are exports and the industry has achieved an average annual increase in production of 8-9%. It is also remarkable that their life expectancy gains over1960-99 were third highest in the world.

This race is one where Australia is a prime contender. However, surprisingly, this still seems to be an area where policy-makers can tend to be stubbornly myopic at times. The commercialisation and balance of payments benefits, as well as employment multiplier effects from health R&D, although not specifically a focus of this report, are well documented elsewhere and it goes almost without saying that they outweigh any tendencies that might still remain to seek a free ride on our OECD colleagues' research efforts. We have paid dearly for missed opportunities in the past, such as colony stimulating factors and haemachromatosis discoveries, where the value was not captured in Australia (see Wills, 1999, Chapter 4). Conversely, the enormity of the gains of successful commercial ventures, such as ResMed, AGEN and Gradipore, are also self-evident.

Australia should be inspired by our own past discoveries, as well as the examples of the US, Canada, Sweden and other leading OECD countries, and wary of the experiences of New Zealand in failing to provide a favourable health R&D climate. The costs of letting investment in health R&D slip are potentially enormous in terms of compromising our future standards of living as measured by healthspan.

- There is a key role for the public sector in basic science and applied research (e.g. in areas such as anti-oxidants and folic acid), although returns are lower due to spillover externalities.
- It is also vital that, due to 'critical mass' and serendipity, a broad coverage of research areas is maintained.
- Collaborative partnerships with the private sector should be carefully and strategically nurtured, particularly with a view to attracting ongoing high levels of funding growth from overseas sources.
- Priorities need to be balanced with risk in the R&D portfolio, so that promising lines of attack against minor sources of mortality and morbidity are included as well as higher risk investigations against major ones.

Health R&D must be seen as an investment in wellness with exceptional returns. The corollary is that public finance should be strategically targeted to cost-effective high priority R&D areas. The ageing of the baby boomer population, who begin turning 60 from 2005, will place unprecedented demands on the Australian health system in particular in relation to chronic conditions of ageing such as Alzheimer's disease, arthritis, cardiovascular disease and cancer. With dependency ratios (those over 65 years relative to the whole population) set to rise from 12% to 25% and health spending set to rise from 9% to 17% of GDP over the next 40 years, the projected cost and impact of chronic illness is forecast to present a challenging burden whose greatest hope is new R&D breakthroughs (Access Economics, 2003b).

> '*The new view of health economics should shape the way we think about health policy. In the early 1990s, the general hysteria about rising health costs led many to believe that the health-care system was wasteful, out of control, and should be reined in. This view was particularly prevalent in the business community, which saw rising health costs as a threat to national competitiveness. The general atmosphere was coloured by the substantial rise in (measured) relative medical-care prices. Over the period from 1975 to 1995, the CPI for medical care rose 64% faster than CPI for all goods and services. In the face of rising prices and growing budgets, a natural response was to try to control spending and limit services.*
>
> *If the results of this and other related papers are confirmed, then the role of the health-care system should be rethought. Over the last half century, economic welfare from health care expenditures appears to have contributed as much to economic welfare as the rest of consumption expenditures. It is an intriguing thought to contemplate that the social productivity of health-care spending might be many times that of other spending. If this is anywhere near the case, it would suggest that the image of a stupendously wasteful health-care system is far off the mark*" (Nordhaus, 2002, p42).

The past 40 years have witnessed an amazing epidemiological transition, riding on the technological wave. Our generation has benefited from standards of living never before experienced. In this country we now face a future full of promise and challenge for preventing and treating disease for ourselves and our children, by virtue of ethically applying recent dramatic advances in genetics, bioengineering, neuroscience and molecular and structural biology. The challenge is to translate the promise into the reality of new understanding, communication, collaboration and improved clinical outcomes.

This report has shown that every dollar invested in this challenge in Australia has historically been recouped as highly valued healthspan, even in the worst case scenario, and in most cases, many times over. Our conclusion for the future must be that Australian health R&D represents an exceptional investment, with exceptional returns.

APPENDIX TABLES

Table 46 Australian health R&D (SEO), by category, $'000, 2000-01

	Public Sector				Private Sector				
	Common-wealth	State/Terr & local	Higher educ'n	Sub-total Public	Business	Non-profit	Sub-total Private	Total	Total exc. business
670400 HUMAN PHARMACEUTICAL PRODUCTS	-	-	1,121	1,121	149,806	-	149,806	150,927	1,121
670401 Prevention - biologicals (e.g. vaccines)	2,118	6,279	1,369	9,766	n.a.	892	n.a.	n.a.	10,658
670402 Diagnostics	7,486	-	662	8,149	n.a.	58	n.a.	n.a.	8,207
670403 Treatments (e.g. chemicals, antibiotics)	24,242	966	19,438	44,646	n.a.	275	n.a.	n.a.	44,921
670499 Other	191	266	4,318	4,775	n.a.	1	n.a.	n.a.	4,776
Subtotal	**34,037**	**7,511**	**26,909**	**68,457**	**149,806**	**1,226**	**151,032**	**219,489**	**69,683**
730100 CLINICAL (ORGANS, DISEASES & COND'S)	-	-	47,483	47,483	215,742	-	215,742	263,226	47,483
730101 Infectious diseases	2,389	15,098	34,054	51,541	n.a.	20,208	n.a.	n.a.	71,748
730102 Immune system & allergy	33	7,451	27,145	34,629	n.a.	11,114	n.a.	n.a.	45,744
730103 Blood disorders	-	8,984	7,501	16,486	n.a.	3,748	n.a.	n.a.	20,234
730104 Nervous system & disorders	35	5,644	55,668	61,347	n.a.	14,807	n.a.	n.a.	76,155
730105 Endocrine organs & diseases (inc diabetes)	35	7,309	26,598	33,942	n.a.	10,362	n.a.	n.a.	44,304
730106 Cardiovascular system & diseases	351	11,125	30,388	41,863	n.a.	46,333	n.a.	n.a.	88,196
730107 Inherited diseases (inc gene therapy)	-	4,281	9,515	13,796	n.a.	8,188	n.a.	n.a.	21,984
730108 Cancer and related disorders	145	26,063	43,880	70,088	n.a.	54,877	n.a.	n.a.	124,966
730109 Surgical methods & procedures	86	4,041	6,886	11,012	n.a.	1,469	n.a.	n.a.	12,481
730110 Respiratory system & diseases (inc asthma)	35	5,631	10,643	16,309	n.a.	3,183	n.a.	n.a.	19,492
730111 Hearing, vision, speech & their disorders	-	2,677	24,729	27,406	n.a.	5,343	n.a.	n.a.	32,749
730112 Oro-dental & disorders	-	-	8,788	8,788	n.a.	683	n.a.	n.a.	9,471
730113 Digestive system & disorders	-	6,661	10,115	16,776	n.a.	1,445	n.a.	n.a.	18,221
730114 Skeletal system & disorders (inc arthritis)	-	4,072	19,640	23,713	n.a.	8,415	n.a.	n.a.	32,127
730115 Urogenital system & disorders	-	2,083	4,586	6,668	n.a.	642	n.a.	n.a.	7,310
730116 Reproductive system & disorders	77	4,620	13,144	17,841	n.a.	4,168	n.a.	n.a.	22,009
730117 Skin & related disorders	292	2,632	2,540	5,464	n.a.	1,221	n.a.	n.a.	6,685
730118 Organs, diseases & abnormal conditions nec	-	788	10,363	11,151	n.a.	917	n.a.	n.a.	12,068
730199 Clinical health nec	2,482	11,486	37,637	51,606	n.a.	1,135	n.a.	n.a.	52,741
Subtotal	**5,959**	**130,647**	**431,304**	**567,910**	**215,742**	**198,258**	**414,001**	**981,910**	**766,168**
730200 PUBLIC HEALTH	-	-	20,228	20,228	30,991	-	30,991	51,219	20,228
730201 Women's health	27	6,570	14,046	20,642	n.a.	1,286	n.a.	n.a.	21,928
730202 Men's health	25	1,350	3,179	4,553	n.a.	n.p.	n.a.	n.a.	n.a.
730203 Health related to ageing	316	2,652	7,100	10,068	n.a.	3,183	n.a.	n.a.	13,251
730204 Child health	-	3,446	9,421	12,868	n.a.	22,448	n.a.	n.a.	35,316
730205 Substance abuse	-	4,193	9,422	13,615	n.a.	1,367	n.a.	n.a.	14,983
730206 Aboriginal & Torres Strait Islander health	216	2,514	6,841	9,571	n.a.	2,203	n.a.	n.a.	11,774
730207 Health related to specific ethnic groups	-	119	1,328	1,447	n.a.	n.p.	n.a.	n.a.	n.a.
730208 Occupational health (exc ec dev't aspects)	925	1,742	6,747	9,414	n.a.	251	n.a.	n.a.	9,665
730209 Rural health	70	1,241	3,790	5,101	n.a.	555	n.a.	n.a.	5,656
730210 Environmental health	879	1,614	13,384	15,877	n.a.	132	n.a.	n.a.	16,009
730211 Mental health	14	7,827	27,948	35,788	n.a.	7,891	n.a.	n.a.	43,680
730212 Disease distribution & transmission	179	1,131	4,489	5,799	n.a.	655	n.a.	n.a.	6,454
730213 Preventive medicine	1,854	2,913	4,996	9,763	n.a.	10,971	n.a.	n.a.	20,734
730214 Dental health	1,226	214	3,335	4,776	n.a.	346	n.a.	n.a.	5,122
730215 Nutrition	-	1,067	5,575	6,642	n.a.	687	n.a.	n.a.	7,329
730216 Food safety	3,464	221	1,786	5,471	n.a.	-	n.a.	n.a.	5,471
730217 Health status (e.g. indicators of well-being)	138	607	3,448	4,193	n.a.	666	n.a.	n.a.	4,860
730218 Social structure & health	-	93	2,605	2,699	n.a.	621	n.a.	n.a.	3,320
730219 Behaviour & health	86	604	10,343	11,034	n.a.	906	n.a.	n.a.	11,940
730220 Injury control	-	410	2,530	2,940	n.a.	263	n.a.	n.a.	3,203
730299 Public health nec	439	2,487	24,513	27,439	n.a.	278	n.a.	n.a.	27,717
Subtotal	**9,858**	**43,014**	**187,056**	**239,929**	**30,991**	**55,540**	**86,531**	**326,459**	**295,469**
730300 HEALTH & SUPPORT SERVICES	-	-	10,911	10,911	29,330	-	29,330	40,241	10,911
730301 Health education & promotion	-	1,866	11,332	13,197	n.a.	516	n.a.	n.a.	13,713
730302 Nursing	536	521	18,690	19,747	n.a.	-	n.a.	n.a.	19,747
730303 Occupational, speech & physiotherapy	-	879	12,908	13,787	n.a.	-	n.a.	n.a.	13,787
730304 Palliative care	-	294	2,228	2,522	n.a.	708	n.a.	n.a.	3,230
730305 Diagnostic methods	412	2,863	4,610	7,886	n.a.	167	n.a.	n.a.	8,052
730306 Evaluation of health outcomes	801	690	7,987	9,478	n.a.	909	n.a.	n.a.	10,387
730307 Health policy evaluation	490	775	4,284	5,548	n.a.	330	n.a.	n.a.	5,879
730308 Health policy economic outcomes	174	335	5,160	5,668	n.a.	-	n.a.	n.a.	5,668
730399 Health & support services nec	1,004	11,886	47,829	60,718	n.a.	451	n.a.	n.a.	61,169
Subtotal	**3,416**	**20,109**	**125,937**	**149,462**	**29,330**	**3,081**	**32,411**	**181,873**	**152,543**
GRAND TOTAL	**53,270**	**201,281**	**771,207**	**1,025,757**	**425,869**	**258,105**	**683,974**	**1,709,731**	**1,283,862**

Source: Access Economics, derived from ABS special data request.

Table 47 Australian health R&D (SEO), by category, % of total, 2000-01

	Public Sector				Private Sector				
	Common-wealth	State/Terr & local	Higher educ'n	Sub-total Public	Business	Non-profit	Sub-total Private	Total	Total exc. Business
670400 HUMAN PHARMACEUTICAL PRODUCTS	0.0%	0.0%	0.1%	0.1%	35.2%	0.0%	21.9%	8.8%	0.1%
670401 Prevention - biologicals (e.g. vaccines)	4.0%	3.1%	0.2%	1.0%	n.a.	0.3%	n.a.	n.a.	0.8%
670402 Diagnostics	14.1%	0.0%	0.1%	0.8%	n.a.	0.0%	n.a.	n.a.	0.6%
670403 Treatments (e.g. chemicals, antibiotics)	45.5%	0.5%	2.5%	4.4%	n.a.	0.1%	n.a.	n.a.	3.5%
670499 Other	0.4%	0.1%	0.6%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
Subtotal	**63.9%**	**3.7%**	**3.5%**	**6.7%**	**35.2%**	**0.5%**	**22.1%**	**12.8%**	**5.4%**
730100 CLINICAL (ORGANS, DISEASES & COND'S)	0.0%	0.0%	6.2%	4.6%	50.7%	0.0%	31.5%	15.4%	3.7%
730101 Infectious diseases	4.5%	7.5%	4.4%	5.0%	n.a.	7.8%	n.a.	n.a.	5.6%
730102 Immune system & allergy	0.1%	3.7%	3.5%	3.4%	n.a.	4.3%	n.a.	n.a.	3.6%
730103 Blood disorders	0.0%	4.5%	1.0%	1.6%	n.a.	1.5%	n.a.	n.a.	1.6%
730104 Nervous system & disorders	0.1%	2.8%	7.2%	6.0%	n.a.	5.7%	n.a.	n.a.	5.9%
730105 Endocrine organs & diseases (inc diabetes)	0.1%	3.6%	3.4%	3.3%	n.a.	4.0%	n.a.	n.a.	3.5%
730106 Cardiovascular system & diseases	0.7%	5.5%	3.9%	4.1%	n.a.	18.0%	n.a.	n.a.	6.9%
730107 Inherited diseases (inc gene therapy)	0.0%	2.1%	1.2%	1.3%	n.a.	3.2%	n.a.	n.a.	1.7%
730108 Cancer and related disorders	0.3%	12.9%	5.7%	6.8%	n.a.	21.3%	n.a.	n.a.	9.7%
730109 Surgical methods & procedures	0.2%	2.0%	0.9%	1.1%	n.a.	0.6%	n.a.	n.a.	1.0%
730110 Respiratory system & diseases (inc asthma)	0.1%	2.8%	1.4%	1.6%	n.a.	1.2%	n.a.	n.a.	1.5%
730111 Hearing, vision, speech & their disorders	0.0%	1.3%	3.2%	2.7%	n.a.	2.1%	n.a.	n.a.	2.6%
730112 Oro-dental & disorders	0.0%	0.0%	1.1%	0.9%	n.a.	0.3%	n.a.	n.a.	0.7%
730113 Digestive system & disorders	0.0%	3.3%	1.3%	1.6%	n.a.	0.6%	n.a.	n.a.	1.4%
730114 Skeletal system & disorders (inc arthritis)	0.0%	2.0%	2.5%	2.3%	n.a.	3.3%	n.a.	n.a.	2.5%
730115 Urogenital system & disorders	0.0%	1.0%	0.6%	0.7%	n.a.	0.2%	n.a.	n.a.	0.6%
730116 Reproductive system & disorders	0.1%	2.3%	1.7%	1.7%	n.a.	1.6%	n.a.	n.a.	1.7%
730117 Skin & related disorders	0.5%	1.3%	0.3%	0.5%	n.a.	0.5%	n.a.	n.a.	0.5%
730118 Organs, diseases & abnormal conditions nec	0.0%	0.4%	1.3%	1.1%	n.a.	0.4%	n.a.	n.a.	0.9%
730199 Clinical health nec	4.7%	5.7%	4.9%	5.0%	n.a.	0.4%	n.a.	n.a.	4.1%
Subtotal	**11.2%**	**64.9%**	**55.9%**	**55.4%**	**50.7%**	**76.8%**	**60.5%**	**57.4%**	**59.7%**
730200 PUBLIC HEALTH	0.0%	0.0%	2.6%	2.0%	7.3%	0.0%	4.5%	3.0%	1.6%
730201 Women's health	0.0%	3.3%	1.8%	2.0%	n.a.	0.5%	n.a.	n.a.	1.7%
730202 Men's health	0.0%	0.7%	0.4%	0.4%	n.a.	n.a.	n.a.	n.a.	n.a.
730203 Health related to ageing	0.6%	1.3%	0.9%	1.0%	n.a.	1.2%	n.a.	n.a.	1.0%
730204 Child health	0.0%	1.7%	1.2%	1.3%	n.a.	8.7%	n.a.	n.a.	2.8%
730205 Substance abuse	0.0%	2.1%	1.2%	1.3%	n.a.	0.5%	n.a.	n.a.	1.2%
730206 Aboriginal & Torres Strait Islander health	0.4%	1.2%	0.9%	0.9%	n.a.	0.9%	n.a.	n.a.	0.9%
730207 Health related to specific ethnic groups	0.0%	0.1%	0.2%	0.1%	n.a.	n.a.	n.a.	n.a.	n.a.
730208 Occupational health (exc ec dev't aspects)	1.7%	0.9%	0.9%	0.9%	n.a.	0.1%	n.a.	n.a.	0.8%
730209 Rural health	0.1%	0.6%	0.5%	0.5%	n.a.	0.2%	n.a.	n.a.	0.4%
730210 Environmental health	1.7%	0.8%	1.7%	1.5%	n.a.	0.1%	n.a.	n.a.	1.2%
730211 Mental health	0.0%	3.9%	3.6%	3.5%	n.a.	3.1%	n.a.	n.a.	3.4%
730212 Disease distribution & transmission	0.3%	0.6%	0.6%	0.6%	n.a.	0.3%	n.a.	n.a.	0.5%
730213 Preventive medicine	3.5%	1.4%	0.6%	1.0%	n.a.	4.3%	n.a.	n.a.	1.6%
730214 Dental health	2.3%	0.1%	0.4%	0.5%	n.a.	0.1%	n.a.	n.a.	0.4%
730215 Nutrition	0.0%	0.5%	0.7%	0.6%	n.a.	0.3%	n.a.	n.a.	0.6%
730216 Food safety	6.5%	0.1%	0.2%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
730217 Health status (e.g. indicators of well-being)	0.3%	0.3%	0.4%	0.4%	n.a.	0.3%	n.a.	n.a.	0.4%
730218 Social structure & health	0.0%	0.0%	0.3%	0.3%	n.a.	0.2%	n.a.	n.a.	0.3%
730219 Behaviour & health	0.2%	0.3%	1.3%	1.1%	n.a.	0.4%	n.a.	n.a.	0.9%
730220 Injury control	0.0%	0.2%	0.3%	0.3%	n.a.	0.1%	n.a.	n.a.	0.2%
730299 Public health nec	0.8%	1.2%	3.2%	2.7%	n.a.	0.1%	n.a.	n.a.	2.2%
Subtotal	**18.5%**	**21.4%**	**24.3%**	**23.4%**	**7.3%**	**21.5%**	**12.7%**	**19.1%**	**23.0%**
730300 HEALTH & SUPPORT SERVICES	0.0%	0.0%	1.4%	1.1%	6.9%	0.0%	4.3%	2.4%	0.8%
730301 Health education & promotion	0.0%	0.9%	1.5%	1.3%	n.a.	0.2%	n.a.	n.a.	1.1%
730302 Nursing	1.0%	0.3%	2.4%	1.9%	n.a.	0.0%	n.a.	n.a.	1.5%
730303 Occupational, speech & physiotherapy	0.0%	0.4%	1.7%	1.3%	n.a.	0.0%	n.a.	n.a.	1.1%
730304 Palliative care	0.0%	0.1%	0.3%	0.2%	n.a.	0.3%	n.a.	n.a.	0.3%
730305 Diagnostic methods	0.8%	1.4%	0.6%	0.8%	n.a.	0.1%	n.a.	n.a.	0.6%
730306 Evaluation of health outcomes	1.5%	0.3%	1.0%	0.9%	n.a.	0.4%	n.a.	n.a.	0.8%
730307 Health policy evaluation	0.9%	0.4%	0.6%	0.5%	n.a.	0.1%	n.a.	n.a.	0.5%
730308 Health policy economic outcomes	0.3%	0.2%	0.7%	0.6%	n.a.	0.0%	n.a.	n.a.	0.4%
730399 Health & support services nec	1.9%	5.9%	6.2%	5.9%	n.a.	0.2%	n.a.	n.a.	4.8%
Subtotal	**6.4%**	**10.0%**	**16.3%**	**14.6%**	**6.9%**	**1.2%**	**4.7%**	**10.6%**	**11.9%**
GRAND TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Access Economics, derived from ABS special data request.

Table 48 Australian health R&D (SEO), by category, $'000, 1998-99

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	-	-	9,568	9,568	14,213	-	14,213	23,782	9,568
70401 Prevention - biologicals (e.g. vaccines)	2,559	1,586	185	4,329	n.a.	729	n.a.	n.a.	5,059
70402 Diagnostics	6,897	-	897	7,794	n.a.	381	n.a.	n.a.	8,175
70403 Treatments (e.g. chemicals, antibiotics)	23,338	225	4,888	28,451	n.a.	148	n.a.	n.a.	28,598
70499 Other	163	334	2,563	3,060	n.a.	-	n.a.	n.a.	3,060
Subtotal	**32,957**	**2,145**	**18,101**	**53,202**	**166,775**	**1,259**	**168,033**	**221,236**	**54,461**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	-	-	25,539	25,539	n.a.	n.p.	n.a.	n.a.	n.a.
130101 Infectious diseases	1,631	11,101	16,687	29,419	n.a.	14,423	n.a.	n.a.	43,842
130102 Immune system & allergy	641	4,698	22,567	27,906	n.a.	12,674	n.a.	n.a.	40,580
130103 Blood disorders	-	4,432	6,499	10,931	n.a.	1,069	n.a.	n.a.	12,000
130104 Neurological disorders	-	3,052	33,663	36,715	n.a.	5,656	n.a.	n.a.	42,371
130105 Endocrine diseases (inc diabetes)	-	6,734	20,141	26,875	n.a.	8,933	n.a.	n.a.	35,809
130106 Cardiovascular diseases	433	8,796	22,996	32,225	n.a.	20,776	n.a.	n.a.	53,001
130107 Inherited diseases	-	3,944	9,303	13,247	n.a.	12,291	n.a.	n.a.	25,538
130108 Cancer & related disorders	240	19,810	23,840	43,890	n.a.	38,211	n.a.	n.a.	82,101
130109 Surgical methods & procedures	-	6,290	6,608	12,898	n.a.	1,319	n.a.	n.a.	14,217
130110 Respiratory diseases (inc asthma)	-	7,483	10,155	17,638	n.a.	1,533	n.a.	n.a.	19,170
130111 Hearing, vision & speech	-	1,808	22,752	24,560	n.a.	6,724	n.a.	n.a.	31,284
130112 Oro-dental	-	336	7,745	8,082	n.a.	1,284	n.a.	n.a.	9,366
130113 Digestive system	-	2,665	9,986	12,651	n.a.	725	n.a.	n.a.	13,376
130114 Arthritis, bone & joint disorders	-	3,614	12,594	16,208	n.a.	5,473	n.a.	n.a.	21,681
130115 Kidney diseases	-	3,169	4,749	7,918	n.a.	2,459	n.a.	n.a.	10,377
130116 Reproductive medicine	82	3,340	10,826	14,247	n.a.	3,361	n.a.	n.a.	17,608
130117 Skin & related conditions	8	546	3,475	4,029	n.a.	n.p.	n.a.	n.a.	n.a.
130118 Other organs, diseases & conditions	-	3,080	3,741	6,821	n.a.	937	n.a.	n.a.	7,759
130199 Clinical health nec	4,259	13,587	25,092	42,939	n.a.	1,336	n.a.	n.a.	44,274
Subtotal	**7,293**	**108,486**	**298,960**	**414,738**	**100,175**	**140,832**	**241,007**	**655,745**	**555,570**
130200 PUBLIC HEALTH	-	-	16,949	16,949	n.a.	n.p.	n.a.	n.a.	n.a.
130201 Women's health	89	2,791	15,511	18,391	n.a.	762	n.a.	n.a.	19,153
130202 Health related to ageing	5,070	2,965	5,043	13,079	n.a.	3,636	n.a.	n.a.	16,715
130203 Child health	-	3,737	8,159	11,896	n.a.	13,231	n.a.	n.a.	25,127
130204 Aboriginal health	429	1,256	4,339	6,024	n.a.	736	n.a.	n.a.	6,760
130205 Substance abuse	345	1,023	9,323	10,691	n.a.	920	n.a.	n.a.	11,611
130206 Occupational health (exc ec dev't aspects)	1,223	1,590	4,395	7,208	n.a.	97	n.a.	n.a.	7,305
130207 Environmental health	575	675	5,695	6,945	n.a.	n.p.	n.a.	n.a.	n.a.
130208 Mental health	311	6,941	17,870	25,122	n.a.	10,049	n.a.	n.a.	35,170
130209 Disease distribution & transmission	-	604	5,368	5,971	n.a.	-	n.a.	n.a.	5,971
130210 Preventive medicine	91	872	5,453	6,415	n.a.	8,474	n.a.	n.a.	14,890
130211 Dental health	4,050	74	1,760	5,884	n.a.	-	n.a.	n.a.	5,884
130212 Nutrition	1,034	114	5,958	7,105	n.a.	449	n.a.	n.a.	7,554
130213 Food safety	-	1,936	876	2,811	n.a.	-	n.a.	n.a.	2,811
130214 Health status (e.g. indicators of well-being)	286	956	3,640	4,882	n.a.	161	n.a.	n.a.	5,043
130215 Social structure & health	58	121	2,201	2,381	n.a.	124	n.a.	n.a.	2,505
130216 Behaviour & health	21	2,949	4,270	7,240	n.a.	387	n.a.	n.a.	7,626
130299 Public health nec	214	4,335	29,027	33,576	n.a.	2,724	n.a.	n.a.	36,300
Subtotal	**13,797**	**32,938**	**145,837**	**192,572**	**14,213**	**42,831**	**57,044**	**249,617**	**235,403**
130300 HEALTH AND SUPPORT SERVICES	-	-	6,146	6,146	n.a.	n.p.	n.a.	n.a.	n.a.
130301 Health education & promotion	30	990	8,269	9,289	n.a.	413	n.a.	n.a.	9,702
130302 Nursing	251	875	14,791	15,917	n.a.	-	n.a.	n.a.	15,917
130303 Occupational, speech & physiotherapy	-	1,020	5,832	6,852	n.a.	62	n.a.	n.a.	6,914
130304 Palliative care	-	150	1,108	1,258	n.a.	72	n.a.	n.a.	1,330
130305 Diagnostic methods	1,114	1,989	4,401	7,505	n.a.	n.p.	n.a.	n.a.	n.a.
130306 Evaluation of health outcomes	155	1,615	4,888	6,658	n.a.	192	n.a.	n.a.	6,850
130307 Health policy evaluation	278	567	3,156	4,000	n.a.	13	n.a.	n.a.	4,013
130308 Health policy economic outcomes	72	382	2,760	3,214	n.a.	13	n.a.	n.a.	3,227
130399 Health & support services nec	1,062	8,747	8,585	18,394	n.a.	5,519	n.a.	n.a.	23,914
Subtotal	**2,961**	**16,336**	**59,936**	**79,233**	**17,565**	**8,047**	**25,612**	**104,845**	**87,280**
191000 MEDICAL AND HEALTH SCIENCES	-	-	16,870	16,870	n.a.	-	n.a.	n.a.	16,870
191001 Medical & health sciences	-	7,990	107,907	115,897	n.a.	4,674	n.a.	n.a.	120,571
Subtotal	**-**	**7,990**	**124,777**	**132,767**	**5,914**	**4,674**	**10,588**	**143,355**	**137,441**
GRAND TOTAL	**57,008**	**167,895**	**647,610**	**872,513**	**304,641**	**197,642**	**502,284**	**1,374,797**	**1,070,155**

Source: Access Economics, derived from ABS special data request.

Table 49 Australian health R&D (SEO), by category, % of total, 1998-99

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	0.0%	0.0%	1.5%	1.1%	4.7%	0.0%	2.8%	1.7%	0.9%
70401 Prevention - biologicals (e.g. vaccines)	4.5%	0.9%	0.0%	0.5%	n.a.	0.4%	n.a.	n.a.	0.5%
70402 Diagnostics	12.1%	0.0%	0.1%	0.9%	n.a.	0.2%	n.a.	n.a.	0.8%
70403 Treatments (e.g. chemicals, antibiotics)	40.9%	0.1%	0.8%	3.3%	n.a.	0.1%	n.a.	n.a.	2.7%
70499 Other	0.3%	0.2%	0.4%	0.4%	n.a.	0.0%	n.a.	n.a.	0.3%
Subtotal	**57.8%**	**1.3%**	**2.8%**	**6.1%**	**54.7%**	**0.6%**	**33.5%**	**16.1%**	**5.1%**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	0.0%	0.0%	3.9%	2.9%	n.a.	n.a.	n.a.	n.a.	n.a.
130101 Infectious diseases	2.9%	6.6%	2.6%	3.4%	n.a.	7.3%	n.a.	n.a.	4.1%
130102 Immune system & allergy	1.1%	2.8%	3.5%	3.2%	n.a.	6.4%	n.a.	n.a.	3.8%
130103 Blood disorders	0.0%	2.6%	1.0%	1.3%	n.a.	0.5%	n.a.	n.a.	1.1%
130104 Neurological disorders	0.0%	1.8%	5.2%	4.2%	n.a.	2.9%	n.a.	n.a.	4.0%
130105 Endocrine diseases (inc diabetes)	0.0%	4.0%	3.1%	3.1%	n.a.	4.5%	n.a.	n.a.	3.3%
130106 Cardiovascular diseases	0.8%	5.2%	3.6%	3.7%	n.a.	10.5%	n.a.	n.a.	5.0%
130107 Inherited diseases	0.0%	2.3%	1.4%	1.5%	n.a.	6.2%	n.a.	n.a.	2.4%
130108 Cancer & related disorders	0.4%	11.8%	3.7%	5.0%	n.a.	19.3%	n.a.	n.a.	7.7%
130109 Surgical methods & procedures	0.0%	3.7%	1.0%	1.5%	n.a.	0.7%	n.a.	n.a.	1.3%
130110 Respiratory diseases (inc asthma)	0.0%	4.5%	1.6%	2.0%	n.a.	0.8%	n.a.	n.a.	1.8%
130111 Hearing, vision & speech	0.0%	1.1%	3.5%	2.8%	n.a.	3.4%	n.a.	n.a.	2.9%
130112 Oro-dental	0.0%	0.2%	1.2%	0.9%	n.a.	0.6%	n.a.	n.a.	0.9%
130113 Digestive system	0.0%	1.6%	1.5%	1.4%	n.a.	0.4%	n.a.	n.a.	1.2%
130114 Arthritis, bone & joint disorders	0.0%	2.2%	1.9%	1.9%	n.a.	2.8%	n.a.	n.a.	2.0%
130115 Kidney diseases	0.0%	1.9%	0.7%	0.9%	n.a.	1.2%	n.a.	n.a.	1.0%
130116 Reproductive medicine	0.1%	2.0%	1.7%	1.6%	n.a.	1.7%	n.a.	n.a.	1.6%
130117 Skin & related conditions	0.0%	0.3%	0.5%	0.5%	n.a.	n.a.	n.a.	n.a.	n.a.
130118 Other organs, diseases & conditions	0.0%	1.8%	0.6%	0.8%	n.a.	0.5%	n.a.	n.a.	0.7%
130199 Clinical health nec	7.5%	8.1%	3.9%	4.9%	n.a.	0.7%	n.a.	n.a.	4.1%
Subtotal	**12.8%**	**64.6%**	**46.2%**	**47.5%**	**32.9%**	**71.3%**	**48.0%**	**47.7%**	**51.9%**
130200 PUBLIC HEALTH	0.0%	0.0%	2.6%	1.9%	n.a.	n.a.	n.a.	n.a.	n.a.
130201 Women's health	0.2%	1.7%	2.4%	2.1%	n.a.	0.4%	n.a.	n.a.	1.8%
130202 Health related to ageing	8.9%	1.8%	0.8%	1.5%	n.a.	1.8%	n.a.	n.a.	1.6%
130203 Child health	0.0%	2.2%	1.3%	1.4%	n.a.	6.7%	n.a.	n.a.	2.3%
130204 Aboriginal health	0.8%	0.7%	0.7%	0.7%	n.a.	0.4%	n.a.	n.a.	0.6%
130205 Substance abuse	0.6%	0.6%	1.4%	1.2%	n.a.	0.5%	n.a.	n.a.	1.1%
130206 Occupational health (exc ec dev't aspects)	2.1%	0.9%	0.7%	0.8%	n.a.	0.0%	n.a.	n.a.	0.7%
130207 Environmental health	1.0%	0.4%	0.9%	0.8%	n.a.	n.a.	n.a.	n.a.	n.a.
130208 Mental health	0.5%	4.1%	2.8%	2.9%	n.a.	5.1%	n.a.	n.a.	3.3%
130209 Disease distribution & transmission	0.0%	0.4%	0.8%	0.7%	n.a.	0.0%	n.a.	n.a.	0.6%
130210 Preventive medicine	0.2%	0.5%	0.8%	0.7%	n.a.	4.3%	n.a.	n.a.	1.4%
130211 Dental health	7.1%	0.0%	0.3%	0.7%	n.a.	0.0%	n.a.	n.a.	0.5%
130212 Nutrition	1.8%	0.1%	0.9%	0.8%	n.a.	0.2%	n.a.	n.a.	0.7%
130213 Food safety	0.0%	1.2%	0.1%	0.3%	n.a.	0.0%	n.a.	n.a.	0.3%
130214 Health status (e.g. indicators of well-being)	0.5%	0.6%	0.6%	0.6%	n.a.	0.1%	n.a.	n.a.	0.5%
130215 Social structure & health	0.1%	0.1%	0.3%	0.3%	n.a.	0.1%	n.a.	n.a.	0.2%
130216 Behaviour & health	0.0%	1.8%	0.7%	0.8%	n.a.	0.2%	n.a.	n.a.	0.7%
130299 Public health nec	0.4%	2.6%	4.5%	3.8%	n.a.	1.4%	n.a.	n.a.	3.4%
Subtotal	**24.2%**	**19.6%**	**22.5%**	**22.1%**	**4.7%**	**21.7%**	**11.4%**	**18.2%**	**22.0%**
130300 HEALTH AND SUPPORT SERVICES	0.0%	0.0%	0.9%	0.7%	n.a.	n.a.	n.a.	n.a.	n.a.
130301 Health education & promotion	0.1%	0.6%	1.3%	1.1%	n.a.	0.2%	n.a.	n.a.	0.9%
130302 Nursing	0.4%	0.5%	2.3%	1.8%	n.a.	0.0%	n.a.	n.a.	1.5%
130303 Occupational, speech & physiotherapy	0.0%	0.6%	0.9%	0.8%	n.a.	0.0%	n.a.	n.a.	0.6%
130304 Palliative care	0.0%	0.1%	0.2%	0.1%	n.a.	0.0%	n.a.	n.a.	0.1%
130305 Diagnostic methods	2.0%	1.2%	0.7%	0.9%	n.a.	n.a.	n.a.	n.a.	n.a.
130306 Evaluation of health outcomes	0.3%	1.0%	0.8%	0.8%	n.a.	0.1%	n.a.	n.a.	0.6%
130307 Health policy evaluation	0.5%	0.3%	0.5%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
130308 Health policy economic outcomes	0.1%	0.2%	0.4%	0.4%	n.a.	0.0%	n.a.	n.a.	0.3%
130399 Health and support services nec	1.9%	5.2%	1.3%	2.1%	n.a.	2.8%	n.a.	n.a.	2.2%
Subtotal	**5.2%**	**9.7%**	**9.3%**	**9.1%**	**5.8%**	**4.1%**	**5.1%**	**7.6%**	**8.2%**
191000 MEDICAL AND HEALTH SCIENCES	0.0%	0.0%	2.6%	1.9%	n.a.	0.0%	n.a.	n.a.	1.6%
191001 Medical and health sciences	0.0%	4.8%	16.7%	13.3%	n.a.	2.4%	n.a.	n.a.	11.3%
Subtotal	**0.0%**	**4.8%**	**19.3%**	**15.2%**	**1.9%**	**2.4%**	**2.1%**	**10.4%**	**12.8%**
GRAND TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Access Economics, derived from ABS special data request.

Table 50 Australian health R&D (SEO), by category, $'000, 1996-97

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	-	-	10,425	10,425	n.a.	-	n.a.	n.a.	10,425
70401 Prevention - biologicals (e.g. vaccines)	3,582	1,668	128	5,378	n.a.	456	n.a.	n.a.	5,834
70402 Diagnostics	4,524	26	441	4,991	n.a.	456	n.a.	n.a.	5,447
70403 Treatments (e.g. chemicals, antibiotics)	15,847	772	3,166	19,786	n.a.	456	n.a.	n.a.	20,242
70499 Other	6,514	223	2,311	9,048	n.a.	-	n.a.	n.a.	9,048
Subtotal	**30,467**	**2,689**	**16,471**	**49,627**	**146,885**	**1,367**	**148,252**	**197,880**	**50,995**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	-	-	26,377	26,377	n.a.	-	n.a.	n.a.	n.a.
130101 Infectious diseases	5,106	17,327	18,862	41,294	n.a.	5,773	n.a.	n.a.	47,067
130102 Immune system & allergy	594	3,530	21,212	25,337	n.a.	17,968	n.a.	n.a.	43,305
130103 Blood disorders	132	3,746	4,126	8,004	n.a.	5,985	n.a.	n.a.	13,989
130104 Neurological disorders	1,890	2,416	36,410	40,716	n.a.	3,534	n.a.	n.a.	44,250
130105 Endocrine diseases (inc diabetes)	912	7,261	11,280	19,452	n.a.	10,630	n.a.	n.a.	30,082
130106 Cardiovascular diseases	315	5,835	18,276	24,426	n.a.	16,409	n.a.	n.a.	40,835
130107 Inherited diseases	-	2,623	8,931	11,553	n.a.	4,275	n.a.	n.a.	15,828
130108 Cancer & related disorders	419	22,662	18,626	41,707	n.a.	26,061	n.a.	n.a.	67,769
130109 Surgical methods & procedures	-	3,404	4,557	7,962	n.a.	4,104	n.a.	n.a.	12,066
130110 Respiratory diseases (inc asthma)	-	4,911	7,718	12,629	n.a.	1,109	n.a.	n.a.	13,739
130111 Hearing, vision & speech	40	2,817	22,839	25,695	n.a.	3,734	n.a.	n.a.	29,430
130112 Oro-dental	-	-	8,544	8,544	n.a.	1,021	n.a.	n.a.	9,565
130113 Digestive system	-	2,777	6,667	9,444	n.a.	1,017	n.a.	n.a.	10,461
130114 Arthritis, bone & joint disorders	-	3,823	7,475	11,298	n.a.	7,165	n.a.	n.a.	18,462
130115 Kidney diseases	-	1,649	4,133	5,782	n.a.	2,393	n.a.	n.a.	8,175
130116 Reproductive medicine	-	3,099	7,580	10,679	n.a.	3,064	n.a.	n.a.	13,742
130117 Skin & related conditions	-	1,117	2,829	3,946	n.a.	393	n.a.	n.a.	4,340
130118 Other organs, diseases & conditions	-	1,193	5,681	6,874	n.a.	433	n.a.	n.a.	7,307
130199 Clinical health nec	317	19,585	16,631	36,532	n.a.	1,155	n.a.	n.a.	37,688
Subtotal	**9,726**	**109,772**	**258,752**	**378,250**	**83,752**	**116,225**	**199,977**	**578,227**	**494,475**
130200 PUBLIC HEALTH	-	-	12,733	12,733	n.a.	-	n.a.	n.a.	n.a.
130201 Women's health	-	2,603	10,381	12,984	n.a.	928	n.a.	n.a.	13,912
130202 Health related to ageing	353	839	4,771	5,963	n.a.	3,568	n.a.	n.a.	9,531
130203 Child health	64	4,636	4,591	9,291	n.a.	4,456	n.a.	n.a.	13,747
130204 Aboriginal health	-	2,248	2,510	4,757	n.a.	-	n.a.	n.a.	4,757
130205 Substance abuse	-	890	7,707	8,596	n.a.	468	n.a.	n.a.	9,064
130206 Occupational health (exc ec dev't aspects)	723	2,030	4,666	7,419	n.a.	n.p.	n.a.	n.a.	n.a.
130207 Environmental health	780	477	4,403	5,659	n.a.	-	n.a.	n.a.	5,659
130208 Mental health	530	7,275	12,131	19,936	n.a.	15,175	n.a.	n.a.	35,111
130209 Disease distribution & transmission	-	457	2,936	3,393	n.a.	-	n.a.	n.a.	3,393
130210 Preventive medicine	481	2,212	2,856	5,549	n.a.	11,244	n.a.	n.a.	16,793
130211 Dental health	-	96	1,166	1,262	n.a.	-	n.a.	n.a.	1,262
130212 Nutrition	244	1,211	4,516	5,970	n.a.	623	n.a.	n.a.	6,593
130213 Food safety	3,168	107	264	3,539	n.a.	-	n.a.	n.a.	3,539
130214 Health status (e.g. indicators of well-being)	249	489	1,146	1,884	n.a.	n.p.	n.a.	n.a.	n.a.
130215 Social structure & health	122	262	1,787	2,171	n.a.	10	n.a.	n.a.	2,181
130216 Behaviour & health	75	2,178	5,002	7,255	n.a.	n.p.	n.a.	n.a.	n.a.
130299 Public health nec	493	6,379	17,444	24,315	n.a.	3,407	n.a.	n.a.	27,723
Subtotal	**7,280**	**34,389**	**101,009**	**142,678**	**12,776**	**40,222**	**52,997**	**195,676**	**182,900**
130300 HEALTH AND SUPPORT SERVICES	-	-	6,238	6,238	n.a.	-	n.a.	n.a.	6,238
130301 Health education & promotion	-	1,554	6,363	7,917	n.a.	209	n.a.	n.a.	8,126
130302 Nursing	-	1,088	8,879	9,967	n.a.	71	n.a.	n.a.	10,038
130303 Occupational, speech & physiotherapy	-	815	5,007	5,822	n.a.	149	n.a.	n.a.	5,971
130304 Palliative care	46	506	1,808	2,360	n.a.	n.p.	n.a.	n.a.	n.a.
130305 Diagnostic methods	2,095	3,424	2,985	8,505	n.a.	561	n.a.	n.a.	9,066
130306 Evaluation of health outcomes	128	5,759	4,025	9,913	n.a.	n.p.	n.a.	n.a.	n.a.
130307 Health policy evaluation	150	957	4,265	5,372	n.a.	-	n.a.	n.a.	5,372
130308 Health policy economic outcomes	187	377	951	1,516	n.a.	20	n.a.	n.a.	1,536
130399 Health & support services nec	47	4,478	13,175	17,699	n.a.	n.p.	n.a.	n.a.	n.a.
Subtotal	2,654	18,959	53,697	75,310	7,469	5,232	12,701	88,011	80,541
191000 MEDICAL AND HEALTH SCIENCES	-	-	20,045	20,045	n.a.	-	n.a.	n.a.	20,045
191001 Medical & health sciences	1,503	3,183	87,152	91,839	n.a.	6,244	n.a.	n.a.	98,083
Subtotal	**1,503**	**3,183**	**107,198**	**111,884**	**6,364**	**6,244**	**12,608**	**124,492**	**118,128**
GRAND TOTAL	**51,630**	**168,993**	**537,127**	**757,749**	**257,246**	**169,290**	**426,536**		**927,039**

Source: Access Economics, derived from ABS special data request.

Table 51 Australian health R&D (SEO), by category, % of total, 1996-97

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	0.0%	0.0%	1.9%	1.4%	n.a.	0.0%	n.a.	n.a.	1.1%
70401 Prevention - biologicals (e.g. vaccines)	6.9%	1.0%	0.0%	0.7%	n.a.	0.3%	n.a.	n.a.	0.6%
70402 Diagnostics	8.8%	0.0%	0.1%	0.7%	n.a.	0.3%	n.a.	n.a.	0.6%
70403 Treatments (e.g. chemicals, antibiotics)	30.7%	0.5%	0.6%	2.6%	n.a.	0.3%	n.a.	n.a.	2.2%
70499 Other	12.6%	0.1%	0.4%	1.2%	n.a.	0.0%	n.a.	n.a.	1.0%
Subtotal	**59.0%**	**1.6%**	**3.1%**	**6.5%**	**57.1%**	**0.8%**	**34.8%**	**16.7%**	**5.5%**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	0.0%	0.0%	4.9%	3.5%	n.a.	n.a.	n.a.	n.a.	n.a.
130101 Infectious diseases	9.9%	10.3%	3.5%	5.4%	n.a.	3.4%	n.a.	n.a.	5.1%
130102 Immune system & allergy	1.2%	2.1%	3.9%	3.3%	n.a.	10.6%	n.a.	n.a.	4.7%
130103 Blood disorders	0.3%	2.2%	0.8%	1.1%	n.a.	3.5%	n.a.	n.a.	1.5%
130104 Neurological disorders	3.7%	1.4%	6.8%	5.4%	n.a.	2.1%	n.a.	n.a.	4.8%
130105 Endocrine diseases (inc diabetes)	1.8%	4.3%	2.1%	2.6%	n.a.	6.3%	n.a.	n.a.	3.2%
130106 Cardiovascular diseases	0.6%	3.5%	3.4%	3.2%	n.a.	9.7%	n.a.	n.a.	4.4%
130107 Inherited diseases	0.0%	1.6%	1.7%	1.5%	n.a.	2.5%	n.a.	n.a.	1.7%
130108 Cancer & related disorders	0.8%	13.4%	3.5%	5.5%	n.a.	15.4%	n.a.	n.a.	7.3%
130109 Surgical methods & procedures	0.0%	2.0%	0.8%	1.1%	n.a.	2.4%	n.a.	n.a.	1.3%
130110 Respiratory diseases (inc asthma)	0.0%	2.9%	1.4%	1.7%	n.a.	0.7%	n.a.	n.a.	1.5%
130111 Hearing, vision & speech	0.1%	1.7%	4.3%	3.4%	n.a.	2.2%	n.a.	n.a.	3.2%
130112 Oro-dental	0.0%	0.0%	1.6%	1.1%	n.a.	0.6%	n.a.	n.a.	1.0%
130113 Digestive system	0.0%	1.6%	1.2%	1.2%	n.a.	0.6%	n.a.	n.a.	1.1%
130114 Arthritis, bone & joint disorders	0.0%	2.3%	1.4%	1.5%	n.a.	4.2%	n.a.	n.a.	2.0%
130115 Kidney diseases	0.0%	1.0%	0.8%	0.8%	n.a.	1.4%	n.a.	n.a.	0.9%
130116 Reproductive medicine	0.0%	1.8%	1.4%	1.4%	n.a.	1.8%	n.a.	n.a.	1.5%
130117 Skin & related conditions	0.0%	0.7%	0.5%	0.5%	n.a.	n.a.	n.a.	n.a.	n.a.
130118 Other organs, diseases & conditions	0.0%	0.7%	1.1%	0.9%	n.a.	0.3%	n.a.	n.a.	0.8%
130199 Clinical health nec	0.6%	11.6%	3.1%	4.8%	n.a.	0.7%	n.a.	n.a.	4.1%
Subtotal	**18.8%**	**65.0%**	**48.2%**	**49.9%**	**32.6%**	**68.7%**	**46.9%**	**48.8%**	**53.3%**
130200 PUBLIC HEALTH	0.0%	0.0%	2.4%	1.7%	n.a.	n.a.	n.a.	n.a.	n.a.
130201 Women's health	0.0%	1.5%	1.9%	1.7%	n.a.	0.5%	n.a.	n.a.	1.5%
130202 Health related to ageing	0.7%	0.5%	0.9%	0.8%	n.a.	2.1%	n.a.	n.a.	1.0%
130203 Child health	0.1%	2.7%	0.9%	1.2%	n.a.	2.6%	n.a.	n.a.	1.5%
130204 Aboriginal health	0.0%	1.3%	0.5%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130205 Substance abuse	0.0%	0.5%	1.4%	1.1%	n.a.	0.3%	n.a.	n.a.	1.0%
130206 Occupational health (exc ec dev't aspects)	1.4%	1.2%	0.9%	1.0%	n.a.	n.a.	n.a.	n.a.	n.a.
130207 Environmental health	1.5%	0.3%	0.8%	0.7%	n.a.	n.a.	n.a.	n.a.	n.a.
130208 Mental health	1.0%	4.3%	2.3%	2.6%	n.a.	9.0%	n.a.	n.a.	3.8%
130209 Disease distribution & transmission	0.0%	0.3%	0.5%	0.4%	n.a.	0.0%	n.a.	n.a.	0.4%
130210 Preventive medicine	0.9%	1.3%	0.5%	0.7%	n.a.	6.6%	n.a.	n.a.	1.8%
130211 Dental health	0.0%	0.1%	0.2%	0.2%	n.a.	0.0%	n.a.	n.a.	0.1%
130212 Nutrition	0.5%	0.7%	0.8%	0.8%	n.a.	0.4%	n.a.	n.a.	0.7%
130213 Food safety	6.1%	0.1%	0.0%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
130214 Health status (e.g. indicators of well-being)	0.5%	0.3%	0.2%	0.2%	n.a.	n.a.	n.a.	n.a.	n.a.
130215 Social structure & health	0.2%	0.2%	0.3%	0.3%	n.a.	0.0%	n.a.	n.a.	0.2%
130216 Behaviour & health	0.1%	1.3%	0.9%	1.0%	n.a.	n.a.	n.a.	n.a.	n.a.
130299 Public health nec	1.0%	3.8%	3.2%	3.2%	n.a.	2.0%	n.a.	n.a.	3.0%
Subtotal	**14.1%**	**20.3%**	**18.8%**	**18.8%**	**5.0%**	**23.8%**	**12.4%**	**16.5%**	**19.7%**
130300 HEALTH AND SUPPORT SERVICES	0.0%	0.0%	1.2%	0.8%	n.a.	n.a.	n.a.	n.a.	n.a.
130301 Health education & promotion	0.0%	0.9%	1.2%	1.0%	n.a.	0.1%	n.a.	n.a.	0.9%
130302 Nursing	0.0%	0.6%	1.7%	1.3%	n.a.	0.0%	n.a.	n.a.	1.1%
130303 Occupational, speech & physiotherapy	0.0%	0.5%	0.9%	0.8%	n.a.	0.1%	n.a.	n.a.	0.6%
130304 Palliative care	0.1%	0.3%	0.3%	0.3%	n.a.	n.a.	n.a.	n.a.	n.a.
130305 Diagnostic methods	4.1%	2.0%	0.6%	1.1%	n.a.	n.a.	n.a.	n.a.	n.a.
130306 Evaluation of health outcomes	0.2%	3.4%	0.7%	1.3%	n.a.	n.a.	n.a.	n.a.	n.a.
130307 Health policy evaluation	0.3%	0.6%	0.8%	0.7%	n.a.	0.0%	n.a.	n.a.	0.6%
130308 Health policy economic outcomes	0.4%	0.2%	0.2%	0.2%	n.a.	0.0%	n.a.	n.a.	0.2%
130399 Health and support services nec	0.1%	2.6%	2.5%	2.3%	n.a.	n.a.	n.a.	n.a.	n.a.
Subtotal	**5.1%**	**11.2%**	**10.0%**	**9.9%**	**2.9%**	**3.1%**	**3.0%**	**7.4%**	**8.7%**
191000 MEDICAL AND HEALTH SCIENCES	0.0%	0.0%	3.7%	2.6%	n.a.	0.0%	n.a.	n.a.	2.2%
191001 Medical and health sciences	2.9%	1.9%	16.2%	12.1%	n.a.	3.7%	n.a.	n.a.	10.6%
Subtotal	**2.9%**	**1.9%**	**20.0%**	**14.8%**	**2.5%**	**3.7%**	**3.0%**	**10.5%**	**12.7%**
GRAND TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Access Economics, derived from ABS special data request.

Table 52 Australian health R&D (SEO), by category, $'000, 1994-95

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	-	-	943	943	n.a.	-	n.a.	n.a.	943
70401 Prevention - biologicals (e.g. vaccines)	9,199	2,449	208	11,856	n.a.	n.p.	n.a.	n.a.	n.a.
70402 Diagnostics	7,971	334	271	8,575	n.a.	166	n.a.	n.a.	8,741
70403 Treatments (e.g. chemicals, antibiotics)	13,462	3,109	4,799	21,369	n.a.	257	n.a.	n.a.	21,626
70499 Other	331	513	291	1,135	n.a.	n.p.	n.a.	n.a.	n.a.
Subtotal	**30,963**	**6,405**	**6,511**	**43,878**	**136,505**	**2,043**	**138,548**	**182,426**	**45,921**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	-	-	34,389	34,389	n.a.	-	n.a.	n.a.	34,389
130101 Infectious diseases	213	15,756	11,104	27,073	n.a.	4,910	n.a.	n.a.	31,983
130102 Immune system & allergy	677	8,919	16,864	26,460	n.a.	n.p.	n.a.	n.a.	n.a.
130103 Blood disorders	-	3,893	3,099	6,992	n.a.	456	n.a.	n.a.	7,448
130104 Neurological disorders	-	5,394	23,643	29,037	n.a.	4,733	n.a.	n.a.	33,770
130105 Endocrine diseases (inc diabetes)	-	4,810	7,360	12,170	n.a.	9,382	n.a.	n.a.	21,552
130106 Cardiovascular diseases	268	14,294	14,630	29,192	n.a.	15,869	n.a.	n.a.	45,061
130107 Inherited diseases	-	4,048	9,067	13,115	n.a.	4,383	n.a.	n.a.	17,498
130108 Cancer & related disorders	1,105	19,977	10,762	31,843	n.a.	24,101	n.a.	n.a.	55,945
130109 Surgical methods & procedures	-	4,398	1,498	5,896	n.a.	505	n.a.	n.a.	6,401
130110 Respiratory diseases (inc asthma)	-	4,655	3,484	8,139	n.a.	1,036	n.a.	n.a.	9,175
130111 Hearing, vision & speech	48	2,221	22,585	24,853	n.a.	2,420	n.a.	n.a.	27,273
130112 Oro-dental	-	1,349	4,997	6,347	n.a.	1,010	n.a.	n.a.	7,357
130113 Digestive system	-	4,971	4,496	9,467	n.a.	n.p.	n.a.	n.a.	n.a.
130114 Arthritis, bone & joint disorders	-	5,143	6,379	11,521	n.a.	4,996	n.a.	n.a.	16,518
130115 Kidney diseases	-	5,668	3,138	8,806	n.a.	1,170	n.a.	n.a.	9,976
130116 Reproductive medicine	-	6,520	6,063	12,583	n.a.	2,716	n.a.	n.a.	15,299
130117 Skin & related conditions	-	3,350	462	3,812	n.a.	481	n.a.	n.a.	4,293
130118 Other organs, diseases & conditions	-	1,379	5,540	6,919	n.a.	1,493	n.a.	n.a.	8,412
130199 Clinical health nec	2,949	7,425	9,711	20,084	n.a.	607	n.a.	n.a.	20,691
Subtotal	**5,260**	**124,167**	**199,271**	**328,698**	**68,738**	**90,772**	**159,510**	**488,209**	**419,471**
130200 PUBLIC HEALTH	-	-	16,770	16,770	n.a.	-	n.a.	n.a.	16,770
130201 Women's health	391	1,236	4,660	6,286	n.a.	2,562	n.a.	n.a.	8,848
130202 Health related to ageing	462	561	2,841	3,864	n.a.	2,447	n.a.	n.a.	6,311
130203 Child health	58	1,453	2,498	4,009	n.a.	8,165	n.a.	n.a.	12,175
130204 Aboriginal health	440	227	699	1,366	n.a.	-	n.a.	n.a.	1,366
130205 Substance abuse	22	643	6,860	7,526	n.a.	378	n.a.	n.a.	7,904
130206 Occupational health (exc ec dev't aspects)	4,983	2,569	3,215	10,768	n.a.	225	n.a.	n.a.	10,993
130207 Environmental health	1,104	1,706	1,338	4,148	n.a.	-	n.a.	n.a.	4,148
130208 Mental health	-	5,552	6,932	12,484	n.a.	4,700	n.a.	n.a.	17,183
130209 Disease distribution & transmission	-	666	6,504	7,170	n.a.	219	n.a.	n.a.	7,389
130210 Preventive medicine	594	3,188	2,366	6,148	n.a.	10,114	n.a.	n.a.	16,262
130211 Dental health	-	-	378	378	n.a.	170	n.a.	n.a.	548
130212 Nutrition	4,078	1,363	3,234	8,676	n.a.	291	n.a.	n.a.	8,967
130213 Food safety	4,261	37	68	4,366	n.a.	108	n.a.	n.a.	4,474
130214 Health status (e.g. indicators of well-being)	2,233	283	815	3,332	n.a.	16	n.a.	n.a.	3,348
130215 Social structure & health	30	87	1,169	1,285	n.a.	3	n.a.	n.a.	1,288
130216 Behaviour & health	41	2,507	3,193	5,741	n.a.	7	n.a.	n.a.	5,748
130299 Public health nec	4,882	11,752	13,567	30,201	n.a.	415	n.a.	n.a.	30,616
Subtotal	**23,578**	**33,831**	**77,107**	**134,516**	**9,480**	**29,822**	**39,302**	**173,817**	**164,338**
130300 HEALTH AND SUPPORT SERVICES	-	-	8,954	8,954	n.a.	-	n.a.	n.a.	8,954
130301 Health education & promotion	328	1,158	3,352	4,838	n.a.	383	n.a.	n.a.	5,222
130302 Nursing	-	738	3,263	4,001	n.a.	112	n.a.	n.a.	4,113
130303 Occupational, speech & physiotherapy	-	338	3,720	4,057	n.a.	65	n.a.	n.a.	4,122
130304 Palliative care	-	179	903	1,082	n.a.	-	n.a.	n.a.	1,082
130305 Diagnostic methods	1,983	5,951	961	8,895	n.a.	-	n.a.	n.a.	8,895
130306 Evaluation of health outcomes	-	2,288	3,318	5,606	n.a.	20	n.a.	n.a.	5,626
130307 Health policy evaluation	2,494	522	807	3,823	n.a.	245	n.a.	n.a.	4,068
130308 Health policy economic outcomes	78	283	477	838	n.a.	-	n.a.	n.a.	838
130399 Health & support services nec	51	4,278	3,616	7,945	n.a.	335	n.a.	n.a.	8,280
Subtotal	**4,934**	**15,734**	**29,370**	**50,038**	**8,170**	**1,161**	**9,330**	**59,368**	**51,198**
191000 MEDICAL AND HEALTH SCIENCES	-	-	50,784	50,784	n.a.	-	n.a.	n.a.	50,784
191001 Medical & health sciences	1,497	6,612	40,976	49,086	n.a.	8,930	n.a.	n.a.	58,016
Subtotal	**1,497**	**6,612**	**91,761**	**99,870**	**3,606**	**8,930**	**12,536**	**112,406**	**108,800**
GRAND TOTAL	**66,232**	**186,749**	**404,019**	**657,000**	**226,497**	**132,728**	**359,225**		**789,728**

Source: Access Economics, derived from ABS special data request.

Table 53 Australian health R&D (SEO), by category, % of total, 1994-95

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	0.0%	0.0%	0.2%	0.1%	n.a.	0.0%	n.a.	n.a.	0.1%
70401 Prevention - biologicals (e.g. vaccines)	13.9%	1.3%	0.1%	1.8%	n.a.	n.p.	n.a.	n.a.	n.a.
70402 Diagnostics	12.0%	0.2%	0.1%	1.3%	n.a.	0.1%	n.a.	n.a.	1.1%
70403 Treatments (e.g. chemicals, antibiotics)	20.3%	1.7%	1.2%	3.3%	n.a.	0.2%	n.a.	n.a.	2.7%
70499 Other	0.5%	0.3%	0.1%	0.2%	n.a.	n.p.	n.a.	n.a.	n.a.
Subtotal	**46.7%**	**3.4%**	**1.6%**	**6.7%**	**60.3%**	**1.5%**	**38.6%**	**18.0%**	**5.8%**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	0.0%	0.0%	8.5%	5.2%	n.a.	0.0%	n.a.	n.a.	4.4%
130101 Infectious diseases	0.3%	8.4%	2.7%	4.1%	n.a.	3.7%	n.a.	n.a.	4.0%
130102 Immune system & allergy	1.0%	4.8%	4.2%	4.0%	n.a.	n.p.	n.a.	n.a.	n.a.
130103 Blood disorders	0.0%	2.1%	0.8%	1.1%	n.a.	0.3%	n.a.	n.a.	0.9%
130104 Neurological disorders	0.0%	2.9%	5.9%	4.4%	n.a.	3.6%	n.a.	n.a.	4.3%
130105 Endocrine diseases (inc diabetes)	0.0%	2.6%	1.8%	1.9%	n.a.	7.1%	n.a.	n.a.	2.7%
130106 Cardiovascular diseases	0.4%	7.7%	3.6%	4.4%	n.a.	12.0%	n.a.	n.a.	5.7%
130107 Inherited diseases	0.0%	2.2%	2.2%	2.0%	n.a.	3.3%	n.a.	n.a.	2.2%
130108 Cancer & related disorders	1.7%	10.7%	2.7%	4.8%	n.a.	18.2%	n.a.	n.a.	7.1%
130109 Surgical methods & procedures	0.0%	2.4%	0.4%	0.9%	n.a.	0.4%	n.a.	n.a.	0.8%
130110 Respiratory diseases (inc asthma)	0.0%	2.5%	0.9%	1.2%	n.a.	0.8%	n.a.	n.a.	1.2%
130111 Hearing, vision & speech	0.1%	1.2%	5.6%	3.8%	n.a.	1.8%	n.a.	n.a.	3.5%
130112 Oro-dental	0.0%	0.7%	1.2%	1.0%	n.a.	0.8%	n.a.	n.a.	0.9%
130113 Digestive system	0.0%	2.7%	1.1%	1.4%	n.a.	n.p.	n.a.	n.a.	n.a.
130114 Arthritis, bone & joint disorders	0.0%	2.8%	1.6%	1.8%	n.a.	3.8%	n.a.	n.a.	2.1%
130115 Kidney diseases	0.0%	3.0%	0.8%	1.3%	n.a.	0.9%	n.a.	n.a.	1.3%
130116 Reproductive medicine	0.0%	3.5%	1.5%	1.9%	n.a.	2.0%	n.a.	n.a.	1.9%
130117 Skin & related conditions	0.0%	1.8%	0.1%	0.6%	n.a.	0.4%	n.a.	n.a.	0.5%
130118 Other organs, diseases & conditions	0.0%	0.7%	1.4%	1.1%	n.a.	1.1%	n.a.	n.a.	1.1%
130199 Clinical health nec	4.5%	4.0%	2.4%	3.1%	n.a.	0.5%	n.a.	n.a.	2.6%
Subtotal	**7.9%**	**66.5%**	**49.3%**	**50.0%**	**30.3%**	**68.4%**	**44.4%**	**48.0%**	**53.1%**
130200 PUBLIC HEALTH	0.0%	0.0%	4.2%	2.6%	n.a.	0.0%	n.a.	n.a.	2.1%
130201 Women's health	0.6%	0.7%	1.2%	1.0%	n.a.	1.9%	n.a.	n.a.	1.1%
130202 Health related to ageing	0.7%	0.3%	0.7%	0.6%	n.a.	1.8%	n.a.	n.a.	0.8%
130203 Child health	0.1%	0.8%	0.6%	0.6%	n.a.	6.2%	n.a.	n.a.	1.5%
130204 Aboriginal health	0.7%	0.1%	0.2%	0.2%	n.a.	0.0%	n.a.	n.a.	0.2%
130205 Substance abuse	0.0%	0.3%	1.7%	1.1%	n.a.	0.3%	n.a.	n.a.	1.0%
130206 Occupational health (exc ec dev't aspects)	7.5%	1.4%	0.8%	1.6%	n.a.	0.2%	n.a.	n.a.	1.4%
130207 Environmental health	1.7%	0.9%	0.3%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130208 Mental health	0.0%	3.0%	1.7%	1.9%	n.a.	3.5%	n.a.	n.a.	2.2%
130209 Disease distribution & transmission	0.0%	0.4%	1.6%	1.1%	n.a.	0.2%	n.a.	n.a.	0.9%
130210 Preventive medicine	0.9%	1.7%	0.6%	0.9%	n.a.	7.6%	n.a.	n.a.	2.1%
130211 Dental health	0.0%	0.0%	0.1%	0.1%	n.a.	0.1%	n.a.	n.a.	0.1%
130212 Nutrition	6.2%	0.7%	0.8%	1.3%	n.a.	0.2%	n.a.	n.a.	1.1%
130213 Food safety	6.4%	0.0%	0.0%	0.7%	n.a.	0.1%	n.a.	n.a.	0.6%
130214 Health status (e.g. indicators of well-being)	3.4%	0.2%	0.2%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
130215 Social structure & health	0.0%	0.0%	0.3%	0.2%	n.a.	0.0%	n.a.	n.a.	0.2%
130216 Behaviour & health	0.1%	1.3%	0.8%	0.9%	n.a.	0.0%	n.a.	n.a.	0.7%
130299 Public health nec	7.4%	6.3%	3.4%	4.6%	n.a.	0.3%	n.a.	n.a.	3.9%
Subtotal	**35.6%**	**18.1%**	**19.1%**	**20.5%**	**4.2%**	**22.5%**	**10.9%**	**17.1%**	**20.8%**
130300 HEALTH AND SUPPORT SERVICES	0.0%	0.0%	2.2%	1.4%	n.a.	0.0%	n.a.	n.a.	1.1%
130301 Health education & promotion	0.5%	0.6%	0.8%	0.7%	n.a.	0.3%	n.a.	n.a.	0.7%
130302 Nursing	0.0%	0.4%	0.8%	0.6%	n.a.	0.1%	n.a.	n.a.	0.5%
130303 Occupational, speech & physiotherapy	0.0%	0.2%	0.9%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130304 Palliative care	0.0%	0.1%	0.2%	0.2%	n.a.	0.0%	n.a.	n.a.	0.1%
130305 Diagnostic methods	3.0%	3.2%	0.2%	1.4%	n.a.	0.0%	n.a.	n.a.	1.1%
130306 Evaluation of health outcomes	0.0%	1.2%	0.8%	0.9%	n.a.	0.0%	n.a.	n.a.	0.7%
130307 Health policy evaluation	3.8%	0.3%	0.2%	0.6%	n.a.	0.2%	n.a.	n.a.	0.5%
130308 Health policy economic outcomes	0.1%	0.2%	0.1%	0.1%	n.a.	0.0%	n.a.	n.a.	0.1%
130399 Health and support services nec	0.1%	2.3%	0.9%	1.2%	n.a.	0.3%	n.a.	n.a.	1.0%
Subtotal	**7.4%**	**8.4%**	**7.3%**	**7.6%**	**3.6%**	**0.9%**	**2.6%**	**5.8%**	**6.5%**
191000 MEDICAL AND HEALTH SCIENCES	0.0%	0.0%	12.6%	7.7%	n.a.	0.0%	n.a.	n.a.	6.4%
191001 Medical and health sciences	2.3%	3.5%	10.1%	7.5%	n.a.	6.7%	n.a.	n.a.	7.3%
Subtotal	**2.3%**	**3.5%**	**22.7%**	**15.2%**	**1.6%**	**6.7%**	**3.5%**	**11.1%**	**13.8%**
GRAND TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Access Economics, derived from ABS special data request.

Table 54 Australian health R&D (SEO), by category, $'000, 1992-93

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	-	-	3,766	3,766	n.a.	-	n.a.	n.a.	3,766
70401 Prevention - biologicals (e.g. vaccines)	5,966	477	70	6,513	n.a.	-	n.a.	n.a.	6,513
70402 Diagnostics	2,613	40	10	2,664	n.a.	22	n.a.	n.a.	2,686
70403 Treatments (e.g. chemicals, antibiotics)	16,497	40	2,272	18,809	n.a.	22	n.a.	n.a.	18,831
70499 Other	-	139	206	345	n.a.	-	n.a.	n.a.	345
Subtotal	**25,076**	**696**	**6,324**	**32,095**	**93,003**	**45**	**93,048**	**125,144**	**32,140**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	-	-	-	-	-	-	n.a.	n.a.	-
130101 Infectious diseases	142	8,119	14,984	23,245	n.a.	3,106	n.a.	n.a.	26,352
130102 Immune system & allergy	145	5,229	19,528	24,902	n.a.	1,159	n.a.	n.a.	26,061
130103 Blood disorders	141	2,300	3,906	6,348	n.a.	-	n.a.	n.a.	6,348
130104 Neurological disorders	145	3,262	26,344	29,751	n.a.	6,402	n.a.	n.a.	36,153
130105 Endocrine diseases (inc diabetes)	331	4,572	9,553	14,456	n.a.	6,652	n.a.	n.a.	21,108
130106 Cardiovascular diseases	652	4,967	16,814	22,433	n.a.	12,636	n.a.	n.a.	35,069
130107 Inherited diseases	3	3,872	4,588	8,463	n.a.	1,214	n.a.	n.a.	9,677
130108 Cancer & related disorders	778	11,522	29,715	42,015	n.a.	31,208	n.a.	n.a.	73,223
130109 Surgical methods & procedures	688	4,578	2,883	8,149	n.a.	4,438	n.a.	n.a.	12,587
130110 Respiratory diseases (inc asthma)	-	2,958	6,693	9,652	n.a.	1,380	n.a.	n.a.	11,032
130111 Hearing, vision & speech	1,166	1,667	16,614	19,447	n.a.	1,250	n.a.	n.a.	20,697
130112 Oro-dental	-	799	3,913	4,713	n.a.	900	n.a.	n.a.	5,613
130113 Digestive system	148	1,951	8,446	10,545	n.a.	310	n.a.	n.a.	10,855
130114 Arthritis, bone & joint disorders	126	1,910	7,036	9,072	n.a.	487	n.a.	n.a.	9,558
130115 Kidney diseases	-	1,987	6,624	8,610	n.a.	887	n.a.	n.a.	9,497
130116 Reproductive medicine	298	3,140	9,976	13,413	n.a.	2,075	n.a.	n.a.	15,488
130117 Skin & related conditions	86	1,679	1,323	3,087	n.a.	20	n.a.	n.a.	3,107
130118 Other organs, diseases & conditions	-	2,198	7,591	9,789	n.a.	292	n.a.	n.a.	10,081
130199 Clinical health nec	305	9,128	18,231	27,664	n.a.	840	n.a.	n.a.	28,504
Subtotal	**5,154**	**75,839**	**214,762**	**295,754**	**41,975**	**75,257**	**117,232**	**412,986**	**371,011**
130200 PUBLIC HEALTH	137	-	-	137	n.a.	-	n.a.	n.a.	137
130201 Women's health	316	1,431	9,247	10,994	n.a.	346	n.a.	n.a.	11,340
130202 Health related to ageing	534	763	3,090	4,387	n.a.	741	n.a.	n.a.	5,128
130203 Child health	3	221	4,601	4,825	n.a.	600	n.a.	n.a.	5,426
130204 Aboriginal health	35	298	1,167	1,500	n.a.	-	n.a.	n.a.	1,500
130205 Substance abuse	35	757	8,762	9,555	n.a.	-	n.a.	n.a.	9,555
130206 Occupational health (exc ec dev't aspects)	5,170	1,400	3,181	9,751	n.a.	n.p.	n.a.	n.a.	n.a.
130207 Environmental health	3,458	102	2,237	5,797	n.a.	n.p.	n.a.	n.a.	n.a.
130208 Mental health	5	2,748	15,421	18,174	n.a.	42	n.a.	n.a.	18,216
130209 Disease distribution & transmission	32	325	2,843	3,200	n.a.	27	n.a.	n.a.	3,227
130210 Preventive medicine	508	3,774	9,799	14,081	n.a.	757	n.a.	n.a.	14,839
130211 Dental health	-	50	1,395	1,444	n.a.	-	n.a.	n.a.	1,444
130212 Nutrition	3,428	1,395	6,446	11,269	n.a.	-	n.a.	n.a.	11,269
130213 Food safety	2,400	39	873	3,312	n.a.	90	n.a.	n.a.	3,401
130214 Health status (e.g. indicators of well-being)	1,934	73	2,133	4,140	n.a.	21	n.a.	n.a.	4,161
130215 Social structure & health	73	14	545	632	n.a.	-	n.a.	n.a.	632
130216 Behaviour & health	1,944	2,984	1,866	6,794	n.a.	79	n.a.	n.a.	6,873
130299 Public health nec	-	8,022	8,067	16,089	n.a.	-	n.a.	n.a.	16,089
Subtotal	**20,014**	**24,394**	**81,673**	**126,081**	**6,888**	**2,900**	**9,788**	**135,869**	**128,981**
130300 HEALTH AND SUPPORT SERVICES	-	-	-	-	n.a.	-	n.a.	n.a.	-
130301 Health education & promotion	402	137	3,530	4,069	n.a.	269	n.a.	n.a.	4,337
130302 Nursing	-	132	2,997	3,129	n.a.	-	n.a.	n.a.	3,129
130303 Occupational, speech & physiotherapy	-	173	3,564	3,737	n.a.	28	n.a.	n.a.	3,765
130304 Palliative care	-	291	542	833	n.a.	-	n.a.	n.a.	833
130305 Diagnostic methods	1,365	2,932	1,150	5,448	n.a.	183	n.a.	n.a.	5,631
130306 Evaluation of health outcomes	-	647	2,801	3,448	n.a.	102	n.a.	n.a.	3,549
130307 Health policy evaluation	2,292	173	2,508	4,974	n.a.	21	n.a.	n.a.	4,995
130308 Health policy economic outcomes	30	359	1,155	1,544	n.a.	-	n.a.	n.a.	1,544
130399 Health & support services nec	91	4,993	4,294	9,378	n.a.	-	n.a.	n.a.	9,378
Subtotal	**4,181**	**9,838**	**22,540**	**36,559**	**8,388**	**603**	**8,990**	**45,550**	**37,162**
191000 MEDICAL AND HEALTH SCIENCES	-	-	20,000	20,000	n.a.	-	n.a.	n.a.	20,000
191001 Medical & health sciences	2,753	5,158	6,969	14,880	n.a.	7,051	n.a.	n.a.	21,932
Subtotal	**2,753**	**5,158**	**26,969**	**34,880**	**1,657**	**7,051**	**8,709**	**43,589**	**41,932**
GRAND TOTAL	**57,179**	**115,925**	**352,267**	**525,370**	**151,911**	**85,856**	**237,767**	**763,137**	**611,226**

Source: Access Economics, derived from ABS special data request.

Table 55 Australian health R&D (SEO), by category, % of total, 1992-93

	Public Sector				Private Sector				
	Common-wealth	State/ Terr & local	Higher educ'n	Sub-total Public	Business	PNP	Sub-total Private	Total	Total exc business
70400 HUMAN PHARMACEUTICAL PRODUCTS	0.0%	0.0%	1.1%	0.7%	n.a.	0.0%	n.a.	n.a.	0.6%
70401 Prevention - biologicals (e.g. vaccines)	10.4%	0.4%	0.0%	1.2%	n.a.	0.0%	n.a.	n.a.	1.1%
70402 Diagnostics	4.6%	0.0%	0.0%	0.5%	n.a.	0.0%	n.a.	n.a.	0.4%
70403 Treatments (e.g. chemicals, antibiotics)	28.9%	0.0%	0.6%	3.6%	n.a.	0.0%	n.a.	n.a.	3.1%
70499 Other	0.0%	0.1%	0.1%	0.1%	n.a.	0.0%	n.a.	n.a.	0.1%
Subtotal	**43.9%**	**0.6%**	**1.8%**	**6.1%**	**61.2%**	**0.1%**	**39.1%**	**16.4%**	**5.3%**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	0.0%	0.0%	0.0%	0.0%	n.a.	0.0%	n.a.	n.a.	0.0%
130101 Infectious diseases	0.2%	7.0%	4.3%	4.4%	n.a.	3.6%	n.a.	n.a.	4.3%
130102 Immune system & allergy	0.3%	4.5%	5.5%	4.7%	n.a.	1.4%	n.a.	n.a.	4.3%
130103 Blood disorders	0.2%	2.0%	1.1%	1.2%	n.a.	0.0%	n.a.	n.a.	1.0%
130104 Neurological disorders	0.3%	2.8%	7.5%	5.7%	n.a.	7.5%	n.a.	n.a.	5.9%
130105 Endocrine diseases (inc diabetes)	0.6%	3.9%	2.7%	2.8%	n.a.	7.7%	n.a.	n.a.	3.5%
130106 Cardiovascular diseases	1.1%	4.3%	4.8%	4.3%	n.a.	14.7%	n.a.	n.a.	5.7%
130107 Inherited diseases	0.0%	3.3%	1.3%	1.6%	n.a.	1.4%	n.a.	n.a.	1.6%
130108 Cancer & related disorders	1.4%	9.9%	8.4%	8.0%	n.a.	36.3%	n.a.	n.a.	12.0%
130109 Surgical methods & procedures	1.2%	3.9%	0.8%	1.6%	n.a.	5.2%	n.a.	n.a.	2.1%
130110 Respiratory diseases (inc asthma)	0.0%	2.6%	1.9%	1.8%	n.a.	1.6%	n.a.	n.a.	1.8%
130111 Hearing, vision & speech	2.0%	1.4%	4.7%	3.7%	n.a.	1.5%	n.a.	n.a.	3.4%
130112 Oro-dental	0.0%	0.7%	1.1%	0.9%	n.a.	1.0%	n.a.	n.a.	0.9%
130113 Digestive system	0.3%	1.7%	2.4%	2.0%	n.a.	0.4%	n.a.	n.a.	1.8%
130114 Arthritis, bone & joint disorders	0.2%	1.6%	2.0%	1.7%	n.a.	0.6%	n.a.	n.a.	1.6%
130115 Kidney diseases	0.0%	1.7%	1.9%	1.6%	n.a.	1.0%	n.a.	n.a.	1.6%
130116 Reproductive medicine	0.5%	2.7%	2.8%	2.6%	n.a.	2.4%	n.a.	n.a.	2.5%
130117 Skin & related conditions	0.2%	1.4%	0.4%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130118 Other organs, diseases & conditions	0.0%	1.9%	2.2%	1.9%	n.a.	0.3%	n.a.	n.a.	1.6%
130199 Clinical health nec	0.5%	7.9%	5.2%	5.3%	n.a.	1.0%	n.a.	n.a.	4.7%
Subtotal	**9.0%**	**65.4%**	**61.0%**	**56.3%**	**27.6%**	**87.7%**	**49.3%**	**54.1%**	**60.7%**
130200 PUBLIC HEALTH	0.2%	0.0%	0.0%	0.0%	n.a.	0.0%	n.a.	n.a.	0.0%
130201 Women's health	0.6%	1.2%	2.6%	2.1%	n.a.	0.4%	n.a.	n.a.	1.9%
130202 Health related to ageing	0.9%	0.7%	0.9%	0.8%	n.a.	0.9%	n.a.	n.a.	0.8%
130203 Child health	0.0%	0.2%	1.3%	0.9%	n.a.	0.7%	n.a.	n.a.	0.9%
130204 Aboriginal health	0.1%	0.3%	0.3%	0.3%	n.a.	0.0%	n.a.	n.a.	0.2%
130205 Substance abuse	0.1%	0.7%	2.5%	1.8%	n.a.	0.0%	n.a.	n.a.	1.6%
130206 Occupational health (exc ec dev't aspects)	9.0%	1.2%	0.9%	1.9%	n.a.	n.p.	n.a.	n.a.	n.a.
130207 Environmental health	6.0%	0.1%	0.6%	1.1%	n.a.	n.p.	n.a.	n.a.	n.a.
130208 Mental health	0.0%	2.4%	4.4%	3.5%	n.a.	0.0%	n.a.	n.a.	3.0%
130209 Disease distribution & transmission	0.1%	0.3%	0.8%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130210 Preventive medicine	0.9%	3.3%	2.8%	2.7%	n.a.	0.9%	n.a.	n.a.	2.4%
130211 Dental health	0.0%	0.0%	0.4%	0.3%	n.a.	0.0%	n.a.	n.a.	0.2%
130212 Nutrition	6.0%	1.2%	1.8%	2.1%	n.a.	0.0%	n.a.	n.a.	1.8%
130213 Food safety	4.2%	0.0%	0.2%	0.6%	n.a.	0.1%	n.a.	n.a.	0.6%
130214 Health status (e.g. indicators of well-being)	3.4%	0.1%	0.6%	0.8%	n.a.	0.0%	n.a.	n.a.	0.7%
130215 Social structure & health	0.1%	0.0%	0.2%	0.1%	n.a.	0.0%	n.a.	n.a.	0.1%
130216 Behaviour & health	3.4%	2.6%	0.5%	1.3%	n.a.	0.1%	n.a.	n.a.	1.1%
130299 Public health nec	0.0%	6.9%	2.3%	3.1%	n.a.	0.0%	n.a.	n.a.	2.6%
Subtotal	**35.0%**	**21.0%**	**23.2%**	**24.0%**	**4.5%**	**3.4%**	**4.1%**	**17.8%**	**21.1%**
130300 HEALTH AND SUPPORT SERVICES	0.0%	0.0%	0.0%	0.0%	n.a.	0.0%	n.a.	n.a.	0.0%
130301 Health education & promotion	0.7%	0.1%	1.0%	0.8%	n.a.	0.3%	n.a.	n.a.	0.7%
130302 Nursing	0.0%	0.1%	0.9%	0.6%	n.a.	0.0%	n.a.	n.a.	0.5%
130303 Occupational, speech & physiotherapy	0.0%	0.1%	1.0%	0.7%	n.a.	0.0%	n.a.	n.a.	0.6%
130304 Palliative care	0.0%	0.3%	0.2%	0.2%	n.a.	0.0%	n.a.	n.a.	0.1%
130305 Diagnostic methods	2.4%	2.5%	0.3%	1.0%	n.a.	0.2%	n.a.	n.a.	0.9%
130306 Evaluation of health outcomes	0.0%	0.6%	0.8%	0.7%	n.a.	0.1%	n.a.	n.a.	0.6%
130307 Health policy evaluation	4.0%	0.1%	0.7%	0.9%	n.a.	0.0%	n.a.	n.a.	0.8%
130308 Health policy economic outcomes	0.1%	0.3%	0.3%	0.3%	n.a.	0.0%	n.a.	n.a.	0.3%
130399 Health and support services nec	0.2%	4.3%	1.2%	1.8%	n.a.	0.0%	n.a.	n.a.	1.5%
Subtotal	**7.3%**	**8.5%**	**6.4%**	**7.0%**	**5.5%**	**0.7%**	**3.8%**	**6.0%**	**6.1%**
191000 MEDICAL AND HEALTH SCIENCES	0.0%	0.0%	5.7%	3.8%	n.a.	0.0%	n.a.	n.a.	3.3%
191001 Medical and health sciences	4.8%	4.4%	2.0%	2.8%	n.a.	8.2%	n.a.	n.a.	3.6%
Subtotal	**4.8%**	**4.4%**	**7.7%**	**6.6%**	**1.1%**	**8.2%**	**3.7%**	**5.7%**	**6.9%**
GRAND TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Access Economics, derived from ABS special data request.

Table 56 Australian health R&D (SEO), by sector and source of funds, 2000-01

	Public sector sources			Private sector sources				
Sector performing the R&D, $'000	**Common -wealth**	**State/Terr & local**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**Total**
Commonwealth	43,754	941	44,696	5,551	2,191	832	8,574	**53,270**
State/Territory/local	36,730	91,911	128,641	27,393	38,360	6,887	72,640	**201,281**
Higher education	622,916	31,156	654,072	43,069	47,215	26,851	117,135	**771,207**
Subtotal Public	**703,400**	**124,009**	**827,409**	**76,012**	**87,766**	**34,570**	**198,349**	**1,025,757**
Business	28,818	3,840	32,658	327,151	-	66,060	393,211	**425,869**
PNP	67,514	25,986	93,501	16,678	128,476	19,451	164,604	**258,105**
Subtotal Private	**96,332**	**29,827**	**126,159**	**343,829**	**128,476**	**85,511**	**557,815**	**683,974**
Grand Total	***799,732***	***153,835***	***953,567***	***419,841***	***216,242***	***120,081***	***756,164***	***1,709,731***
% of column totals								
Commonwealth	5.5%	0.6%	4.7%	1.3%	1.0%	0.7%	1.1%	**3.1%**
State/Territory/local	4.6%	59.7%	13.5%	6.5%	17.7%	5.7%	9.6%	**11.8%**
Higher education	77.9%	20.3%	68.6%	10.3%	21.8%	22.4%	15.5%	**45.1%**
Subtotal Public	**88.0%**	**80.6%**	**86.8%**	**18.1%**	**40.6%**	**28.8%**	**26.2%**	**60.0%**
Business	3.6%	2.5%	3.4%	77.9%	0.0%	55.0%	52.0%	**24.9%**
PNP	8.4%	16.9%	9.8%	4.0%	59.4%	16.2%	21.8%	**15.1%**
Subtotal Private	**12.0%**	**19.4%**	**13.2%**	**81.9%**	**59.4%**	**71.2%**	**73.8%**	**40.0%**
Grand Total	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***
% of row totals								
Commonwealth	82.1%	1.8%	83.9%	10.4%	4.1%	1.6%	16.1%	**100.0%**
State/Territory/local	18.2%	45.7%	63.9%	13.6%	19.1%	3.4%	36.1%	**100.0%**
Higher education	80.8%	4.0%	84.8%	5.6%	6.1%	3.5%	15.2%	**100.0%**
Subtotal Public	**68.6%**	**12.1%**	**80.7%**	**7.4%**	**8.6%**	**3.4%**	**19.3%**	**100.0%**
Business	6.8%	0.9%	7.7%	76.8%	0.0%	15.5%	92.3%	**100.0%**
PNP	26.2%	10.1%	36.2%	6.5%	49.8%	7.5%	63.8%	**100.0%**
Subtotal Private	**14.1%**	**4.4%**	**18.4%**	**50.3%**	**18.8%**	**12.5%**	**81.6%**	**100.0%**
Grand Total	***46.8%***	***9.0%***	***55.8%***	***24.6%***	***12.6%***	***7.0%***	***44.2%***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Table 57 Australian health R&D (SEO), by sector and source of funds, 1998-99

	Public sector sources			Private sector sources				
Sector performing the R&D, $'000	**Common -wealth**	**State/Terr & local**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**Total**
Commonwealth	47,614	1,089	48,703	4,998	2,527	779	8,304	**57,008**
State/Territory/local	29,507	85,073	114,579	22,771	26,895	3,650	53,316	**167,895**
Higher education	518,265	27,148	545,413	37,855	45,292	19,050	102,197	**647,610**
Subtotal Public	**595,386**	**113,310**	**708,696**	**65,624**	**74,714**	**23,479**	**163,817**	**872,513**
Business	13,277	438	13,715	244,612	12,550	33,765	290,926	**304,641**
PNP	51,796	24,545	76,341	28,678	83,017	9,607	121,302	**197,642**
Subtotal Private	**65,073**	**24,983**	**90,056**	**273,290**	**95,567**	**43,371**	**412,228**	**502,284**
Grand Total	***660,459***	***138,293***	***798,752***	***338,913***	***170,281***	***66,851***	***576,045***	***1,374,797***
% of column totals								
Commonwealth	7.2%	0.8%	6.1%	1.5%	1.5%	1.2%	1.4%	**4.1%**
State/Territory/local	4.5%	61.5%	14.3%	6.7%	15.8%	5.5%	9.3%	**12.2%**
Higher education	78.5%	19.6%	68.3%	11.2%	26.6%	28.5%	17.7%	**47.1%**
Subtotal Public	**90.1%**	**81.9%**	**88.7%**	**19.4%**	**43.9%**	**35.1%**	**28.4%**	**63.5%**
Business	2.0%	0.3%	1.7%	72.2%	7.4%	50.5%	50.5%	**22.2%**
PNP	7.8%	17.7%	9.6%	8.5%	48.8%	14.4%	21.1%	**14.4%**
Subtotal Private	**9.9%**	**18.1%**	**11.3%**	**80.6%**	**56.1%**	**64.9%**	**71.6%**	**36.5%**
Grand Total	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***
% of row totals								
Commonwealth	83.5%	1.9%	85.4%	8.8%	4.4%	1.4%	14.6%	**100.0%**
State/Territory/local	17.6%	50.7%	68.2%	13.6%	16.0%	2.2%	31.8%	**100.0%**
Higher education	80.0%	4.2%	84.2%	5.8%	7.0%	2.9%	15.8%	**100.0%**
Subtotal Public	**68.2%**	**13.0%**	**81.2%**	**7.5%**	**8.6%**	**2.7%**	**18.8%**	**100.0%**
Business	4.4%	0.1%	4.5%	80.3%	4.1%	11.1%	95.5%	**100.0%**
PNP	26.2%	12.4%	38.6%	14.5%	42.0%	4.9%	61.4%	**100.0%**
Subtotal Private	**13.0%**	**5.0%**	**17.9%**	**54.4%**	**19.0%**	**8.6%**	**82.1%**	**100.0%**
Grand Total	***48.0%***	***10.1%***	***58.1%***	***24.7%***	***12.4%***	***4.9%***	***41.9%***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Table 58 Australian health R&D (SEO), by sector and source of funds, 1996-97

	Public sector sources			Private sector sources				
Sector performing the R&D, $'000	**Common -wealth**	**State/Terr & local**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**Total**
Commonwealth	43,291	311	43,602	5,485	2,156	386	8,027	**51,630**
State/Territory/local	29,503	84,891	114,394	21,751	28,402	4,446	54,599	**168,993**
Higher education	432,188	22,262	454,450	35,876	36,704	10,096	82,676	**537,127**
Subtotal Public	**504,982**	**107,465**	**612,446**	**63,113**	**67,262**	**14,928**	**145,303**	**757,749**
Business	9,704	n.p.	n.p.	213,165	14,594	n.p.	227,759	**257,246**
PNP	48,932	16,415	65,347	29,263	69,227	5,453	103,943	**169,290**
Subtotal Private	**58,636**	**n.p.**	**n.p.**	**242,428**	**83,821**	**n.p.**	**n.p.**	**426,536**
Grand Total	***563,618***	***n.p.***	***n.p.***	***305,541***	***151,083***	***n.p.***	***n.p.***	***1,184,285***
% of column totals								
Commonwealth	7.7%	n.p.	n.p.	1.8%	1.4%	n.p.	n.p.	**4.4%**
State/Territory/local	5.2%	n.p.	n.p.	7.1%	18.8%	n.p.	n.p.	**14.3%**
Higher education	76.7%	n.p.	n.p.	11.7%	24.3%	n.p.	n.p.	**45.4%**
Subtotal Public	**89.6%**	**n.p.**	**n.p.**	**20.7%**	**44.5%**	**n.p.**	**n.p.**	**64.0%**
Business	1.7%	n.p.	n.p.	69.8%	9.7%	n.p.	n.p.	**21.7%**
PNP	8.7%	n.p.	n.p.	9.6%	45.8%	n.p.	n.p.	**14.3%**
Subtotal Private	**10.4%**	**n.p.**	**n.p.**	**79.3%**	**55.5%**	**n.p.**	**n.p.**	**36.0%**
Grand Total	***100.0%***	***n.p.***	***n.p.***	***100.0%***	***100.0%***	***n.p.***	***n.p.***	**100.0%**
% of row totals								
Commonwealth	83.8%	0.6%	84.5%	10.6%	4.2%	0.7%	15.5%	**100.0%**
State/Territory/local	17.5%	50.2%	67.7%	12.9%	16.8%	2.6%	32.3%	**100.0%**
Higher education	80.5%	4.1%	84.6%	6.7%	6.8%	1.9%	15.4%	**100.0%**
Subtotal Public	**66.6%**	**14.2%**	**80.8%**	**8.3%**	**8.9%**	**2.0%**	**19.2%**	**100.0%**
Business	3.8%	n.p.	n.p.	82.9%	5.7%	n.p.	88.5%	**100.0%**
PNP	28.9%	9.7%	38.6%	17.3%	40.9%	3.2%	61.4%	**100.0%**
Subtotal Private	**13.7%**	**n.p.**	**n.p.**	**56.8%**	**19.7%**	**n.p.**	**n.p.**	**100.0%**
Grand Total	***47.6%***	***n.p.***	***n.p.***	***25.8%***	***12.8%***	***n.p.***	***n.p.***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Table 59 Australian health R&D (SEO), by sector and source of funds, 1994-95

	Public sector sources			Private sector sources				
Sector performing the R&D, $'000	**Common -wealth**	**State/Terr & local**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**Total**
Commonwealth	58,972	79	59,051	5,287	1,659	235	7,181	**66,232**
State/Territory/local	31,575	105,737	137,313	13,054	32,961	3,421	49,436	**186,749**
Higher education	330,564	17,336	347,899	17,005	33,548	5,567	56,120	**404,019**
Subtotal Public	**421,111**	**123,152**	**544,263**	**35,346**	**68,169**	**9,222**	**112,737**	**657,000**
Business	6,932	1,222	8,154	187,594	5,629	25,119	218,343	**226,497**
PNP	42,329	18,762	61,091	11,295	56,810	3,532	71,637	**132,728**
Subtotal Private	**49,261**	**19,984**	**69,245**	**198,889**	**62,439**	**28,652**	**289,980**	**359,225**
Grand Total	***470,372***	***143,136***	***613,508***	***234,236***	***130,608***	***37,874***	***402,717***	***1,016,225***
% of column totals								
Commonwealth	12.5%	0.1%	9.6%	2.3%	1.3%	0.6%	1.8%	**6.5%**
State/Territory/local	6.7%	73.9%	22.4%	5.6%	25.2%	9.0%	12.3%	**18.4%**
Higher education	70.3%	12.1%	56.7%	7.3%	25.7%	14.7%	13.9%	**39.8%**
Subtotal Public	**89.5%**	**86.0%**	**88.7%**	**15.1%**	**52.2%**	**24.3%**	**28.0%**	**64.7%**
Business	1.5%	0.9%	1.3%	80.1%	4.3%	66.3%	54.2%	**22.3%**
PNP	9.0%	13.1%	10.0%	4.8%	43.5%	9.3%	17.8%	**13.1%**
Subtotal Private	**10.5%**	**14.0%**	**11.3%**	**84.9%**	**47.8%**	**75.7%**	**72.0%**	**35.3%**
Grand Total	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***
% of row totals								
Commonwealth	89.0%	0.1%	89.2%	8.0%	2.5%	0.4%	10.8%	**100.0%**
State/Territory/local	16.9%	56.6%	73.5%	7.0%	17.7%	1.8%	26.5%	**100.0%**
Higher education	81.8%	4.3%	86.1%	4.2%	8.3%	1.4%	13.9%	**100.0%**
Subtotal Public	**64.1%**	**18.7%**	**82.8%**	**5.4%**	**10.4%**	**1.4%**	**17.2%**	**100.0%**
Business	3.1%	n.p.	n.p.	82.8%	2.5%	n.p.	96.4%	**100.0%**
PNP	31.9%	14.1%	46.0%	8.5%	42.8%	2.7%	54.0%	**100.0%**
Subtotal Private	**13.7%**	**n.p.**	**n.p.**	**55.4%**	**17.4%**	**n.p.**	**n.p.**	**100.0%**
Grand Total	***46.3%***	***n.p.***	***n.p.***	***23.0%***	***12.9%***	***n.p.***	***n.p.***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Table 60 Australian health R&D (SEO), by sector and source of funds, 1992-93

	Public sector sources			Private sector sources				
Sector performing the R&D, $'000	**Common -wealth**	**State/Terr & local**	**Total**	**Business**	**Other Aust**	**Overseas**	**Total**	**Total**
Commonwealth	49,241	317	49,558	4,007	2,813	801	7,621	**57,179**
State/Territory/local	23,610	58,428	82,038	7,551	23,011	3,324	33,887	**115,925**
Higher education	298,596	10,518	309,114	9,380	29,882	3,891	43,153	**352,267**
Subtotal Public	**371,447**	**69,263**	**440,710**	**20,939**	**55,706**	**8,016**	**84,660**	**525,370**
Business	2,666	30	2,696	145,909	1,211	2,095	149,215	**151,911**
PNP	31,230	9,338	40,568	5,541	36,545	3,203	45,288	**85,856**
Subtotal Private	**33,896**	**9,368**	**43,264**	**151,450**	**37,755**	**5,298**	**194,503**	**237,767**
Grand Total	***405,343***	***78,631***	***483,974***	***172,388***	***93,461***	***13,314***	***279,164***	***763,137***
% of column totals								
Commonwealth	12.1%	0.4%	10.2%	2.3%	3.0%	6.0%	2.7%	**7.5%**
State/Territory/local	5.8%	74.3%	17.0%	4.4%	24.6%	25.0%	12.1%	**15.2%**
Higher education	73.7%	13.4%	63.9%	5.4%	32.0%	29.2%	15.5%	**46.2%**
Subtotal Public	**91.6%**	**88.1%**	**91.1%**	**12.1%**	**59.6%**	**60.2%**	**30.3%**	**68.8%**
Business	0.7%	0.0%	0.6%	84.6%	1.3%	15.7%	53.5%	**19.9%**
PNP	7.7%	11.9%	8.4%	3.2%	39.1%	24.1%	16.2%	**11.3%**
Subtotal Private	**8.4%**	**11.9%**	**8.9%**	**87.9%**	**40.4%**	**39.8%**	**69.7%**	**31.2%**
Grand Total	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***	***100.0%***
% of row totals								
Commonwealth	86.1%	0.6%	86.7%	7.0%	4.9%	1.4%	13.3%	**100.0%**
State/Territory/local	20.4%	50.4%	70.8%	6.5%	19.9%	2.9%	29.2%	**100.0%**
Higher education	84.8%	3.0%	87.7%	2.7%	8.5%	1.1%	12.3%	**100.0%**
Subtotal Public	**70.7%**	**13.2%**	**83.9%**	**4.0%**	**10.6%**	**1.5%**	**16.1%**	**100.0%**
Business	1.8%	0.0%	1.8%	96.0%	0.8%	1.4%	98.2%	**100.0%**
PNP	36.4%	10.9%	47.3%	6.5%	42.6%	3.7%	52.7%	**100.0%**
Subtotal Private	**14.3%**	**3.9%**	**18.2%**	**63.7%**	**15.9%**	**2.2%**	**81.8%**	**100.0%**
Grand Total	***53.1%***	***10.3%***	***63.4%***	***22.6%***	***12.2%***	***1.7%***	***36.6%***	***100.0%***

Source: Access Economics, derived from ABS special data request.

Table 61 Gains in longevity, wellness and healthspan by cause, low case, Australia, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
	1999	1960-1999	1999	1960-1999	1999	1960-1999
Selected causes	**$m**	**$bn**	**$m**	**$bn**	**$m**	**$bn**
Cardiovascular	33,320	683	28,718	589	62,038	1,272
External causes (injury)	13,358	274	11,513	236	24,871	510
Cancer	6,839	140	5,894	121	12,733	261
Congenital	7,329	150	6,317	129	13,645	280
Respiratory	9,097	186	7,841	161	16,938	347
Digestive	5,454	112	4,701	96	10,155	208
Genitourinary	3,941	81	3,397	70	7,338	150
Nervous system	1,363	28	1,175	24	2,539	52
Infectious & parasitic	2,855	59	2,461	50	5,315	109
Endocrine, metabolic	980	20	845	17	1,825	37
Mental	(597)	(12)	(514)	(11)	(1,111)	(23)
Skin	746	15	643	13	1,388	28
Symptoms etc	(1,491)	(31)	(1,285)	(26)	(2,777)	(57)
Blood	-	-	-	-	-	-
Musculoskeletal	(21)	(0)	(18)	(0)	(40)	(1)
Other	23,200	476	19,996	410	43,197	886
All causes	**106,372**	**2,181**	**91,682**	**1,879**	**198,055**	**4,060**

Source: Access Economics.

Table 62 Gains in longevity, wellness and healthspan by cause, high case, Australia, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
	1999	1960-1999	1999	1960-1999	1999	1960-1999
Selected causes	**$m**	**$bn**	**$m**	**$bn**	**$m**	**$bn**
Cardiovascular	66,640	1,366	57,437	1,177	124,077	2,544
External causes (injury)	26,716	548	23,026	472	49,742	1,020
Cancer	13,677	280	11,789	242	25,466	522
Congenital	14,657	300	12,633	259	27,291	559
Respiratory	18,194	373	15,681	321	33,875	694
Digestive	10,908	224	9,401	193	20,309	416
Genitourinary	7,883	162	6,794	139	14,677	301
Nervous system	2,727	56	2,350	48	5,077	104
Infectious & parasitic	5,710	117	4,921	101	10,631	218
Endocrine, metabolic	1,960	40	1,689	35	3,649	75
Mental	(1,193)	(24)	(1,028)	(21)	(2,221)	(46)
Skin	1,491	31	1,285	26	2,777	57
Symptoms etc	(2,983)	(61)	(2,571)	(53)	(5,553)	(114)
Blood	-	-	-	-	-	-
Musculoskeletal	(43)	(1)	(37)	(1)	(79)	(2)
Other	46,401	951	39,993	820	86,394	1,771
All causes	**212,745**	**4,361**	**183,365**	**3,759**	**396,109**	**8,120**

Source: Access Economics.

Table 63 Gains in longevity, wellness and healthspan from Australian R&D, low case, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
	1999	1960-1999	1999	1960-1999	1999	1960-1999
Selected causes	**$m**	**$bn**	**$m**	**$bn**	**$m**	**$bn**
Cardiovascular	249.9	5.1	215.4	4.4	465.3	9.5
External causes (injury)	100.2	2.1	86.3	1.8	186.5	3.8
Cancer	51.3	1.1	44.2	0.9	95.5	2.0
Congenital	55.0	1.1	47.4	1.0	102.3	2.1
Respiratory	68.2	1.4	58.8	1.2	127.0	2.6
Digestive	40.9	0.8	35.3	0.7	76.2	1.6
Genitourinary	29.6	0.6	25.5	0.5	55.0	1.1
Nervous system	10.2	0.2	8.8	0.2	19.0	0.4
Infectious & parasitic	21.4	0.4	18.5	0.4	39.9	0.8
Endocrine, metabolic	7.3	0.2	6.3	0.1	13.7	0.3
Mental	(4.5)	(0.1)	(3.9)	(0.1)	(8.3)	(0.2)
Skin	5.6	0.1	4.8	0.1	10.4	0.2
Symptoms etc	(11.2)	(0.2)	(9.6)	(0.2)	(20.8)	(0.4)
Blood	-	-	-	-	-	-
Musculoskeletal	(0.2)	(0.0)	(0.1)	(0.0)	(0.3)	(0.0)
Other	174.0	3.6	150.0	3.1	324.0	6.6
All causes	**797.8**	**16.4**	**687.6**	**14.1**	**1,485.4**	**30.5**

Source: Access Economics.

Table 64 Gains in longevity, wellness and healthspan from Australian R&D, high case, 1960-1999

	Base case					
	Value of greater longevity		Value of greater wellness		Value of greater healthspan	
	1999	1960-1999	1999	1960-1999	1999	1960-1999
Selected causes	**$m**	**$bn**	**$m**	**$bn**	**$m**	**$bn**
Cardiovascular	1,166.2	23.9	1,005.1	20.6	2,171.3	44.5
External causes (injury)	467.5	9.6	403.0	8.3	870.5	17.8
Cancer	239.4	4.9	206.3	4.2	445.7	9.1
Congenital	256.5	5.3	221.1	4.5	477.6	9.8
Respiratory	318.4	6.5	274.4	5.6	592.8	12.2
Digestive	190.9	3.9	164.5	3.4	355.4	7.3
Genitourinary	137.9	2.8	118.9	2.4	256.8	5.3
Nervous system	47.7	1.0	41.1	0.8	88.9	1.8
Infectious & parasitic	99.9	2.0	86.1	1.8	186.0	3.8
Endocrine, metabolic	34.3	0.7	29.6	0.6	63.9	1.3
Mental	(20.9)	(0.4)	(18.0)	(0.4)	(38.9)	(0.8)
Skin	26.1	0.5	22.5	0.5	48.6	1.0
Symptoms etc	(52.2)	(1.1)	(45.0)	(0.9)	(97.2)	(2.0)
Blood	-	-	-	-	-	-
Musculoskeletal	(0.7)	(0.0)	(0.6)	(0.0)	(1.4)	(0.0)
Other	812.0	16.6	699.9	14.3	1,511.9	31.0
All causes	**3,723.0**	**76.3**	**3,208.9**	**65.8**	**6,931.9**	**142.1**

Source: Access Economics.

Table 65 Australian health R&D, $'000, allocated total by category, 1998-99

70400 Human pharmaceutical products	23,782
70401 Prevention - biologicals (e.g. vaccines)	22,250
70402 Diagnostics	35,958
70403 Treatments (e.g. chemicals, antibiotics)	125,786
70499 Other	13,461
Subtotal	**221,236**
130100 CLINICAL (ORGANS, DISEASES & COND'S)	25,539
130101 Infectious diseases	51,747
130102 Immune system & allergy	47,896
130103 Blood disorders	14,164
130104 Neurological disorders	50,011
130105 Endocrine diseases (inc diabetes)	42,265
130106 Cardiovascular diseases	62,557
130107 Inherited diseases	30,143
130108 Cancer & related disorders	96,905
130109 Surgical methods & procedures	16,781
130110 Respiratory diseases (inc asthma)	22,627
130111 Hearing, vision & speech	36,925
130112 Oro-dental	11,055
130113 Digestive system	15,788
130114 Arthritis, bone & joint disorders	25,591
130115 Kidney diseases	12,248
130116 Reproductive medicine	20,783
130117 Skin & related conditions	11,305
130118 Other organs, diseases & conditions	9,158
130199 Clinical health nec	52,258
Subtotal	655,745
130200 PUBLIC HEALTH	16,949
130201 Women's health	20,309
130202 Health related to ageing	17,724
130203 Child health	26,644
130204 Aboriginal health	7,168
130205 Substance abuse	12,312
130206 Occupational health (exc ec dev't aspects)	7,746
130207 Environmental health	9,536
130208 Mental health	37,294
130209 Disease distribution & transmission	6,332
130210 Preventive medicine	15,789
130211 Dental health	6,240
130212 Nutrition	8,011
130213 Food safety	2,981
130214 Health status (e.g. indicators of well-being)	5,348
130215 Social structure & health	2,656
130216 Behaviour & health	8,087
130299 Public health nec	38,492
Subtotal	249,617
130300 HEALTH AND SUPPORT SERVICES	6,146
130301 Health education & promotion	11,654
130302 Nursing	19,121
130303 Occupational, speech & physiotherapy	8,306
130304 Palliative care	1,597
130305 Diagnostic methods	12,370
130306 Evaluation of health outcomes	8,228
130307 Health policy evaluation	4,820
130308 Health policy economic outcomes	3,876
130399 Health and support services nec	28,726
Subtotal	104,845
191000 MEDICAL AND HEALTH SCIENCES	17,596
191001 Medical and health sciences	125,759
Subtotal	143,355
Grand total	**1,374,797**

Source: Access Economics.

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