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Canadian Institutes of Health Research

Finding a Balance in Federal Health Research Funding

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Canada

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Abbreviations

ACMC	-	Association of Canadian Medical Colleges
CFI	-	Canada Foundation for Innovation
CGS	-	Canada Graduate Scholarships
CHSRF	-	Canadian Health Services Research Foundation
CIHI	-	Canadian Institute for Health Information
CIHR	-	Canadian Institutes of Health Research
CPHI	-	Canadian Population Health Initiative
CRC	-	Canada Research Chairs
GBAORD	-	Government Budget Appropriations and Outlays for Research and Development
GDP	-	Gross Domestic Product
GERD	-	Gross Expenditure on Research and Development
NCE	-	Networks of Centres of Excellence
NIH	-	National Institutes of Health
NRC	-	National Research Council
NSERC	-	Natural Sciences and Engineering Research Council
OECD	-	Organisation for Economic Co-operation and Development
R&D	-	Research and Development
SSHRC	-	Social Sciences and Humanities Research Council

Executive Summary

This paper has been prepared by the Canadian Institutes of Health Research (CIHR) with the objective of defining the allocation of health research expenditure in Canada[i] between infrastructure investments, goal oriented research and support for human capital. The paper focuses on expenditures by federal granting agencies and federally funded commissions or foundations. Matching funds are included for certain programs.

The first section of the paper discusses a conceptual framework for the classification and analysis of research expenditures, building on work previously undertaken by CIHR's Research and Strategic Planning departments. It concludes that there is considerable difficulty in applying a consistent framework to data published in financial statements due to overlapping classifications of research activities. Nonetheless, a consistent use of terms is necessary in order to have an informed discussion of issues.

The second section of the paper analyzes estimates of health research expenditures in fiscal 2001-02 and projections to 2004-05. Federal funding for research activities was approximately $950 million in 2001-02 and is expected to grow to $1.33 billion by 2004-05. Matching funds by provincial and private sector partners bring the totals to $1.19 billion and $1.74 billion respectively.

In 2001-02, 25% of federal funding was allocated to infrastructure, 12% to human capital support and 59% to research projects (with the remaining 4% for program delivery costs). When co-funding from provincial and private sector partners is included, infrastructure investments received 34% of research funding. The percentage for infrastructure is expected to increase to 36% in 2004-05. Matching funds tend to be oriented toward infrastructure investments, which are expected to comprise 71% of co-funding in 2004-05 (most of these funds are for projects in which the Canada Foundation for Innovation is the federal partner).

Expense breakdowns of CIHR, NSERC and SSHRC project grants are also analyzed. Student and postdoctoral salaries (another form of support for human capital) range from 12% to 31% of grant expenditures. Equipment expenses (project specific infrastructure) range from 5% to 11%.

Section 3 of the paper consists of a review of international literature with a view to identifying information about the allocation of health research funding in other countries. Initiatives to bolster research funding have recently been announced in the UK and the US. Although detailed estimates of the allocation of funds were not found, it appears that funding increases in the UK provide a smaller share of funds for infrastructure than Canadian initiatives. As recently as 1990, there was virtually no support for infrastructure and less than 5% for human capital in US federal funding of health research, although this could be changing as the result of recently announced initiatives.

[i] The paper was prepared under contract to CIHR by Vern Hicks of Health Economics Consulting Services.

The review found no detailed estimates of the allocation of research funds such as those presented in Section 2. OECD data provide the most consistent basis for international comparisons but they lack details of how funds are allocated. Comparisons of funding allocations from scholarly papers or reports are complicated by a tendency of many authors to adopt a broad concept of infrastructure that includes human capital and other resources.

The last section of the paper identifies issues in the allocation of research funding. The issues are classified as policy and technical in order to facilitate future dialogue and investigation.

Introduction

Research funding has found a new priority in public policy during the last five years. Canada's innovation agenda recognizes the importance of research to economic growth, future productivity and the nation's ability to adapt to changing social and industrial exigencies that result from globalization.

The present research funding strategy recognizes the necessity of investments in infrastructure, human capital and strategic research in addition to the traditional focus on curiosity-driven research by academics. New funding programs have been developed which bridge the traditional boundaries of the three main research funding agencies.[ii] These programs include the Canada Foundation for Innovation (1999), Canada Research Chairs (2000) and Indirect Costs (2003).

The Canadian Institutes of Health Research (CIHR) was established in 2000, replacing funding activities of the Medical Research Council and the National Health Research Development Program. CIHR has an expanded mandate that includes the creation of knowledge and its translation into products and services that will strengthen the health care system and improve the health of Canadians.

Partnerships within the research community and between the academic and commercial sectors are also recognized as essential to future uptake of and support for research in the evolving approach to research funding.

While all of these developments are laudable, they also raise public policy questions in the allocation of health research funding. How to approach the issue of setting a balance among competing priorities for future research funding is one such question. As we build research capacity and infrastructure we make explicit or implicit choices about how future research dollars will be allocated.

This paper was prepared by CIHR with a view to defining the present allocation of federal health research funding and to project changes over the next three years, based on plans and priorities articulated in public policy documents or identified by stakeholders.[iii] Specific objectives were:

- document the balance of health research funding by federal agencies between funding for infrastructure and other research activities;
- develop and vet a conceptual framework for analysis of health research funding; and
- identify issues arising from the analysis of health research expenditure trends.

The first section of the report defines a conceptual framework for thinking about and measuring research funding. The second section provides estimates of the magnitude of health research funding from 2001-02 to 2004-05, focusing on research activities supported by federal granting agencies. The third section consists of a literature review based on published and gray literature from Canada and other countries that are at similar stages of economic development. The last section identifies policy issues and implications.

[ii] NSERC, SSHRC and CIHR.

[iii] The paper was prepared under contract to CIHR by Vern Hicks of Health Economics Consulting Services.

While this report is limited to health research funding, there is a potential to extend the discussion to other research areas as well. All the major federal funding agencies have been interviewed during the preparation of the report and most have provided input into the conceptual framework. Collaborative work that has gone into the development of this report could provide a staging base for more widely ranging discussions about research funding in Canada during the next decade.

Section 1: Conceptual Framework

This section provides a conceptual framework to guide a discussion of health research funding. It builds on work by CIHR's Research and Strategic Planning departments. The first part of the framework defines key concepts. The second part maps specific funding categories into CIHR's five Strategic Outcome categories. Definitions of funding activities are included as an appendix.

There was general agreement among stakeholders interviewed about the utility of the framework as a conceptual device. Most agencies do not use these concepts as explicit items in annual financial statements, however. In the case of specialized programs such as CFI, all funding is directed to infrastructure, although there are a relatively large number of theme areas supported by the infrastructure grants. In the case of NCE, support of highly qualified personnel (human capital) is a major priority. Other agencies fund all three of the major areas examined in this report (infrastructure, human capital and goal oriented research). Some of the agencies focus most of their funding on intramural research (e.g. NRC, Health Canada), which is more difficult to classify within the framework since all three of the major areas may be included in specific research activities.

Classification of Financial Data

CIHR has prepared multi-year estimates for its strategic outcomes in its 2003-04 *Report on Plans and Priorities*. The outcome categories are not used in its financial statements, however. It would be necessary to create a three-way cross classification to map grant expenditures into the *Plans and Priorities* categories. There could also be a question of precedence in classification – for example, how to classify support for human capital within a partnership and avoid double counting.

Financial statements of other agencies were also reviewed. All three of the major funding agencies identify goal oriented research (the first of CIHR's Strategic Outcomes) and have a further break down into open competitions and strategic grants (with the difference being that open competitions accept investigator identified objectives while strategic grants are directed to priorities identified by the granting agencies). Infrastructure funding is often a component of research grants, in the form of expenditures for equipment. Special reports were obtained from the three major funding agencies that showed the percent of grant funding allocated to equipment.[iv]

Support for researcher training and salaries (human capital) is identified by all three agencies in their financial statements. Salary support for students and postdoctoral

[iv] The percentage for equipment was obtained from annual reports from grant recipients made with the tri-agency form 300. Estimates of support for student salaries were also obtained from these reports.

fellows, another form of support for human capital development, is included in competitive grants and the percentage was obtained for the three agencies.

Knowledge translation is a relatively new priority. It is identified in the CIHR *Report on Plans and Priorities* but not shown as an explicit category in the financial statements of any of the three major funding agencies. Knowledge transfer is explicitly identified in the CHSRF financial statements, however. It is also a priority for the Canadian Population Health Initiative of CIHI (where the concept is referred to as knowledge exchange).

The conclusion that emerged from attempts to fully implement the framework or the strategic outcome categories in the *Report on Plans and Priorities* was that most published financial reports cannot be fully mapped into either classification system. The main constraint is the overlapping nature of functions and purposes of research activity. A strategic research grant, for example, may be defined as both goal oriented research and as a partnership, depending on the analyst's perspective. Similarly, a grant can include elements of knowledge translation and communications. There are also issues of overlapping sub-categories, which could be classified in different ways (e.g. support for grant writing).

The financial estimates for this report use the categories of goal oriented research, human capital, infrastructure and administration. The infrastructure category includes both dedicated infrastructure funding and the proportion of research grants allocated to equipment purchases (financial reports from grant recipients and estimates from officials of specific programs indicated a convergence of equipment expenditures to approximately 7% to 10% of grant expenditures). Human capital is comprised of training grants, salary support and the CRC program. In the data sub-section comparing the three funding agencies, grant expenditures are broken down to show support for student and postdoctoral salaries, infrastructure and other expenses.

Framework for Classifying Health Research Expenditures

Health Research Expenditures
R&D programs directed towards the protection and improvement of human health.
(Includes food hygiene and nutrition, medical radiation, biochemical engineering, medical information, rationalisation of treatment and pharmacology, epidemiology, prevention of industrial diseases and drug addiction.) [1]

Health Research Funding in Canada
Funding by agencies dedicated to furthering health research or funding by other agencies that fits the definition of health research.

CIHR: All funding

NSERC & SSHRC:

- Funding to projects that have health research as the primary objective.

Other agencies or programs:

- Funding for health projects or for infrastructure (e.g. laboratories)
- A share of funding for intellectual resources for research that serves several disciplines (e.g. libraries).

Allocation of Health Research Funding

Infrastructure and Equipment: the costs of well-equipped research facilities.

Types of Infrastructure:

- Capital Investment, upgrades and maintenance (buildings and technology)
- Equipment
- Information Resources (databases, research platforms, information systems and library documents)

Uses of infrastructure:

- Project specific
- Shared resources (e.g. libraries, labs and lab equipment)

Human Capital (Research Capacity): Academic training and the development of specialized skills. Salary support for researchers.

Goal Oriented Research: Research projects designed to further knowledge about the protection and promotion of health. Includes both investigator-initiated research and strategic research where topics are identified by funding agencies.

Knowledge Translation: The translation of health research results into forms that will influence decision-making in the health policy or medical practice sectors. The development of commercial products from health research.

Communications & Collaboration: Activities that promote sharing of knowledge or the development and implementation of standards to guide research activities (e.g. workshops, ethics guidelines).

Clarification Notes

In the current dialogue about health research funding, there is a tendency among some stakeholders to include support for researchers or research teams when discussing infrastructure. While this approach reflects a well-founded desire to recognize the importance of both human and physical capital, precision is better served by recognizing each concept separately.

Primary Purpose

In the case of funding for infrastructure and human capital the estimates are limited to resources dedicated to research as a *primary goal or a shared goal* (e.g. academics). Knowledge resources that serve many purposes (such as surveys or databases of Statistics Canada and CIHI) are not included.

CIHR Strategic Outcomes and Health Research Funding Categories[v]

1. Outstanding, Ethical and Responsive Canadian Health Research

- Infrastructure and Equipment
- Research Platforms
- Open Operating Grants
- Strategic Research Grants
- Maintenance Grants
- Collaborative Grants
- Ethics

2. A Strong Capacity for Health Research: Excellent Researchers and a Robust Research Environment

- Training Awards
- Salary awards
- Communications and collaboration
- Regional Development

3. Translation and Use of Knowledge

- Clinical Trials
- Knowledge Translation
- Commercialization
- Innovation Programs

4. Partnerships and Public Engagement

- Industry Collaborations
- International Programs
- Science Promotion

5. Organizational Excellence

[v] Sources: CIHR Report on Plans and Priorities, 2003-2004
Federal Landscape of Health Research in Canada

See Appendix for Glossary of Terms.

Section 2: Estimates of Health Research Funding in Canada

There are different models for reporting health research funding in Canada. Statistics Canada uses a model based on Gross Domestic Product (GDP) reporting concepts known as Gross Expenditure on Research and Development (GERD). This concept is similar to the OECD reporting framework.[2] According to latest published data, total gross domestic expenditures for health R&D in Canada were $5.08 billion during fiscal 2003, of which $853 million were federal government expenditures (forecast values).[3] The Statistics Canada series also includes provincial governments, non-profit organizations, business R&D, the imputed value of researcher time and indirect costs in the higher education sector, and expenditure from foreign sources.

The Canadian Institute for Health Information (CIHI) reported health research expenditure of $1.87 billion in calendar 2003 (forecast value).[4] Of this amount $1.21 billion was provided by the public sector – federal and provincial governments. CIHI reporting is based on actual expenditures without imputation for the value of services provided by researchers in academic institutions. Other significant difference between GERD and CIHI is that the value of research & development conducted by pharmaceutical manufacturers is included with expenditure for drugs in the CIHI reporting model. Once adjustments are made for these conceptual differences, the CIHI and Statistics Canada estimates differ by less than 10%.

The Association of Canadian Medical Colleges (ACMC) reported total research funding for medical schools and teaching hospitals of $1.48 billion in 2000-01, of which $448 million was provided by federal agencies.[5] The ACMC data would not include funding for research performed in non-medical faculties or in institutions other than university and teaching hospitals.

Financial reports reviewed for this study identified expenditures in fiscal 2003-04 of approximately $1.3 billion by the federal sector and matching funds of approximately $418 million from other sectors that participated in programs funded in part by the federal government. Federal funding includes amounts not included in the Statistics Canada series (e.g. Genome Canada). It also includes estimates of health research funding from agencies that would not normally be identified in the CIHI data. Matching funds include contributions from provincial governments and the private sector, which means that it is not possible to add federal contributions, matching funds and expenditures reported independently by other public and private sectors without double counting certain contributions.

The data comparisons discussed in this section focus on federal expenditures. A major objective was to allocate research expenditures to functional categories in the framework. Categories included in the comparisons are infrastructure, goal oriented research, human capital and program delivery, or administrative costs.

Funding by Federal Agencies

The distribution of health research funding by federal agencies is shown in Table 1 for fiscal 2001-02 with projections to 2004-05.[vi] Matching funds shown for partners are amounts committed under specific programs that require matching funds from provincial

[vi] Agencies included in the 'Other Agencies' estimate include CHSRF, Genome Canada, National Research Council, Health Canada and the Canadian Population Health Initiative.

or private sector partners or from recipient institutions.[vii] Both provincial, non-profit and private sectors contribute additional funding to health research, which is not shown here. As an example, CIHR receives approximately $75 million annually for a number of partnership projects.

Some programs have been established independently by the federal government but are administered by the funding agencies. Expenditure for the Canada Research Chairs (CRC), Networks of Centres of Excellence (NCE) and Canada Graduate Scholarships (CGS) are included in the CIHR budgets shown in the first section of Table 1 and are not double counted in the total. The amounts shown are the shares allocated to CIHR, except for CRC funding, which includes Chairs funded directly through CIHR and 12 Chairs funded jointly with CHSRF. Funding for Indirect costs is disbursed by SSHRC, but shares are calculated for each of the three federal funding agencies and the amount shown in Table 1 is the CIHR share (it is not included in the CIHR line and therefore is added in as a separate item). Amounts for 2003-04 and 2004-05 are amounts shown in *Reports on Plans and Priorities* or amounts estimated by officials of the agencies.[viii] Except for CIHR, CHSRF and CPHI, where all funding is included, amounts shown in the table are the shares of funding allocated to health research projects.

Table 1: Health Research Funding by Federal Agencies and Matching Funds by Other Sectors - ($ 000)

Federal Agencies	**2001-02**	**2002-03**	**2003-04**	**2004-05**
CIHR	527,925	650,000	726,700	752,000
NSERC	69,589	76,525	89,210	95,039
SSHRC	9,981	9,867	10,000	10,000
CFI	107,605	162,243	189,183	186,887
Other Agencies	163,039	183,448	216,744	210,935
Indirect Costs	70,000	0	78,750	78,750
Sub-Total	948,139	1,082,082	1,310,587	1,333,611
Included in CIHR Budgets				
Research Chairs	22,051	34,225	82,600	105,000
Networks of Centres of Excellence	24,810	25,031	25,000	25,000
Canada Graduate Scholarships			2,500	5,000
Matching funds	242,686	333,057	418,259	401,816
Total	1,190,824	1,415,140	1,728,846	1,735,427

Health research funding grew rapidly in fiscal 2002-03 and in fiscal 2003-04 (Figure 1). In 2004-05 funding is expected to be approximately $1.7 billion, almost the same as the previous year. Growth over the three years from 2001-02 to 2003-04 is forecast to be impressive, however. While estimates were not developed beyond 2004-05 for this

[vii] Agencies and programs for which matching funds are reported in Table 1 consist of CFI, Genome Canada, NRC and NCE.

[viii] Estimates provided for CFI were based on commitments. Since most commitments cover a number of years, annual estimates were obtained by assuming a four-year completion cycle for investments.

report, CIHR has forecast the need for increases in its budget during subsequent years, stabilizing at approximately $1 billion in fiscal 2007-08.[6]

Federal funding for health research is expected to grow from $950 million in 2001-02 to $1.3 billion in 2004-05. The distribution of funding shares is expected to change slightly by 2004-05. CIHR is projected to remain stable at approximately 56%, while CFI is projected to increase from 11% to 14% (Figure 2, 3). Longer term projections would result in a higher share for CIHR and a lower share for CFI, however, since CFI disbursements are expected to peak in 2004-05 and then decline, based on the simulation methodology used in this report.

The Canada Research Chairs program (CRC) will show the highest rate of growth, with funding in 2004-05 over four times higher than 2001-02. CRC is expected to represent approximately 14% of CIHR's total budget in 2004-05. The high growth of CRC over the next two years reflects expected rates of growth to reach its targets, after which it will stabilize.

Figure 1:

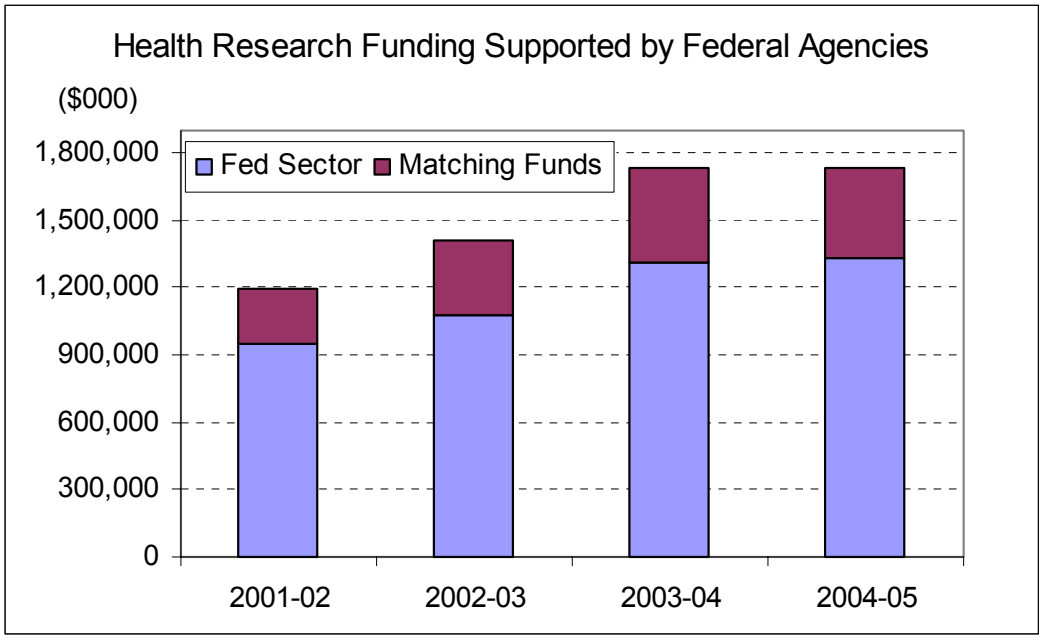


Figure 2:

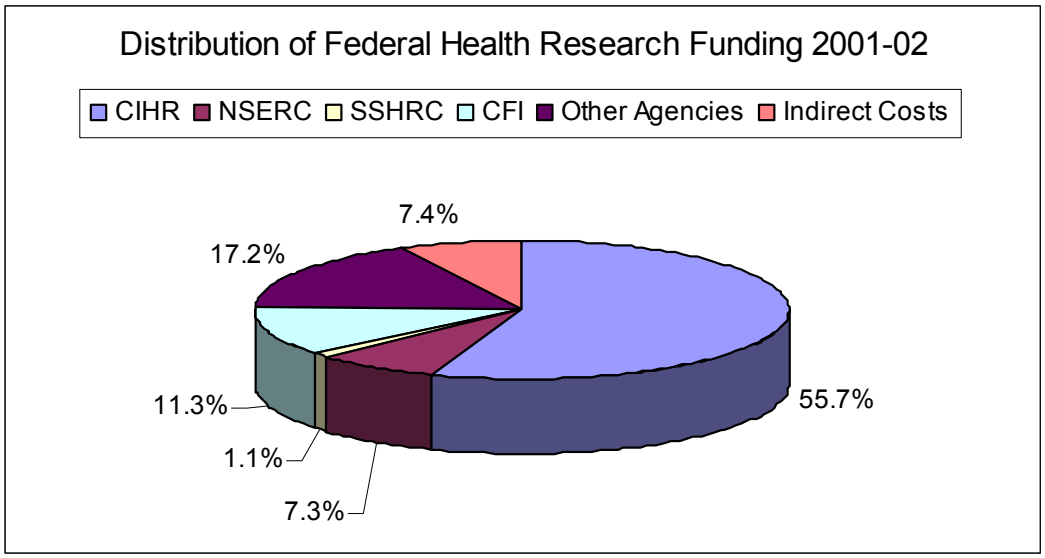
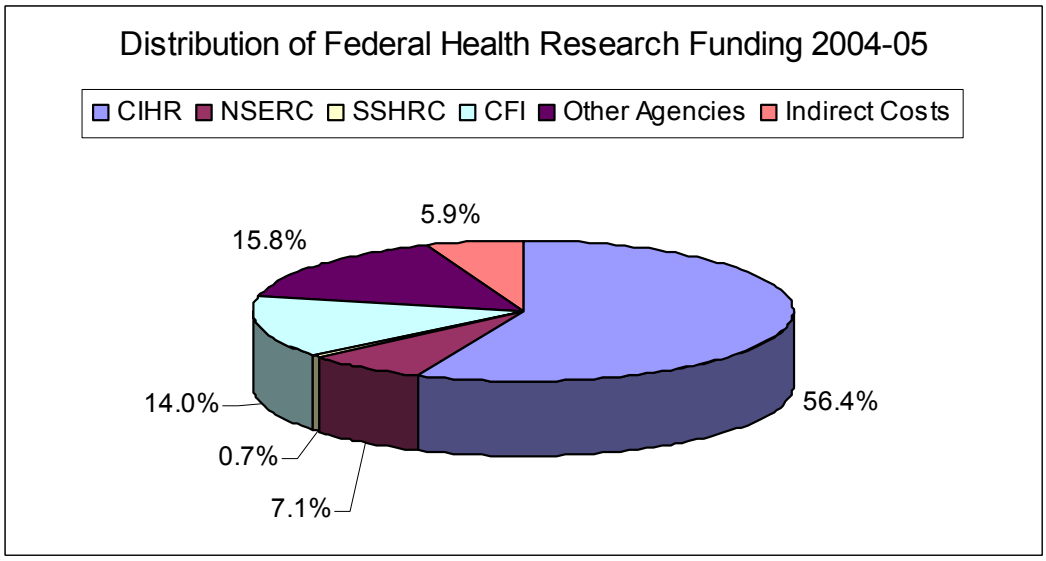


Figure 3:

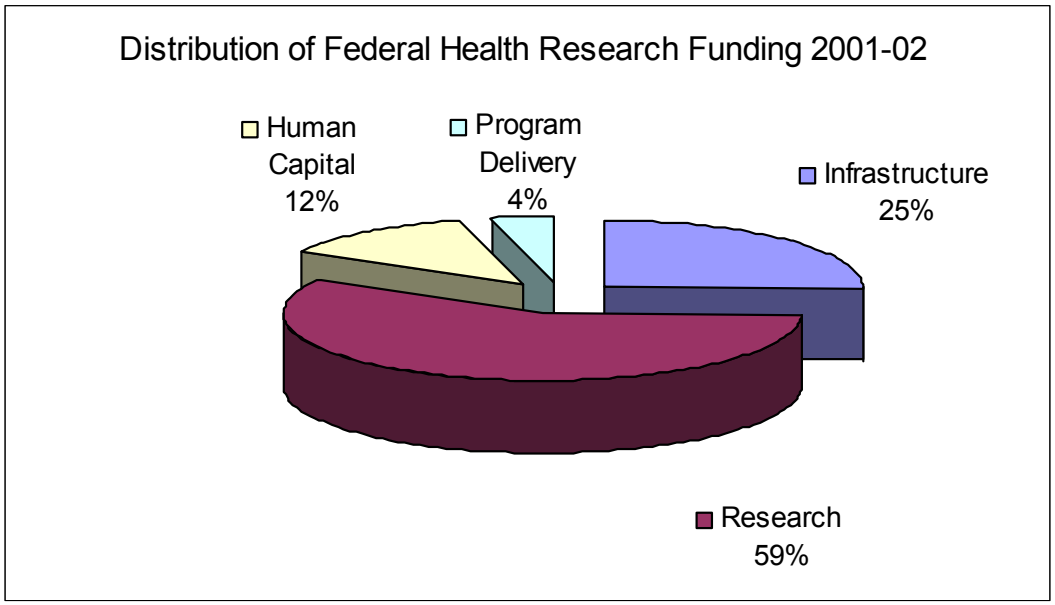


Functional Distribution of Federal Funding

In 2001-02, funding for research projects accounted for 59% of federal funds committed to health research (Figure 4). The term, research projects, refers to grants for investigator identified projects in open competitions, strategic or commissioned research and intramural research. Infrastructure accounted for 25% of funding. Support for human capital (training and salary support) represented 12% and program administration costs accounted for the remainder.

Infrastructure funding is concentrated in CFI and the Indirect Costs program. CIHR's Equipment and Maintenance fund and NRC infrastructure investments each accounted for over $10 million in 2001-02. Infrastructure also includes amounts paid for equipment in research grants by CIHR, NSERC and SSHRC (typically 8% to 11% of grant expenditure).

Figure 4:



Federal Funding and Matching Funds

Infrastructure funding represents 34% of total health research funding in 2001-02 when both federal and matching funds are included (Figure 5).[ix] The share for infrastructure is expected to increase to 36% by fiscal 2004-05.

The balance of funding for infrastructure and other research activities is very different when federal and matching funds are considered separately (Figures 6, 7). Matching funds are predominantly allocated to infrastructure, and according to these projections will be more concentrated in future, with 66% of matching funds allocated to infrastructure in 2001-02 and 71% in 2004-05. The concentration of matching funds in

[ix] Human capital and program delivery costs, which are shown separately in Figure 4, are included in a more general category of research in Figure 5. Breakdowns of these sub-categories are not available for matching funds.

infrastructure is not surprising in view of the fact that CFI accounts for most infrastructure investment and the program requires a 60% share of matching funds in total project investment.

Figure 5:

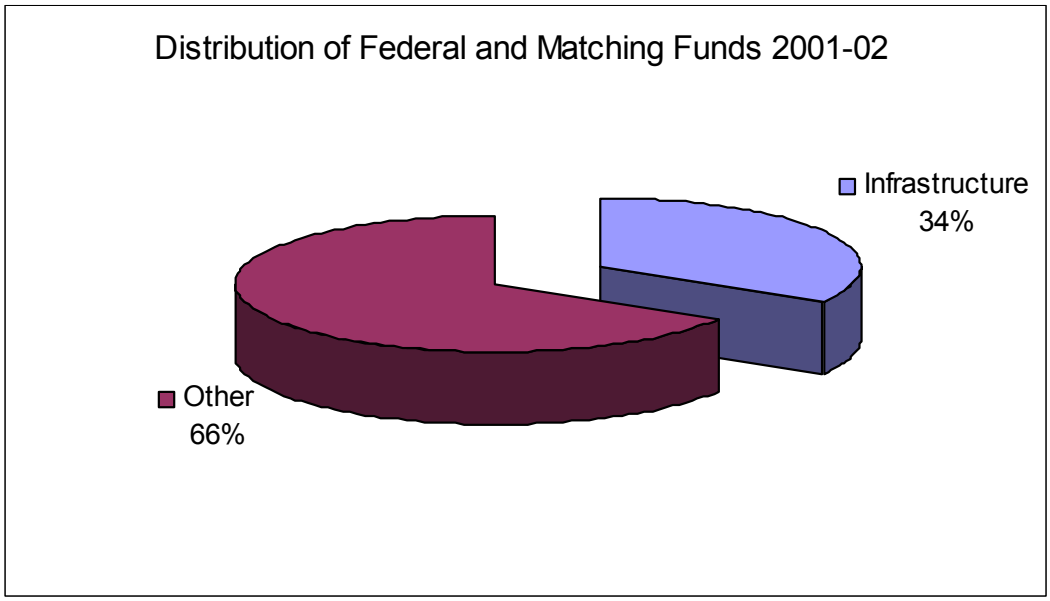


Figure 6:

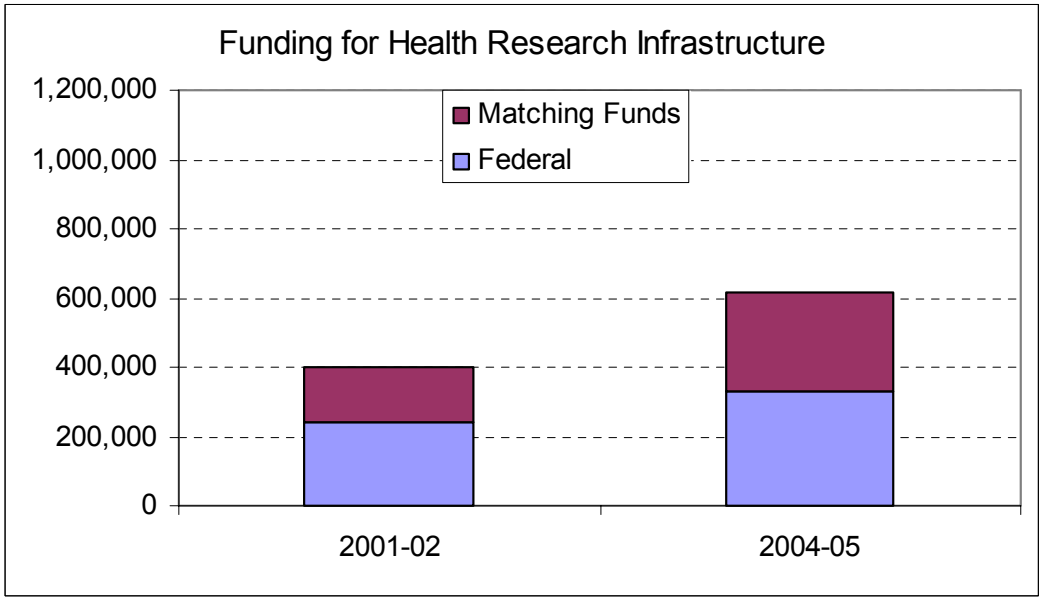
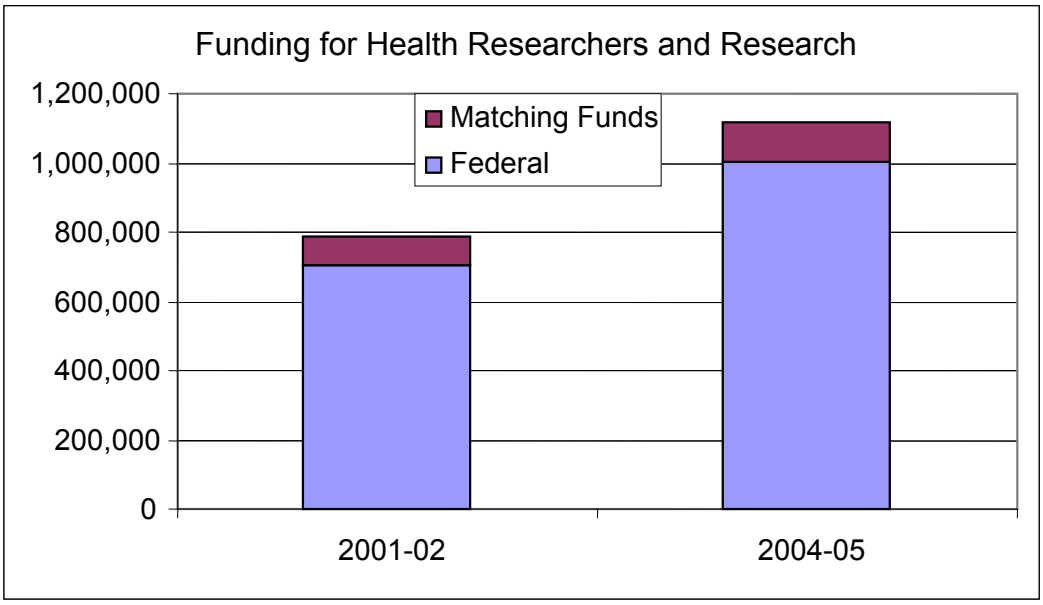


Figure 7:



Breakdown of Research Grants by Functional Categories

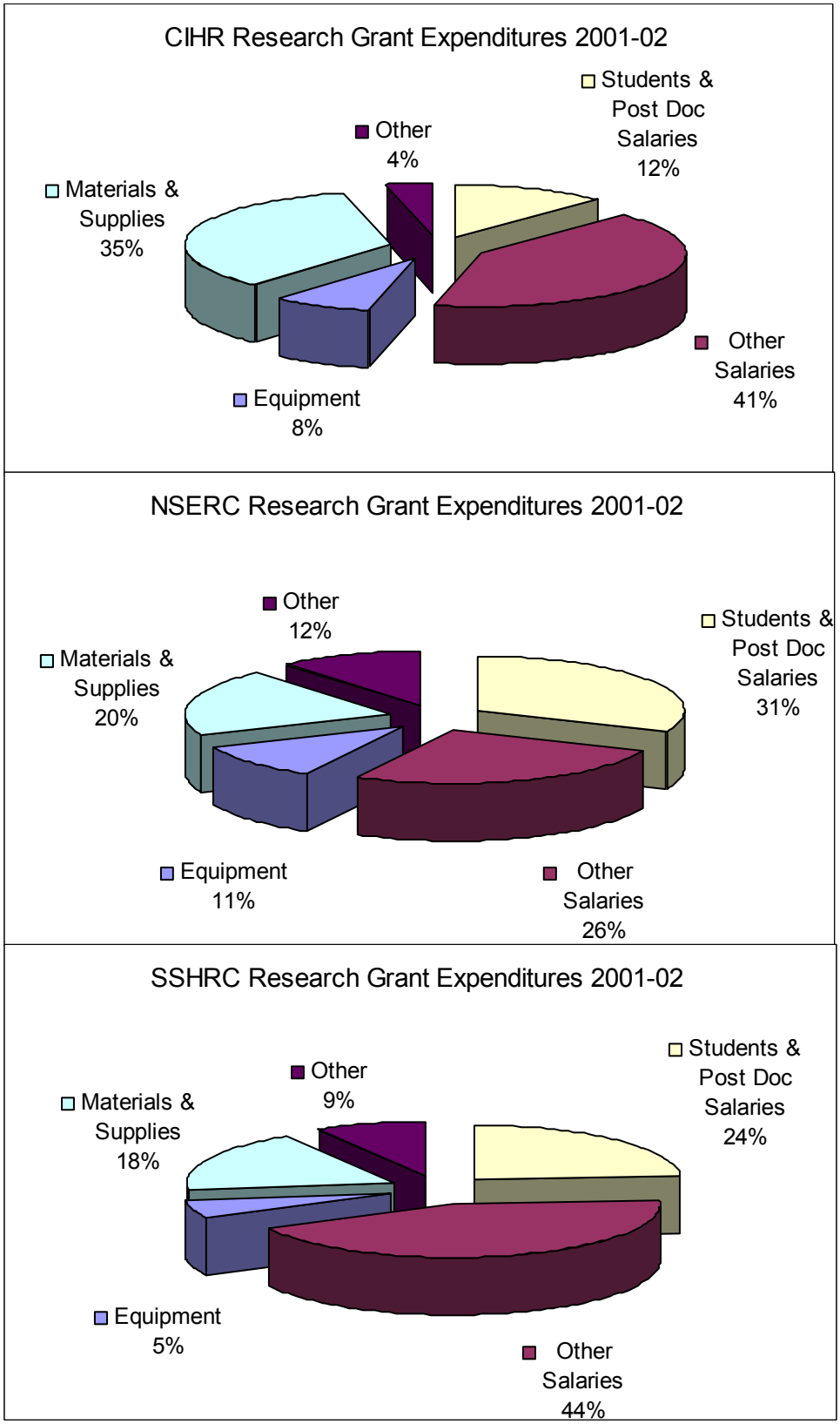
This section discusses the breakdown of research grants by CIHR, NSERC and SSHRC by functional categories. The data are taken from a tri-agency reporting system that uses the same reporting form and definitions for annual reports from grant recipients.

The major functional categories analyzed are: Students & Post Doctoral Salaries, Other Salaries, Equipment, Materials & Supplies and Other expenses (e.g. travel) (Figure 8). Expenditures for equipment were included in the estimates provided earlier for infrastructure. The estimates for student and postdoctoral salaries are interesting in that they are a form of investment in human capital. Research activities provide both training and financial support to researchers who are still in training programs.

Student and postdoctoral salaries represent approximately 12% of CIHR, 24% of SSHRC and 31% of NSERC grant expenditures. The combined value of these salaries was approximately $57 million in fiscal 2001-02. This amount for researchers in training was equivalent to an additional 49% when compared to the $114 million invested in specific human capital programs for researcher training and salary support that year.

Salaries of trainees plus other salaries account for 53% to 68% of grant expenditure by the three agencies. Equipment accounted for 5% to 11% of grant expenditure, a more consistent percentage between the three agencies than any of the other categories. Equipment was also estimated to be in the range of 10% of expenditures by NCE and Genome.

Figure 8:


CIHR Research Grant Expenditures 2001-02
Students & Post Doc Salaries 12%
Other 4%
Materials & Supplies 35%
Other Salaries 41%
Equipment 8%
NSERC Research Grant Expenditures 2001-02
Other 12%
Students & Post Doc Salaries 31%
Materials & Supplies 20%
Equipment 11%
Other Salaries 26%
SSHRC Research Grant Expenditures 2001-02
Students & Post Doc Salaries 24%
Other 9%
Materials & Supplies 18%
Equipment 5%
Other Salaries 44%

Section 3: Literature Review

The principle objective of the literature review was to determine if there are international norms with respect to the allocation of health research funding between infrastructure, human capital and goal oriented research.

There were few reports that addressed the allocation of funding. One major policy paper that did address the issue was a 1990 study by a committee appointed by the US National Academy of Sciences and the Institute of Medicine.[7] The study maintained that support for all three of the major components of research (training, infrastructure and research projects) had declined over the previous two decades and was inadequate at the time the report was prepared. Federal support in the US for research facilities had been eliminated during the previous ten years except for indirect costs associated with project grants. NIH support for training as a percent of its extramural budget had declined from 17.2% in 1970 to 4.2% in 1988 (pg. 169-70). In its funding guidelines, the committee ranked researchers as the 'most vital long-term investment' (pg. 172) with capital investments in facilities and research projects ranking second and third. Looking ahead to 2000 the committee recommended that in the event of a two percent annual growth in health sciences funding, training should increase to 6.75% of extramural research budget and that construction funds should increase to 0.5% (from 0.25% in 1990) (pg.178-179). These percentages are much less than those in the present distribution of federal research funds in Canada, but it is important to view the recommendations in the context of differences between Canada and the US in the overall organization and financing of health research institutions.

The UK government announced a strategy in 2002 to increase government funding of science and technology (including biological sciences).[8] Increases over existing levels of funding, detailed below (pg. 1), suggested a balance, *at the margin*, of 28% for human capital (items 1,4), 14% for infrastructure and 58% for research projects. The UK government budget for research in 2000-01 was £4.19 billion, including £1.45 billion for the Higher Education Funding Councils (the remainder was split between the Science Budget and Civil Departments).[9]

- £100 million per year by 2005-06 to improve the development of the science and technology skills base.
- £400 million per year by 2005-06 in science and engineering research programs.
- £100 million per year by 2005-06 in equipment and capital infrastructure.
- £90 million per year by 2005-06 to consolidate the Higher Education Innovation Fund as a permanent third stream of funding for universities.

A recent report by the *British Academy of Medical Sciences* expressed concern about the lack of career support and research facilities for the medical sciences, noting that the current interest in molecular research may be crowding out funding for support of medical sciences.[10,11]

The OECD had been the leader in international comparative work on productivity and innovation. OECD work published recently includes a major study that examines a broad range of determinants of economic growth.[12] The OECD analyses show that research & development, physical capital and human capital were all among the seven principal drivers of economic growth as shown by multivariate analysis of international data.[13] These findings relate to macroeconomic indicators of GDP growth for the entire economy. Nonetheless, economic conditions have long been recognized as important

determinants of health and health expenditures are an important component of GDP. These inter-relationships imply that investments in health research and development will contribute to economic growth. OECD comparative data show health expenditures ranging from 5.9% to 13% of GDP in 2000 for 12 countries that report health expenditures in a way that is most consistent with the boundaries of health proposed by the OECD. [14]

OECD reports health research in two ways:[15]

- Government budget appropriations and outlays for R&D (GBAORD), which are available only for federal governments. Health is one of 12 categories based on socio-economic objectives used to report GBAORD. The definition used to distinguish health is quoted in Section 2 of this report.
- Gross Domestic Expenditure on R&D (GERD), which is reported by performing sectors. Reporting sectors include government, higher education, business enterprise and private non-profit institutes. This series is not reported by all OECD countries; R&D by business enterprise is the most frequently reported series.

The OECD series do not break down expenditures into functional categories such as infrastructure and human capital. GERD in Canada follows national income accounting principals by including estimates of the value of time spent in research by university faculty as well as cash expenditures. By contrast, GABORD is the series most consistent with estimates provided in Section 2 of this study.

Estimates of the functional allocation of health research in other countries using international standards are not available. The search for international norms included a review of published literature in scholarly journals and of gray literature.

Pubmed (Medline) searches found 34,200 references using the search terms 'Health Research Funding' and 750 references using the search terms 'Health Research Infrastructure'. *Biomed Central,* a web based publisher of biomedical research journals, found 619 references. *ABI Inform*, a business oriented database, found 35 references. The clear winner, or loser depending on whether success is measured by number of references or the possibility of actually reviewing references found, was *Google*, which scored 10.1 million hits for health research funding and 1.7 million for a sub-set dealing with infrastructure funding. One insight, was that huge amounts of gray literature have moved to the Worldwide Web. This could be both a blessing and a curse for researchers who have long pursued the potentially rich source of reports and studies that have not been published in publicly available sources - we have received what we wished for and now face the consequences. The following discussion reviews some of the literature that may be useful in further work in this area.

There is a clear trend in current literature to view the term, 'infrastructure' in very broad terms. Literature searches for health research infrastructure found many references to health human resources and resources used in the provision of public health. Health information systems, which are included with infrastructure in the conceptual framework for this report, also are featured in many articles. As an example of the broad approach, a recent article on funding activities of the National Center for Research Resources at the U.S. National Institutes of Health (NIH) refers to 'infrastructure needs ranging from the nursing support provided by General Clinical Research Centers to training grants for future clinician investigators.'[16] While the broad concept of infrastructure applied in

these uses is not technically incorrect, it nonetheless confounds attempts to study infrastructure funding as defined in the framework for this project. Some papers have a strong advocacy approach that includes infrastructure as a component of strengthened health research systems.[17,18]

A major reevaluation of the future directions of the U.S. NIH resulted in a roadmap that was published in 2003. One component of the roadmap is a series of projects to re-engineer clinical research processes. Documents in this component separate researcher training from research networks. Networks include infrastructure as an important component, e.g. 'An inventory of existing clinical research networks will explore existing informatics and training infrastructures to pinpoint characteristics that promote or inhibit successful network interactivity, productivity and expansion, or broadening of research scope.'[19] A number of working groups have been formed to pursue the aims of the re-engineering projects and one or more of these working groups could be useful collaborators if CIHR wishes to engage in international investigations of infrastructure issues.

On a very different scale, an Australian report (1995) recommended a three tiered scale of infrastructure grants ranging from 20% of funded research for independent institutes to 12% for institutes based in universities and 10% for grant holders not affiliated with institutions (in all cases a funding threshold of $300,000 during each of the previous three years was incorporated in the recommendations).[20]

Comparative work in research finding has been carried out in Canada by the Science and Technology Observatory, including an analysis of funding trends by type of research, research funder and performer.[21] The work does not deal with functional allocations of research funding but does cover other important dimensions of health research and research funding.

The conclusion that seems to flow from this review is that a preferred approach to studying the functional allocation of health funding internationally would be to have teams of analysts in different jurisdictions undertake measurements using a common framework of definitions. Three reasons for adopting this approach are: (1) the information is not available in the literature or from accredited databases; (2) common standards are necessary to provide consistent measurement; and (3) teams are an important characteristic of the approach. One obvious advantage is a common purpose. Another is the ability to share funding and the willingness to collaborate.

Section 4: Discussion and Issues

There has been a major infusion of federal investment in research in Canada since 1998. Health sciences, other sciences and the humanities have all benefited from this increased investment. In the health sector, R&D, measured through GDP accounting principles, doubled from $2.5 billion in 1996 to $5.08 billion in 2003.[22]

Federal investments account for the major portion of cash investments in health research carried out in the higher education sector. Federal investments in some programs have leveraged additional investments from provincial governments, the non-profit sector and the private sector. There has been an attempt to provide coordination between different funding agencies through appointments to boards of directors and governance committees. On the other hand, there appears to have been no central plan to guide the balance of investments between goal oriented research, human capital and investments in infrastructure.

Infrastructure represents approximately 25% of federal funding for health research. About one-quarter of this amount represents equipment costs in grant funding, which would often be one-time investments for specific projects with the possibility of residual benefits for other research activities. Approximately 75% of infrastructure investment represents large scale capital that has long-term potential.

When matching funds are added to federal investments, the share of funding allocated to infrastructure increases to 34% in fiscal 2001-02 and is expected to grow to 36% by 2004-05. In 2004-05, approximately 71% of matching funds will be devoted to infrastructure investments.

Human capital investment represents approximately 12% of federal funding in fiscal 2001-02. If salaries of students and postdoctoral fellows supported by research grants are added in, the share allocated to human capital increases to almost 18%.

The impressive shares of health research funding allocated to investments in infrastructure and researchers clearly have implications for the future of health research in Canada. Much of the discussion to date has been focused on the fact that Canada is moving up through the ranks of industrialized countries in terms of its support for research and in terms of its ability to attract and retain researchers. There has been little attention to the effects of this enhanced capacity on the demand for future research funding and the types of research that will be funded. This section discusses those issues. It is intended to provide a basis for further dialogue among stakeholders and does not draw conclusions.

Issues

There are many reasons to invest in research capacity. These include:

- to position the nation and its research community to compete in the high technology global economy of the future;
- to modernize research facilities and create appropriate resources to pursue current research agendas; and
- to attract and retain top scientists as teachers and researchers.

With any new initiative there are risks as well as benefits. It is not clear if there has been a careful analysis of benefits, costs and risks in the present federal research investment strategy. Concerns that should be considered by stakeholders are outlined below.

Policy Issues

1. Is there a 'correct' balance between investments in physical and human capacity and funding of goal oriented research?

   The creation of enhanced capacity will clearly create pressures to use that capacity to its potential. Research commitments tend to be multi-year at present. There is a possibility that the desire to maintain full capacity utilization for new facilities and researchers may tend to crowd out traditional investigator initiated, or curiosity driven, research in some intellectual sectors. This concern will be especially relevant if funding for goal oriented research stabilizes or declines during a period when research capacity is increasing.

2. Should research institutions and their partners be required to develop a business plan for infrastructure investments?

   Officials of the National Research Council, which funds and carries out intramural research, described the process NRC uses for evaluating proposals for new infrastructure investments. That process involves accounting for future costs, revenues and the participation of funding partners. A similar approach could be considered for large investments presently funded through other federal agencies. Investments that have the potential to be self-supporting through commercialization of research results or through fees for use of the facilities should be identified. Net costs, benefits and timelines for financial viability should be part of the business plan for these investments. For investments that do not have the prospect to be self-supporting, net social benefits could be defined and weighed against the opportunity costs of the investment.

3. Who should be involved in vetting new investments in health research capacity?

   Candidates include infrastructure funding agencies, research funding agencies (including the major federal, provincial and, where relevant, non-government agencies). Commercial partners could also participate in this process, especially in defining long-term commitments where they would be involved as funding partners or clients.

4. Should there be a guaranteed pool of funds to support research in new facilities? If so, how should the funds be budgeted? Should there be an interest earning fund set aside or a combination of future commitments from both public and private sector partners.

5. What degree of financial risk is acceptable where future uses of infrastructure are difficult to define? Who bears the risk, or how is risk shared between universities, consortiums or funding agencies?

6. Should there be a rationalization of publicly financed research facilities to achieve advantages of scale and avoid excess costs of unnecessary duplication? Are there

lessons to be learned from consolidation in other sectors, such as hospitals, during the last decade?

Technical Issues

7. Have maintenance and upgrade costs been adequately factored into life cycle planning for large infrastructure investments? High technology facilities and research platforms may require large continuing investments in order to maintain optimum potential in a rapidly developing professional environment.

8. What degree of capacity utilization should be considered optimal for research facilities, considering both present and future uses of the facilities?

9. Is it possible to define the elasticity of demand for future research funding relative to increased investment in new infrastructure or increases in human capital (i.e. what will be the present value of future demand for funding resulting from a percentage increase in investment above present levels)?

Appendix 1: Glossary[x]

Federal Landscape of Health Research in Canada

Funding Roles:

Infrastructure and Equipment: Funding programs or activities that cover the costs of well-equipped research facilities; including building and equipment costs, costs of data resources and information technology.

Research Platforms: Funding programs or activities that cover the cost of specialized processes or structures (eg. sequencing techniques, specialized facilities) that support groups of researchers.

Open Operating Grants: Funding programs or activities that cover the costs of conducting research, by an individual or small group of investigators, on a self-identified topic.

Strategic Research Grants: Funding programs or activities that cover the costs of conducting research, related to priorities defined by the organization, or its partners, and which is designed to contribute to strategic objectives.

Maintenance Grants: Funding programs or activities that cover the costs of maintaining instruments or facilities for the conduct of ongoing research. Includes funding for databases and other information sources.

Training Awards: Grants provided to students to support them in their academic training to prepare them to be future researchers.

Training Program Grants: Block grants to groups of investigators.

Salary Awards: Salary support provided to investigators at various stages in their careers.

Clinical Trials: Funding programs or activities that support the cost of randomized controlled trials (RCT) which are conducted to determine whether an intervention leads to improved health.

Collaborative Grants: Funding of programs or activities whose primary purpose is to promote collaboration and interdisciplinary activity (eg. for CIHR - CAHR, IHRT, NET, ICE groups).

Innovation Programs: Funding of programs or activities whose primary purpose is to promote commercialization (eg. for CIHR - POP, IPM Program).

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[x] Source: CIHR *External Scan Glossary, 2003*

Industry Collaborations: Funding of programs or activities whose primary purpose is to promote closer links between the academic community and Canadian companies with an interest in health research and development (eg. for CIHR – Rx&D, SME).

Regional Development: Funding of programs or activities whose purpose is to facilitate the growth of health research capacity in targeted geographic and institutional areas (eg. for CIHR-RPP, Development Grants).

Knowledge Translation: Funding of activities related to the exchange, synthesis and application of research findings to health care.

Ethics: Activities related to the funding of research in ethics.

International Programs: Funding of programs or activities undertaken to foster international collaboration on health research and capacity-building.

Science Promotion: Funding of programs or activities undertaken to promote awareness of the role that health research plays in the lives of Canadians.

Appendix 2: Federal Government Research Funding Agencies and Programs

Part 1: Funding Agencies

Canadian Institutes of Health Research (CIHR)
Canada's national funding agency for health research. Established in 2000, CIHR replaced funding activities of the former National Health Research and Development Program and the Medical Research Council. CIHR has 13 Institutes, which work with the research community to identify priorities for both investigator-initiated research and strategic initiatives. CIHR, a federal agency, reports to the Minister of Health. Annual Budget 2001-02: $528 million; 2004-05: $752 million.

Persons Interviewed: Terry Campbell, Director, Corporate Planning and Policy; Mark Bisby, Vice President, Research; Gaëtan Cyr, Manager, Financial Administration, Grants and Awards.

Natural Sciences and Engineering Research Council (NSERC)
Canada's national research funding agency for natural sciences and engineering. Reports to the federal government through Industry Canada. Annual Budget 2001-02: $626 million, of which $69.6 million was for projects with a principal objective of health research (many of these projects involve development of drugs and health related materials).

Person interviewed: Barney Laciac, Senior Planning Analyst, Policy and International Relations.

Social Sciences and Humanities Research Council (SSHRC)
Canada's national research funding agency for social sciences and humanities. Reports to the federal government through Industry Canada. Annual budget 2001-02: $161.5 million, plus a one-time payment of $199.9 million for indirect costs (applies to institutions who received grants from all three funding agencies). Projects with a principal objective of health or mental health accounted for $9.9 million of funding in 2001-02 – this amount is quite stable from year-to-year.

Persons interviewed: Hélène Régnier, Senior Policy Analyst, Planning and Statistics; Christian Sylvain, Director, Corporate Policy and Planning.

Canada Foundation for Innovation (CFI)
CFI provides funding to universities, hospitals and colleges for capital projects. Commitments include $125 thousand to support each Research Chair supported by the CRC program. Other capital projects are funded based on open competitions. Funded projects must fit into each institution's strategic plan (which is also a key requirement for obtaining CRC funding).

Most projects are in the large capital category, including facilities, major equipment, databases and tissue banks. Operating costs are normally not funded, but there is a special fund of $450 million to support maintenance and operating costs of funded equipment – facilities can receive 30% of the value of funded capital costs from this fund for maintenance. There is an Equal Opportunity Fund from which institutions can receive support to set up research facilities for new faculty members.

CFI reports to the federal government through Industry Canada. Government Funding is in the form of a multi-year commitment rather than fiscal year funding. Uncommitted funds are invested and used to pay the costs of future commitments. In total, $4.5 billion will be available during the mandated life span of CFI (1997 to 2010). Due to the long term nature of most commitments, annual payouts will vary depending on progress in completing each funded project. In 2001-02 the amount committed was $870.9 million while the amount spent, on a cash basis, was $239.1 million. Institutions are expected to match CFI funding from other sources (provincial governments, partner organizations and own funds) with a required mix of 40% CFI and 60% matching funds.

The main areas supported by CFI are health, environment, sciences and engineering. The share for health (based on activity codes in institutions' strategic plans) was estimated at 45%. For purposes of developing annual estimates of future disbursements used in this report, a four year project completion cycle was assumed.

Person interviewed: Carmen Charette, Senior Vice President.

Genome Canada

Genome Canada was established in 2001. It funds five regional centres that manage research and maintain data resources relating to genomics and proteomics. At present, the centres operate 57 large scale projects with an average value of $10 million. Co-funding is provided by partner organizations, which include provincial governments, international consortiums and the private sector.

Genome Canada reports to the federal government through Industry Canada. Financial commitments are multi-year investments. In total, $700 million has been committed, with $309 million funded by Genome Canada and $391 million from partners. As of March 31, 2003, $104.6 million of Genome funding had been disbursed, with the remainder scheduled to be disbursed during fiscal 2003-04 and 2004-05.

Research program areas funded by Genome Canada include health, agriculture, fisheries, environment and forestry. The share of health was estimated for this report as the amounts allocated to the health program area plus a share of amounts allocated to research platforms, informatics, new technologies and corporate administration. The shares of funding for health, based on these estimates, were 68.5% for Genome Canada investments and 75.9% for partner investments. These amounts were projected to 2004-05 using percentages for future disbursements in the March 31, 2003 financial statement.

Person interviewed: Eugidio Nascimento, Vice President, Finance.

National Research Council (NRC)
NRC conducts research and develops new technologies. NRC operates laboratories and observatories. NRC also participates in collaborative projects, providing contributions in cash and in-kind (primarily expertise and time of professional staff). It also provides expertise and incubation facilities for small businesses. Many activities generate revenues from royalties (e.g. patented vaccines) or fee-for-service (e.g. rental of wind tunnels or fees to pharmaceutical companies for developmental work). Health activities include the development of vaccines, pharmaceuticals, medical devices and imaging technology.

Budget in 2001-02: $721 million with revenues of $153 million. Capital expenditures now account for approximately 15% of total expenditures. Health expenditure (mainly biopharmaceuticals and biodiagnostics) accounted for $69.7 million - estimates provided for this report by NRC officials.

Persons interviewed: Dr. Daniel Levac, Officer, VP Research, Corporate Services; Bruce Baskerville, Senior Performance Measurement Officer, Corporate Services.

Canadian Health Services Research Foundation (CHSRF)
CHSRF funds and promotes the use of health services research. Activities include commissioned research and development of knowledge synthesis and transfer mechanisms. Closely aligned with CIHR's Institute for Health Services and Policy Research, with whom CHSRF provides 50% funding for 12 Research Chairs in health services.

Expenditures for fiscal 2001-02 were $9.7 million. CHSRF also administered an additional $3.8 million of co-sponsor funds.

Persons interviewed: Nancy Quattrocchi, Chief Administrative Officer; Linda Murphy, Advisor to the Executive Director.

Health Canada
Health Canada carries out intramural research as part of its mandate and funds research into specified strategic areas. Estimates of health research funding used in this report were those reported as 'R&D Expenditures by Socio economic Objective - Intramural + Extramural' in the Statistics Canada survey, '*Federal science expenditures - Dépenses scientifiques fédérales'.* Most expenditures were reported by Health Protection Branch.

Persons interviewed: Dr. Kevin Keough; Dr. Mary L'Abbe, Office of the Chief Scientist.

Canadian Population Health Initiative (CPHI)
CPHI was formed in 1999 as part of the Canadian Institute for Health Information (CIHI). CPHI's role was to create a focus on population health. CPHI has allocated $11 million to 44 research teams for work between 2000 and 2005. Its activities are now shifting from research funding to knowledge synthesis. Future expenditures are expected to be allocated in approximately equal shares to knowledge generation, policy analysis and knowledge reporting & exchange.

Person interviewed: Carmen Connolly, Director, CPHI.

Part 2: Programs

In addition to agencies that fund or carry out health research directly, there are four programs that are funded through the three national research granting agencies: Networks of Centres of Excellence (NCE), Canada Research Chairs (CRC), Canada Graduate Scholarships (CGS), Indirect Costs. These four programs, together with CFI, are closely related and complementary. NCE, CRC and CGS support individual researchers. CFI and Indirect costs support infrastructure, such as libraries and technologies, that are not specific to any one research project.

Networks of Centres of Excellence (NCE)

NCE supports collaborative research at 22 centres, which are university based or consortia of university and private organizations. Many NCEs have spin-off companies to bring new technologies to market. Centres are usually multidisciplinary and eight to ten have a health component. Training of highly qualified personnel is a major component of NCE activities, accounting for approximately 40% of expenditures. Highly qualified personnel are defined as 'research staff such as research associates and technicians, and research trainees such as postdoctoral fellows, graduate students and summer students' (NCE Annual Report 2001-02, Pg. 7).

Centres apply for funding and successful applicants are funded for a seven year cycle. Most centres have been funded for a four year period and have three years left in their present funding cycles. The networks are eligible to apply for a second funding cycle.

Funding is allocated by centre and project. The share of health is not pre-determined, but has averaged $25 million out of $77 million in annual funding by NCE over the last four years (32.5%).

In order to qualify for NCE funding, each centre must provide matching funds, which can consist of cash and in-kind contributions. Federal funds are administered and paid through the three funding agencies. Commitments are reasonably stable over the next three years, with health funding of approximately $25 million per year expected to continue.

Person interviewed: Dr. Jean Claude Gravel, Director.

Canada Research Chairs (CRC)

Program created in 2000 to support 2,000 research Chairs at Canadian universities. This is a multi-year program with a total budget of $900 million. CRC grants are made at two levels:

- Junior chairs receive $100,000 per year for five years, renewable once.
- Senior chairs receive $200,000 per year for seven years, renewable indefinitely

The breakdown of chairs is:

- the natural sciences and engineering (45%);
- the health sciences (35%);
- the social sciences and humanities (20%).

The CRC program is a financial partnership with CFI, although the two programs have separate administrative structures. Institutions have the potential to receive $125,000 in

CFI money for each Chair. Both CRC and CFI contributions are designated for the university rather than individual researchers. Each university must submit a research plan and identify how the research program of individual Chair candidates fits the research strategy of the institution.

The three major funding agencies administer CRC funds and each agency receives amounts annually from the CRC parliamentary allocation to cover the amounts committed. The Chairs program has a five year mandate after which it will be reviewed.

Person interviewed: Denis Croux, Director of Operations, CRC and Indirect Costs.

Indirect Costs
This program is complementary to CRC and CFI. It covers indirect costs of institutions for resources shared by a number of researchers (e.g. libraries). Funding began during the 2003-04 fiscal year with a budget of $225 million annually for this year and the next two years. There was a one-time grant of $199 million in 2001-02. There was no allocation in 2002-03.

The calculation formula for indirect costs uses the same data as the CRC program. One difference, however, is that community colleges can receive funding for indirect costs whereas only universities qualify for CRC.

The formula used to determine the amounts of grants to each institution provides for different levels of funding based on the size of the recipient institution. Amounts are based on average annual funding from the three granting agencies over the last three years. The smallest institutions can receive grants of up to 80%, mid-sized institutions receive 40% and the largest institutions receive 20%. Funds are reallocated annually based on the available budget and the funding formula, and the percentages could vary depending on the amount of funds available. Institutions must identify how funds will be spent when applying for grants and then report expenditures annually. There is no requirement for matching funds by institutions other the balance of eligible expenditures not covered by the funding formula.

Payments are made by SSHRC. Percentage shares are calculated for the three granting agencies. Shares should be approximately the same as for CRC but could vary somewhat due to the inverse relationship between institution size and the percentage paid. Indirect costs supported by the program include infrastructure (such as libraries) and administration of the research enterprise. At this point in time, estimates of the breakdown of funds are not available. For purposes of this report, all expenditures were grouped with infrastructure.

Canada Graduate Scholarships (CGS)
Program introduced in 2003-04 as part of the Millenium Scholarships program. Each of the 3 federal funding agencies receives a share of the CGS budget in proportion to the distribution of the full-time graduate student community in Canada. Shares are 60% SSHRC; 30% NSERC and 10% CIHR. Each agency administers its share of the program. Amounts available to CIHR were $2.5 million in 2003-04, increasing to $5 million in 2004-05.

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