ABSTRACT

Economic benefit of health research and development (R&D)

- Australian health R&D expenditure between 1992-93 and 2004-05 is estimated to return a net benefit of approximately $29.5 billion. For the average dollar invested in Australian health R&D, $2.17 in health benefits is returned, with a minimum of $0.57 and maximum of $6.01.
- The annual value to Australians of gains in wellbeing (from all sources, not just Australian R&D) are over $100 billion for females and over $270 billion for males by 2045.
- Australian health R&D expenditure is estimated to be 1.1% of the global expenditure on health R&D. The proportion of world health returns attributable to Australian R&D is approximately 3.04%.
- Health R&D provides returns to Australia of 117%, exceeded only by mining (159%) and wholesale/retail (438%) of sectors considered.

Gains in wellbeing

- Australia is becoming a healthier nation with life expectancy one of the highest in the world.
- For Australia, approximately 1.34 million Disability Adjusted Life Years (DALYs are a measure of a year of healthy life lost) will be averted in 2023 relative to 1993 levels, 839,000 by males and 497,286 by females.

Expenditure on health R&D

- Australia spent $2.8 billion on health R&D in 2004-05 (0.38% of gross domestic product – GDP) ranking in the middle of comparable countries in the Organization for Economic Cooperation and Development (OECD). New Zealand (NZ), The Czech Republic and Japan spend less relative to GDP while the United Kingdom (UK), United States (US), Germany, France, Denmark and Canada spend more, of the ten countries studied.
- Cancer was the leading area of non-business clinical research ($233 million), followed by cardiovascular and neurological disorders. The highest average annual growth rate of this R&D between 1992-93 and 2004-2005 was in arthritis, bone and joint disorders (17%) and infectious diseases (13%).
- Universities performed 44% of health R&D, businesses 26%, private non-profit (PNP) organisations 16% and government institutions 14%. The public sector thus performed 58% and the private sector 42%.
- The majority of health R&D since 1992-93 has been undertaken in clinical R&D, which increased from $413 million to $1.43 billion (an average growth rate of 12% annually).

Potential impacts (case study examples)

- The development of Gardasil to vaccinate against 70% of cervical cancer has potential returns in terms of wellbeing of around 2.5:1.
- Prevention or delay of vision loss associated with diabetes, or vision gain through intensive hyperglycaemic control means 4,111 fewer people with visual impairment by 2025 representing savings of $7.6 billion (in 2008 prices).

- Decreasing incidence of Alzheimer's disease by 5% through Australian R&D will result in savings of $10.3 billion by 2050. Over half of these savings would be in the residential care sector.
- The value of a Group A Streptococci (GAS) vaccine could provide health benefits valued at $319.7 million per year, of which $78.4 million would be realised by indigenous Australians.

Focus

- The greatest burden of disease currently is from cancer (19% of Australia's total), followed by cardiovascular disease (18%). The major burden is from mortality associated with these two diseases. Non-fatal diseases also play a significant and increasing role in the burden of disease and the years of healthy life lost due to disability. An emphasis for the future should be reducing disability within the population.
- Composition of burden of disease changes across age with greatest burden up to age 40 years from mental disorders and injuries; after age 40, cancer is the leading cause until age 75 where cardiovascular disease takes over.
- Australia has a comparative advantage in health R&D given levels of discovery, publications and citations. In addition to the 'good international citizen' arguments, there are therefore weighty economic reasons for sustaining and enhancing health R&D investment.

Context

- The returns presented in the 2003 ASMR *Exceptional Returns* report found a mean B/C ratio of 2.4 with a minimum of 1.0 and a maximum of 5.0. These returns were derived by retrospectively comparing the estimated gains in any year with the research spend in that same year. This report captures the lag between R&D and its benefits and finds a mean B/C ratio of 2.17 with a minimum of 0.57 and a maximum of 6.0.

EXECUTIVE SUMMARY

This report estimates the economic value of health R&D in Australia, updating the Access Economics (2003) *Exceptional Returns* report for the Australian Society for Medical Research (ASMR) in light of recent increases in health R&D expenditures. These increases are reflected in Australian Bureau of Statistics (ABS) data, and the analysis also includes sensitivity analysis, benchmarking of the rates of return and case studies of four specific examples of the wellbeing returns to health R&D.

Methods

The major return on investment (ROI) from health R&D is the gain in wellbeing achieved from lowering mortality rates and associated morbidity, relative to what they would otherwise have been (ie, in the absence of the R&D). Gains in Australian wellbeing were estimated from 1993 to 2023 by the Australian Institute of Health and Welfare (AIHW, Begg et al, 2007). Wellbeing was measured using burden of disease methodology, which is non-financial. The metric of wellbeing is the Disability Adjusted Life Year (DALY), which comprises both a mortality component (Year(s) of Life Lost due to premature death, YLLs) and a morbidity component (Year(s) of healthy life Lost due to Disability, YLDs).

The value of the DALYs averted relative to 1993 levels was converted to a dollar equivalent using willingness to pay (WTP) estimates of the value of a statistical life (year) (VSL/Y). Access Economics recently undertook a literature investigation and meta-analysis for an Australian Government client to determine the most appropriate estimate of the average VSLY in Australia (Access Economics, 2008). The meta-analysis included 244 studies (17 Australian and 227 international studies) between 1973 and 2007, and recommended that, where a VSLY is required for decision making, an appropriate average for Australia in 2006 prices is $252,014. This is higher than the VSLY used in Access Economics (2003) and was, additionally, converted to 2008 dollars by multiplying by two years of inflation (2.9% in each year, from the Access Economics Macroeconomic model). This resulted in a base case VSLY of $266,843 with lower and upper bounds of $164,553 and $360,238.

Naturally, not all the potential future gains in wellbeing as estimated by the AIHW are due to Australia's own R&D. The methodology estimates the proportion due to research as opposed to other factors (eg, public health awareness and preventive programs such as 'Slip Slop Slap' or 'Quit', screening and early intervention initiatives, the public subsidy of drugs and interventions through the Pharmaceutical Benefits Scheme and the Medicare Benefits Schedule, and so on). Based on the factors identified in Access Economics (2003), this proportion is re-estimated as 50% (30% to 70%) for R&D.

The other important parameter is the proportion of wellbeing gains due to R&D that can be attributed to Australia's own R&D rather than that outside our borders. In Access Economics (2003) this was estimated as 2.5% for Australian health R&D, reflecting that Australia 'punches above our weight' given our world population share of 0.3% (Wills, 1998). In this report the estimate is 3.04%, based on recent bibliometric evidence from the Department of Education, Science and Training (DEST). This higher global contribution seems reasonable given that Australia's expenditure on health R&D has increased in recent years.

Expenditure on health R&D was estimated for the period 1992-93 to 2004-05, the only years for which there are available Australian Bureau of Statistics (ABS) data (two-yearly, on a socioeconomic objective – SEO basis).

The ROI analysis compared the value of the wellbeing gains projected to occur with a 40-year lag from the expenditure year, to take account of lags in R&D translation into benefits, and the long period for which benefits from R&D may continue to be realised. Thus the total benefits over (fiscal years) FY2033-2045 relative to FY1993 were compared with the expenditures over FY1993-2005. This is a slightly different approach from Access Economics (2003) in relation to lags, as it projects forward rather than retrospective analysis, although since the AIHW projections are based on historical trends there is considerable similarity in the method. To retain the 40-year period used in Access Economics (2003) implicitly assumes that most of the value of the benefits of R&D are captured within this period. In reality many benefits may be more prolonged (eg, we continue to benefit from polio vaccines). The methodology may also be conservative because it only includes the value of wellbeing gains that accrue to the individual as benefits.

- Other health sector benefits of averting DALYs accrue to governments (eg, health expenditures saved), to firms (to the extent that they bear part of the productivity losses associated with disease and injury) and to the rest of the society (eg, the value of informal care from family and friends).
- Outside the health sector there are also benefits, such as the commercial gains to firms and the economy of producing preventive and therapeutic interventions. A good example is the cervical cancer vaccine (Gardasil®) developed and produced in Australia that is exported worldwide.

An Excel model was used to estimate the net present value (NPV) of the net benefit streams as well as the ROI and the Benefit/Cost (B/C) ratio for health R&D undertaken over 1992-93 to 2004-05, which were benchmarked in terms of:

- historical benchmarks and comparisons in expenditure since 1998-99 in light of the recommendations of the 'Wills' Review of Health and Medical Research in 1998, which marked somewhat of a turning point in terms on focus on health R&D in Australia;
- international benchmarks – with data from the Organization for Economic Cooperation and Development (OECD) used to compare health R&D expenditure in Australia with that in comparable OECD countries including the UK, Canada, the US, western Europe, Japan and Korea; and
- benchmarks in other sectors of the Australian economy, in terms of expenditures and rates of return – notably manufacturing, mining, wholesale and retail trade and in agriculture.

The final aspect of the analysis was to present four case study examples of the value of health R&D in Australia, specifically in the therapeutic areas of diabetes, dementia, cancer, and indigenous health.

Gains in wellbeing

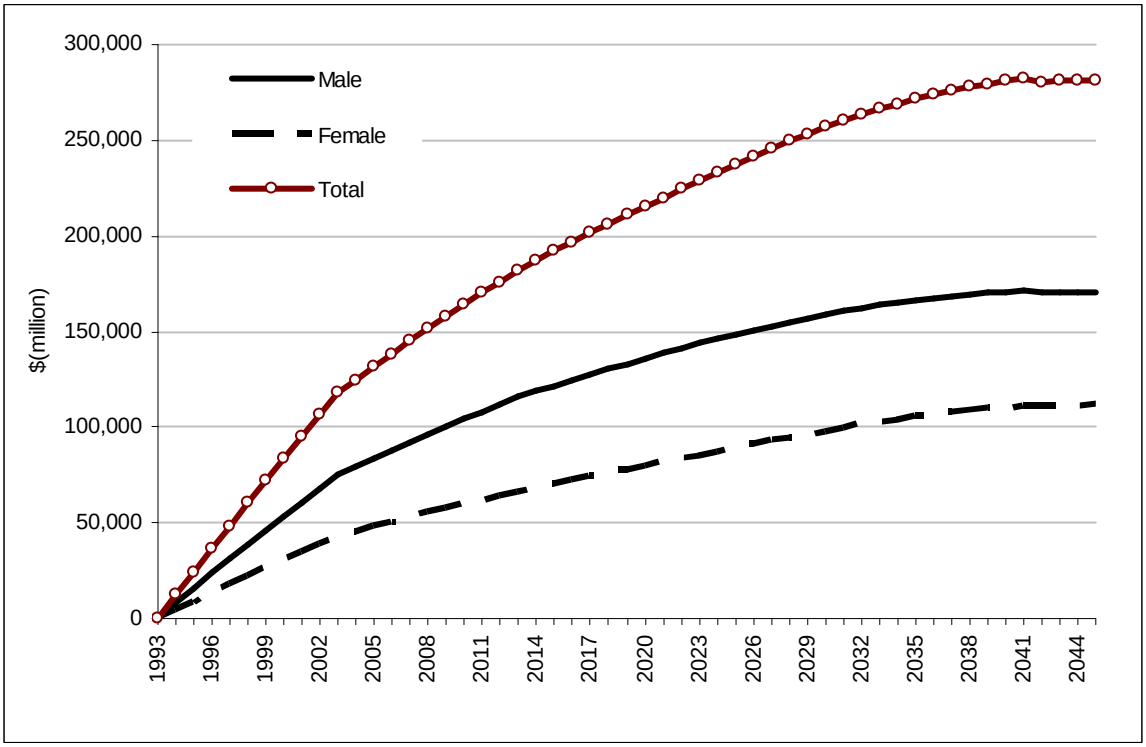
For Australia, nearly 1.34 million DALYs are estimated to be averted in 2023 relative to 1993 burden of disease levels (in terms of DALYs per 1,000 population). Of these, 839,000 DALYs are averted by males and 497,286 by females, primarily reflecting higher expected benefits to males in the future in relation to cardiovascular disease, cancer, chronic respiratory disease, injuries, and endocrine and metabolic disorders.

Notably – there are wellbeing *losses* projected in the future for acute respiratory infections, diabetes mellitus, nervous system and sense disorders, musculoskeletal disease and oral conditions – as well as mental disorders for females and, for males, infectious and parasitic diseases. These conditions are those where disability is the main source of disease burden rather than premature mortality. Together with the increasing overall proportion of Australia's burden of disease that is due to YLD rather than YLL, this suggests that a prime emphasis of

health R&D in the future should also be on reducing disability within the Australian population.

Applying the VSLY to the total number of DALYs averted, **the annual value to Australians of gains in wellbeing expected to result from all impacts on health** (not just Australian R&D) **are over $100 billion for females and over $270 billion for males by 2045** (see chart below).

ANNUAL VALUE OF DISCOUNTED GAINS IN WELLBEING, BY GENDER, 1993-2045



Source: Access Economics.

Expenditure on health R&D in Australia

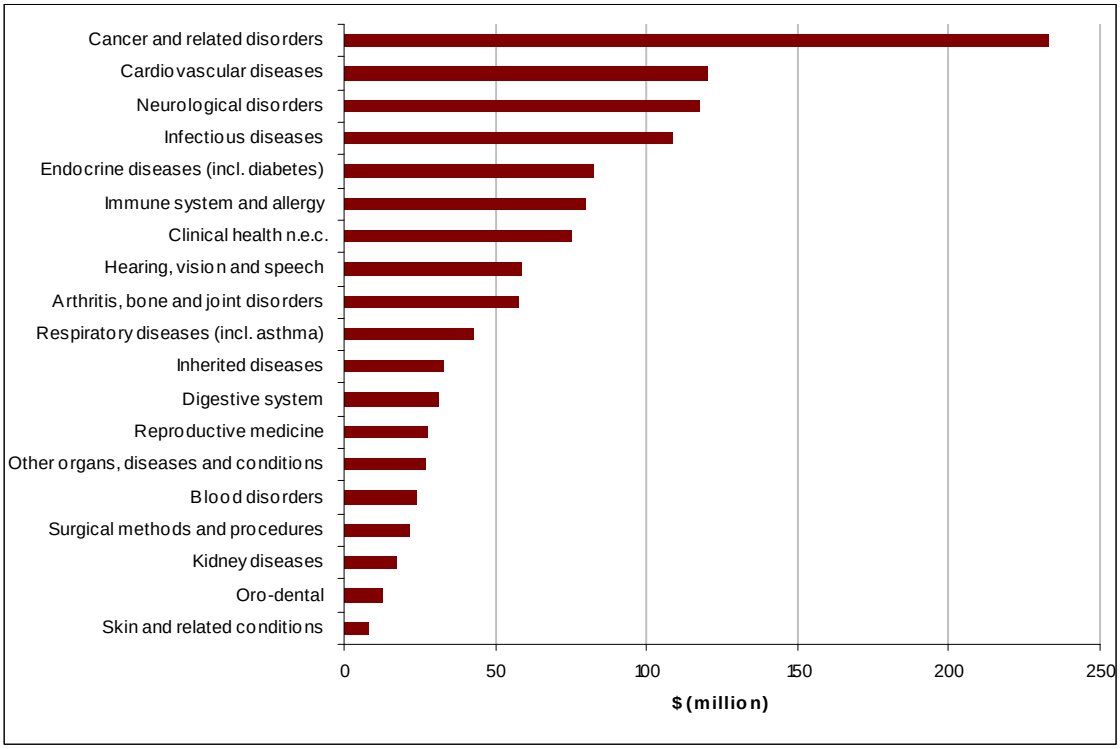
In 2004-05, **$2.8 billion was spent on health R&D in Australia** – Australian Standard Research Classification (ASRC) SEO subdivision 730000 Health.

- Around 44% of health R&D was performed by higher education facilities, 26% by business, 16% by private non-profit (PNP) organisations and 14% by Government facilities.
- Although the Commonwealth sector performs the least amount of health R&D, most of the funding comes from the Commonwealth government. In 2004-05, the Commonwealth contributed around $1.4 billion of funds across all five sectors. The majority of this spending went to higher education facilities (79%) while business received the lowest amount of funding (2%). The business sector spends the second highest amount of funds on health R&D and, not surprisingly, most of these funds are spent on R&D undertaken by business. Overseas funding accounts for around $121 million (4%) of Australian health R&D spending, of which the majority is performed by the PNP sector.
- The majority of health R&D since 1992-93 has been undertaken in clinical research, which has increased from around $413 million to $1.43 billion at an average annual growth rate of 12%. R&D expenditure on human pharmaceutical products and public health had similar expenditures in 2004-05 with $548 million and $536 million spent

respectively, although the average annual growth rate for the former was larger at 15% compared to 12%. Health and support services (which includes medical and health sciences prior to 2000-01) had the lowest expenditure in 2004-05 at $250 million and the lowest average annual growth rate at 12%.

- Of non-business clinical R&D (business data were not available by class), around $233 million was spent on cancer, which was nearly double the expenditure for cardiovascular disease at $120 million. The smallest class of expenditure in 2004-05 was for skin and related conditions, at around $8 million (see chart below).

TOTAL NON-BUSINESS CLINICAL R&D (SEO) EXPENDITURE, BY CLASS, 2004-05



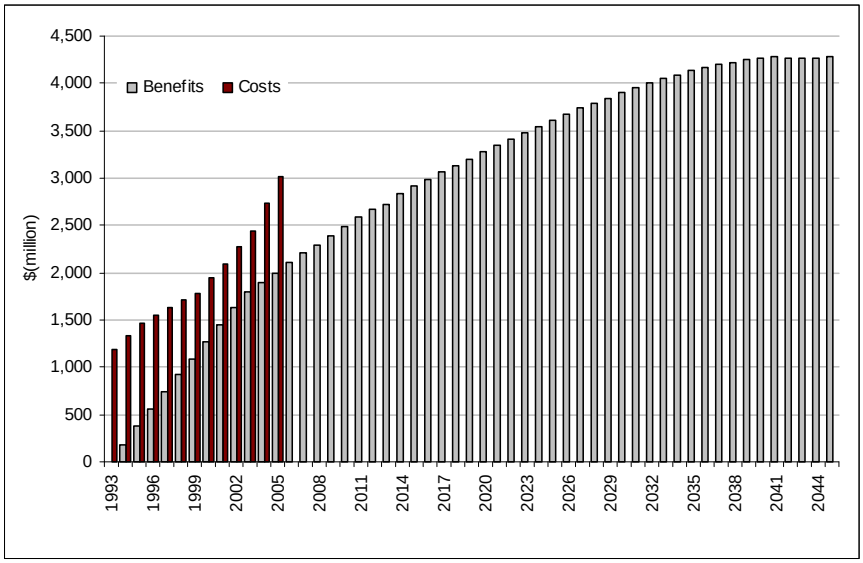
Source: Access Economics, based on ABS data.

Net benefits, ROI and Benefit/Cost ratio

The projected net benefits from health R&D over the period 1992-93 to 2004-05 are estimated as $29.5 billion, representing an average net benefit of around $2.3 billion per year. The ROI is around 117%, which means that a dollar invested in Australian health R&D is estimated to return an average net health benefit valued at $1.17. To put it another way, the B/C ratio is 2.17, which means that a dollar invested in Australian health R&D returns $2.17 in health benefits.

Expenditure has increased substantially since 1993, reaching just over $3.0 billion (in 2008 prices). Similarly, benefits have also been increasing since 1993 but at a decreasing rate. The annual benefit stream from gains in wellbeing and the cost stream associated with Australian health R&D are shown in the next chart.

BENEFIT AND COST STREAMS FROM AUSTRALIAN HEALTH R&D, 1993 TO 2045

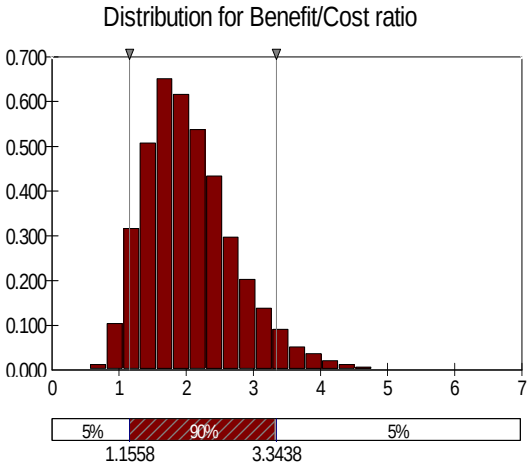


Sensitivity analysis

A sensitivity analysis was undertaken using a Monte Carlo simulation to investigate how the net benefits, ROI and B/C ratio change with different assumptions regarding inputs used within the model. This helps account for uncertainty and provides an indication of confidence in the results. The inputs that were investigated included:

- the VSLY (a gamma distribution around $266,843);
- the delay in benefits from R&D (a discrete distribution at 20, 30, 50 and 60 years compared to 40 years);
- the proportion of Australia health gains attributed to world R&D (a triangular distribution around 50% - bounded at 30% and 70%); and
- the proportion of world R&D gains attributed to Australian R&D (a triangular distribution around 3.04% - bounded at 2% and 4%).

Even though there is large uncertainty surrounding the inputs, there is a 90% chance that the net benefits from Australian R&D lie in the range $3.9 billion to $59.1 billion that the ROI from Australian R&D is between 15.6% and 234.4% and the B/C ratio is in the range 1.16 to 3.34.



The B/C ratio is estimated as 2.17 (90%CI 1.16 to 3.34, min 0.57, max 6.01). This compares with 2.4 (min 1.0, max 5.0) in the 2003 analysis. The slight decline largely reflects the increased expenditures on health R&D in the interim together with lower expected future gains as the disability burden of the chronic diseases of ageing are projected to increase in coming decades, despite the contribution of R&D.

Benchmarking

It should be noted that there is a wide variation in methodologies and assumptions when making benchmarking comparisons intersectorally and internationally.

Historical: **Australia's health R&D expenditure has increased substantially since the Wills review in 1998**. Compared to historical benchmark at that time of around $1.7 billion, R&D reached $2.8 billion in 2004-05, an average growth rate of around 12% per year. This real growth has occurred across all sectors (although highest in the business sector) and across all areas (health and support services, clinical R&D and public health R&D) except for human pharmaceutical products.

International: **Australia ranks in the middle of comparable countries with health R&D** expenditure estimated as 0.38% of GDP[1] (Organization for Economic Cooperation and Development – OECD, 2007). New Zealand, The Czech Republic and Japan spend less relative to GDP, while the UK, US, Germany, France, Denmark and Canada all spend more, of the ten countries studied.

Sectoral: **The ROI for health R&D is higher than the average ROIs for R&D in other sectors**. According to Shanks and Zheng (2006), the ROI for health R&D of 117% is higher than the market and manufacturing sectors (each around 50%) and agriculture (around 24%), but lower than the mining sector (159%) and the wholesale and retail trade sector (a very high 438%). The health R&D ROI is also higher than the average gross rate of return presented within the Productivity Commission (2007) review (65% to 85%).

Case study examples

To place the modelling in the context of real world examples, four studies were reviewed based on R&D activity translating into wellbeing gains.

- Gardasil is a vaccine against certain types of human papillomavirus (HPV) which is founded on research breakthroughs initiating from Australia, notably by Professor Ian Frazer at the University of Queensland and his fellow researcher, the late Dr Jian Zhou – in collaboration with other bodies including Commonwealth Serum Laboratories (CSL) Australia, the US Cancer Research Institute, the University of Rochester (New York) and Merck Sharp & Dohme.
  - Using an average lifetime cost per incident and actively prevalent case of cancer averted of $1.63 million, 1,701 such cases per annum in Australia, 50% of benefits attributable to R&D, 60% coverage by the vaccination program and 13% of the R&D component due to Australian (as opposed to overseas) research based on royalty attribution, yields an attributable benefit of $63 million per annum, which (compared to $8.5 million per annum in costs) yields a B/C ratio of 7.5:1. Taking into account that benefits occur 37 years in the future are valued at

[1] The OECD estimate is a little higher than the ABS estimate, which is closer to 0.3% of GDP.

less than a third of the value of an event occurring now, in NPV terms, the B/C ratio may be closer to 2.5:1 than 7.5:1. The calculation does not take account the cost of the immunisation program or the availability of alternatives, and another caveat is that cervical cancers have yet to demonstrate long term efficacy. That said, the potential benefits worldwide are the saving of 225,000 lives each year worldwide.

- For diabetes, the example is from trial data on intensive hyperglycaemic control in bringing about a reduction in visual impairment from diabetic eye diseases. The major eye diseases associated with diabetes are diabetic retinopathy (DR), cataract and neovascular glaucoma (NVG).
  - Extending intensive blood glucose treatment to those whose diabetes is currently not controlled (around 28% of people with treated diabetes) will result in a significant reduction in diabetic eye disease and hence in visual impairment and associated deaths (eg, falls, accidents). By 2025, it is projected that there would be 4,111 fewer people with visual impairment than in the base case and 18,850 DALYs averted (a NPV increase of around $7.6 billion in 2008 prices).
  - Moreover, there are additional benefits from treating blood glucose that flow from reducing other (non ophthalmic) complications of diabetes, such as reduced risks to kidney, and heart disease, and reduced risk of amputation, nerve damage, and stroke. Although these have not been quantified in the modelling here, they represent a significant benefit from intensive glucose control as studied in these R&D trials.
- For Alzheimer's disease (AD), the example models the potential gains from R&D that could delay the onset of dementia.
  - If incidence of AD could be reduced by 5% through Australian R&D, then over the period 2005-2010, cumulative savings of $195 million would be realised - $10.3 billion over 2005-2050.
  - If incidence of AD could be reduced by 50% through Australian R&D, then over the period 2005-2010, cumulative savings of $1.97 billion would be realised - $104.9 billion over 2005-2050.
  - Over half of these savings (an estimated 57%) would be in the health and residential care sector.
- Development of a vaccine for Group A streptococci bacteria, currently commencing Phase I trials, has potential wellbeing gains in terms of deaths averted worth around $319.7 million, of which $78.4 million would be realised by indigenous Australians.
  - This may be conservative given the scale of other benefits, such as morbidity and hospitalisations averted.
  - Such vaccination R&D aligns well with the Rudd Federal Government commitment to preventive health and to removing the mortality gap between indigenous and non-indigenous Australians.

Health R&D can 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. This report has shown that on average every dollar invested in the future health challenges of demographic ageing in Australia is likely to be recouped as highly valued healthspan, and in most cases, many times over. Health R&D remains an exceptional investment, with exceptional returns.

Access Economics
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