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Clinical research lags behind biomedical, population-based health, and health services research at multiple levels

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Abstract

Purpose: Concerns regarding a decline in clinical research have been raised internationally. In this study, research initiatives and competitiveness of investigators seeking funding for clinical research were compared with those for three other health research themes in Canada, namely, biomedical, population-based, and health services research.

Methods: A retrospective, multi-level descriptive study was conducted using administrative data from the Canadian Institutes for Health Research (CIHR) research grants program. Annual growth rates in numbers of proposals submitted since year 2000 (level I of comparison), success rates of submissions (level II), and growth rates in funding received since fiscal-year 1999-00 (level III) were compared across themes.

Results:

Proposal submission (Level I): The average annual rate of growth in proposal submissions for biomedical, clinical, population-based and health services research was 11.8%, 6.3%, 105.0% and 43.2%, respectively.

Success rate (Level II) was lower in clinical research (24%; P -value<0.001) compared with biomedical (34%), population-based (29%), and health services (28%) research.

Funding (Level III) grew at an average rate of 16.1% per year for biomedical, 28.2% for clinical, 65.9% for population-based, and 86.2% for health services research. However, the median amount funded for clinical projects

(CAD \$154,535) was less (P -value < 0.0001) than that for biomedical projects (\$225,346).

Conclusion: The overall growth of research activities in clinical theme was slower than with research in other themes—fewer proposals were submitted and lower proportion of submissions was successful. Smaller amounts of funding were received for clinical projects compared with biomedical projects, but a handful of large-scale clinical projects influenced the growth rate in funding for all clinical research. This report underscores the concern that multi-level problems plague clinical research.

Keywords: Clinical research; clinician-scientist; physician scientist; health research; research growth; biomedical research; population-based health; health systems and services

The unique contribution of the clinician-scientist to health research and health care, especially in the transfer of knowledge from bench to bedside, has been internationally recognized.^{1, 2} However, for over a quarter of a century, concerns have been raised about the decline in the number and research activities of the clinician-scientist.¹⁻⁵ Disaffection of physicians for research, prolonged training time to develop a research career, decrease in the funding rate of operating grants proposals, limited career prospects, downsizing

of the health care system, and increased clinical responsibilities were identified as some of the factors undermining the survival of the clinician-scientist in Canada.^{4,6}

More recently, the idea that clinical research, and not just the clinician-scientist, was endangered was put forth.⁷ The smaller number of clinician-scientists actually engaged in direct, patient-oriented research (POR) was highlighted alongside the larger problem of declining number of clinician-scientists.⁸ The number of clinician-scientists involved in direct POR was estimated to be fewer than 100 MDs and MD/PhDs in a given year in Canada.⁸

The purpose of the present study was to compare, quantitatively and retrospectively, clinical research activities with activities across other research areas using data routinely collected at the Canadian Institutes for Health Research (CIHR). CIHR is the government of Canada's health research funding agency.⁹ It supports the work of about 10,000 researchers and trainees in universities, teaching hospitals, and research institutions across Canada through various grants and awards.⁹ Our assumption is that trends identified using its data can be a valid indicator, although not an all-inclusive measure, of trends at the national level. CIHR categorizes health research in four broad themes: bio-medical; clinical; social, cultural, environmental and population health (shortened as 'population-based' in this manuscript); and health services research.¹⁰ Clinical research is defined as¹⁰:

Research with the goal of improving the diagnosis, and treatment (including rehabilitation and palliation), of disease and injury; improving the health and quality of life of individuals as they pass through normal life stages; research on, or for the treatment of, patients.

Materials & Methods

The research grants program, the largest program at the CIHR, receives applications submitted under CIHR open/strategic grant competitions and includes major program categories such as operating grants,

randomized controlled trials (RCTs), and equipment & maintenance grants. To assess clinical research activities within the context of all research activities, the initiatives and competitiveness of investigators seeking funding through the research grants program were compared across the four themes at three levels of the funding process: Level I—Proposal submission; Level II—Success of submitted proposals; Level III—Funding received. Categorization of research theme was made by the investigator during proposal submission by choosing the theme that most appropriately described the area of proposed research.

In response to our special request in July 2006, CIHR made available to us the number and success of proposal submissions in the research grants program. Data were received on Microsoft Excel spreadsheets (Microsoft Corp., Redmond, Washington) by competition year (2000 to 2005) and theme.[†] Amounts funded toward individual research projects during fiscal years 1999-00 to 2005-06 were downloaded in November 2006 from the CIHR website by theme.¹¹ Fiscal-year break-down of multi-year awards were also included in the downloaded database. CIHR fiscal year begins on April 1 of each year and extends until March 31 of the following year. Downloaded data were first accessed as a Microsoft Excel spreadsheet and then exported into SAS/STAT (SAS Institute, Cary, North Carolina) for further handling and analyses.

For comparison at level I, annual trends in proposal submission were studied by charting the number and percentage of submitted proposals by year and calculating the rate of growth in submission. The average annual rate of growth in proposal submission was defined as the average percentage increase (or decrease) in the number of proposals submitted during the years 2000 to 2005. A percentage change from one year to the next was calculated, in pairs, thus: $(N_{\text{year2}} - N_{\text{year1}}) \div N_{\text{year1}} * 100$, where 'N' was defined as the number of proposals submitted in a given year. Percent changes were averaged for all pairs of years (2000-01; 2001-02; etc.) to get average annual per-

[†] Corresponding data for the year 2006 were not available as of April 27, 2007.

FIGURE 1. Thematic distribution (%) of proposals submitted to CIHR in research grants program in the years 2000 to 2005

percentage increase in proposal submission for the period from 2000 to 2005.

Level II comparisons were made in two ways: by determining success rates of submitted proposals and by calculating growth in the absolute numbers of proposals accepted for funding. Success rate was defined as the percentage of submissions that was accepted for funding. The average annual rate of growth in number of proposals accepted for funding was defined as the average percentage increase (or decrease) in number accepted during the years 2000 to 2005, and was given by: average of $[(N_{\text{year2}} - N_{\text{year1}}) \div N_{\text{year1}}] * 100$, where 'N' was defined as the number of proposals accepted for funding in a given year.

For level III, trends in annual funding and theme-specific growth in funding were compared. Rate of growth in funding was defined as the average annual percentage increase (or decrease) in amounts funded during the period 1999-00 to 2005-06. It was calculated as the average of $[(\$_{\text{year2}} - \$_{\text{year1}}) \div \$_{\text{year1}}] * 100$, where '\$' was defined as the amount funded in a given fiscal year. Also, descriptive statistics of total amounts funded towards individual research projects (i.e., mean, median amounts funded) were compared across themes.

To identify what proportion of clinician-scientists and clinician-scientist trainees are engaged in clinical vs. other themes of research, details on salary and trainee award programs specific for clinician-scientists

FIGURE 2. Average annual rate of growth (% increase per year) in the number of proposals submitted to CIHR*, number of proposals accepted*, and amounts funded†, by theme, in research grants program

* Based on competition years 2000 to 2005

† Based on fiscal years 1999-00 to 2005-06

and clinician-scientist trainees was downloaded for fiscal-years 1999-00 to 2005-06. A list of the identified award programs is given in Appendix I. The proportion of award-recipients indicating their research theme as 'clinical' was determined.

Statistical analyses

Chi-square analysis was performed for testing differences in population proportions. Significant differences in population means were determined using T-tests for normally distributed data and Mann-Whitney tests for non-parametric data. Statistical significance was determined at P -value < 0.05 .

Results

Growth in proposal submission (Level I)

The number of research grant proposals submitted to the CIHR in all themes gradually increased from 3,206 in the year 2000 to 6,554 in 2005 (Figure 1), indicating that proposal submission had more than doubled in this 6-year period. The average annual growth rate was determined to be 15.9% per year (Figure 2).

FIGURE 3. Theme-specific success rates (%) of proposals submitted to CIHR in research grants program in the years 2000 to 2005.

Biomedical, the single largest research theme in any given year (Figure 1), accounted for 60.7% of all research grants proposals submitted during the entire study period. Clinical research, the second largest theme, accounted for 13.8% of all proposals submitted during the same period. Despite an increase in absolute numbers of proposals submitted, both biomedical and clinical research represented smaller proportions of submissions in 2005 (57.3% and 12.4%, respectively) than in 2000 (68.3% and 19.4%, respectively). This proportional decrease is likely due to a substantial increase in proposal submission for population-based and health services research in this 6-year period. The average annual rate of growth in research grants program for clinical research (6.3%) was smaller than that for biomedical research (11.8%), population-based health (105.0%) and health services research (43.2%).

Success rate of submitted proposals (Level II)

In general, the gradual increase in the number of proposals submitted over the 6-year period was accompanied with a gradual increase in the absolute number of proposals accepted for funding. However, the percentage of proposals accepted for funding decreased over time (Figure 3). The overall success rate for proposals submitted in the years 2000-2005 in all themes was 33.5%. Success rate was lower in clinical

research (24%; $P \leq 0.001$) compared with biomedical (34%), population-based (29%), and health services (28%) research. In any given year, except 2001, proposals for clinical research had the lowest success rates.

From 2000 to 2005, the average growth rate in number of proposals accepted for funding in all themes in the research grants program was 11.1%, while specifically in biomedical, clinical, population-based and health services research it was 6.1%, 4.0%, 115.3%, and 44.5%, respectively (Figure 2). Biomedical research accounted for more than half of the proposals accepted for funding in any given year and represented 62% of proposals accepted for funding in the entire 6-year period. Clinical, population-based and health services research accounted for 10.1%, 10.4%, 6.8%, respectively, of proposals accepted for funding in the same 6-year period. The remaining proportion (10.7%) of accepted proposals belonged in the not applicable/not specified theme.

Growth in funding (Level III)

CIHR funding for research grants has increased gradually from CAD\$249,192,395 in fiscal year 1999-00 to \$603,413,881 in fiscal year 2005-06, at an average rate of 16.2% per fiscal year. Total CIHR funding for the entire period from 1999-00 to 2005-06 was \$3,109,516,289, awarded towards 10,856 research projects.

In any given year, biomedical was the largest research theme. (Figure 4). Also, cumulatively for the entire study period, 62.2% of CIHR funding towards research grants was received for biomedical research; 10.8% for clinical research. The average annual rate of growth in funding for biomedical, clinical, population-based and health services research was determined to be 16.1%, 28.2%, 65.9% and 86.2%, respectively (Figure 2).

Thematic differences observed in growth in funding were consistent with patterns of growth in the numbers of proposals submitted and accepted for funding—i.e., relatively modest rates of increase were observed for biomedical and clinical research (themes with relatively larger baseline funding) while rates

FIGURE 4. Thematic distribution (%) of funding received from the CIHR in research grants programs in fiscal years 1999-00 to 2005-06.

were more dramatic for population-based and health services research (themes with smaller proportion of baseline funding). Clinical research exhibited a double-digit growth rate in funding (28.2%), contrasting the single-digit rates of growth in number of proposals submitted (6.3%) and number of proposals accepted for funding (4%). Also, mean amount funded for clinical research project grants (\$347,212) was not ($P=0.491$) different from mean amount funded for biomedical research projects (\$326,834). (Table 1). However, variances were large and distributions were skewed for all themes indicating that the median could be a better measure of funding distribution. The median amount for clinical research projects (\$154,535) was lower than the median amount for biomedical research projects (\$224,346) ($P<0.0001$). The 90th percentile for clinical projects (\$651,591) was lower than the 90th percentile for biomedical projects (\$726,777). It appears that a small number of large-scale, big-budget projects influenced the mean funding (Table 1), and thus, the rate of growth in funding for all clinical research. The median amounts received for 961 population-based and 658 health services projects (\$97,436 and \$92,239, respectively) were lower than those for biomedical and clinical research projects.

One hundred and sixty five investigators had received 201 awards through programs specific for clinician-scientists or clinician-scientist trainees dur-

ing the seven fiscal-year period under study. Distribution of research themes among the 165 investigators are provided in Table 2. Only eight (20%; $P=0.0001$) of clinician-scientist salary award recipients, 15 (28.3%; $P<0.0001$) of clinician-scientist fellows and one (1.1%; $P<0.0001$) of MD/PhD award recipients indicated clinical as their research theme.

Discussion

This retrospective report quantitatively details the extent to which systematic growth in clinical research lags behind growth in biomedical, population-based and health services research at three levels of the funding process at the CIHR—proposal submission, proposal acceptance and amounts funded—in a multi-year period. In general, percent growth in smaller areas tends to appear exaggerated compared with percent growth in larger areas, as was the case with growth in population-based health and health services research. At the beginning of the study period, the proportions represented by clinical research were closer to proportions represented by population-based and health services research, than to those represented by the largest theme, biomedical research. Yet, the percent increase in the numbers of proposals submitted and accepted was the smallest for clinical research than for any other research theme.

In this context, the 28.2% average growth per year in funded amounts for clinical research was encouraging. However, only about 10% of the total funding towards research grants, in the seven fiscal-year period under study, was received for clinical research. In contrast, in the United States, the percentages of the National Institutes for Health (NIH) dollars committed to clinical research ranged from a high of 38% in fiscal year 1997 to a low of 32% in fiscal year 1999.¹² As more recent data from the NIH were not available, one could conclude that the proportion of funding received for clinical research in Canada is only about one-third of the proportion received in the United States.

The costs for performing clinical research are higher than those for performing preclinical research.¹³⁻¹⁵ Yet, in the present study, relatively smaller amounts, on average, were funded to a large

TABLE 1. CIHR funding for clinical research projects in fiscal years 1999-00 to 2005-06, compared with funding for biomedical projects

Descriptive statistics	Amounts funded (CAD \$)*	
	Biomedical (n [†] =5,920)	Clinical (n=969)
Sum	1,934,857,734	336,448,293
Mean (Standard deviation)	326,834 (387,475)	347,212 (906,216)
Maximum	7,385,233	18,624,991
95 th percentile	891,460	962,498
90 th percentile	726,777	651,591
Median	225,346	154,535

* Median amount funded was significantly lower for clinical projects compared with biomedical projects ($P < 0.0001$).

[†] n = Number of projects

number of clinical projects compared with biomedical projects. This suggests that a majority of the clinical research projects conducted may be relatively modest in scope.

The small proportion (<1/3rd) of clinician-scientists and clinician-scientist trainees with CIHR awards indicating their research theme as clinical may ultimately be the most troubling finding of this study. It is not known from the data analyzed whether these proportions reflect true population proportions or whether they were a result of lower success rates among clinician-scientists and clinician-scientist trainees in clinical research seeking awards. It is our hope that some of the award recipients in the 'not applicable/not specified' category conduct research in more than one theme, including clinical.

The present study did not distinguish POR from clinical research. Also, at every level of this comparative study, data were included under 'not applicable/not specified' theme. This categorization likely included some projects that covered more than one theme of research, including the clinical theme.

In conclusion, the present findings using CIHR data indicated that the concept of a decline in clinical research in Canada is a relative one. Growth in clinical research was slower than growth in other research themes. Fewer proposals were submitted for clinical

TABLE 2. Research themes of 165 clinician-scientist and clinician-scientist trainees* with CIHR awards in fiscal years 1999-00 to 2005-06.

Award category and theme	Number	Percent [†]
Clinician scientist salary award	40	100.0
Biomedical	21	52.5
Clinical	8	20.0
Population-based	0	0.0
Health services	1	2.5
Not applicable/specified	10	25.0
Clinician-scientist fellowship award	53	100.0
Biomedical	23	43.4
Clinical	15	28.3
Population-based	2	3.8
Health services	4	7.6
Not applicable/specified	9	17.0
MD/PhD studentship award	94	100.0
Biomedical	68	72.3
Clinical	1	1.1
Population-based	0	0.0
Health services	0	0.0
Not applicable/specified	25	26.6

* An individual investigator may have received awards in more than one program category.

[†] Proportionate distribution of research themes of awardees was significantly ($P \leq 0.0001$) different in each award category.

research, lower proportion of submissions were successful, and smaller amounts of funding were received, despite a handful of large-scale projects that influenced average amounts funded and rate of growth in funding. It is likely that researchers, specifically, clinical researchers, have unique challenges at multiple levels that affect their successful involvement in clinical research activities. Therefore, it appears that solutions must be multi-faceted and aimed at multiple levels.

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Appendix I

CIHR salary award and trainee award programs specific to clinician-scientists and clinician-scientist trainees in fiscal years 1999-00 to 2005-06.

Program Family	Program
Salary Program	CIHR Clinician Scientist – Phase 2; CIHR/PMAC Health Program – Clinician Scientist; CIHR/Rx&D Research Program – Clinician Scientist Phase II; Eli Lilly/CCO/CIHR/Rx&D Research Program – Clinician Scientist Phase II; Institute of Aging – Clinician Scientist Phase II.
Fellowship Program	CIHR Clinician Scientist – Phase 1; CIHR/Rx&D Research Program – Clinician Scientist Phase I
Studentship Program	CIHR/Rx&D Research Program – MD/PhD program studentships; MD/PhD program studentship; Walter and Jessie Boyd & Charles Scriver MD/PhD studentship award