

HOW IS FUNDING MEDICAL RESEARCH BETTER FOR PATIENTS?

VALUING THE IMPACT OF ALBERTA'S HEALTH RESEARCH

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SUMMARY

With rising health care costs, often health research is viewed as a major cost driver, calling to question the role and value of provincial funding of health research. Most agree that the quality of healthcare provided is directly linked to our ability to conduct quality research; however currently there is little empirical evidence supporting the link between engagement in health research and healthcare performance. In Canada this has resulted in funding for health research that varies over time and between provinces.

While medical knowledge is a public good, we hypothesize there are local benefits from health research, such as the attraction of a specialized human capital workforce, which fosters a culture of innovation in clinical practice. To address this question, we look at whether health outcomes are impacted by changes in provincial research funding in Alberta compared to other provinces. Provincial funding for medical research, which varies greatly over time and among provinces, is used as a proxy for medical treatment inputs. Trend rates of reduction in mortality from potentially avoidable causes (MPAC) (comprised of mortality from preventable causes (MPC) and mortality from treatable causes (MTC)), are used as a proxy health outcome measure sensitive to the contributions of technological progress in medical treatment.

Our analysis suggests that investment in health research has payback in health outcomes, with greater improvements in the province where the research occurs. The trend declines seen in age standardized MPAC rates in different Canadian provinces may be impacted by shifts in provincial research funding investment, suggesting that knowledge is not transferred without cost between provinces. Up until the mid-1980s, Alberta had the most rapid rate of decline in MPAC compared to the other provinces. This is striking given the large and unique investment in medical research funding in Alberta in the early 1980s through AHFMR, the only provincial health research funding agency at the time. However in recent years, Alberta's rate of decrease in MPAC has occurred at a rate slower than the other provinces (British Columbia, Ontario or Quebec) with provincial medical research funding. This is striking at a population level, where Alberta's failure to achieve a reduction in age standardized rates of MTC comparable to British Columbia, Ontario or Quebec after 1985 represents 240 unnecessary deaths in 2011 and 48,250 Potential Life Years Lost worth around \$4.8 billion.

The findings from our study suggest that some of the divergence in the rates of reduction in MPAC between provinces may be due to beneficial changes in institutional structure and human capital, resulting in differences across provinces in the capacity to adopt new effective healthcare innovations. While health indicators such as MPAC are the result of complex interactions between the patient, treatment and the healthcare system, as well as socioeconomic and demographic factors, this analysis suggests that a different capacity for health research within the provinces impacts health outcomes. The findings from this analysis are limited by the lack of data related to research funding and the health research workforces within provinces.

This analysis has important implications for health research policy and funding allocations, suggesting that decision makers should consider the long-term impact provincial funding for health research has on health outcomes. This study also highlights the lack of longitudinal public data available for provincial health research funding. This information is critical to inform future health research policy.

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INTRODUCTION

“Advances in medical knowledge, borne of medical research, are a main source of longer and healthier lives. The value of gains in health over the past half century appears to have far outstripped the comparatively modest investments in medical R&D, and it is plausible that future investments can yield “extraordinary returns.”¹

What is the value of medical and health research for the province of Alberta? Since the creation of the Alberta Heritage Foundation for Medical Research (AHFMR) in 1979, Alberta has been a province that has been a major investor in medical research. However, over AHFMR’s 35 years of existence there has been an on-going debate as to why research should be supported, what research should be supported, and more recently, whether medical and health research should be supported in Alberta to the extent that it is. Research support through Alberta Health Services since 2009 has eroded. AHFMR was re-purposed into Alberta Innovates Health Solutions (AIHS) with a shift from funding researchers in university faculty positions and trainees to funding research projects, particularly research with commercial potential. Most recently in the Alberta Budget for 2015, former Premier Prentice had scheduled a 30% reduction in the AIHS budget representing a major contraction of research resources for university researchers in the province.

When Stephen Duckett was appointed the CEO of Alberta Health Services in 2009 the role and value of health research in the province was an open question. At the time, Globe and Mail columnist Andre Picard characterized Alberta’s health care system as the best, most innovative health system in Canada over the 2000s because of regionalization of system management that contributed to strong alliances between university researchers and health regions. Alternative payment plans for physicians encouraged a balance of research, teaching and patient care.² The perceived success of Alberta’s regionalized structure and its stimulus for synergies between research and services for patients was at risk with the creation of a single authority and a mandate to control costs in the immediate term. Duckett indicated that he only intended to fund research with “measurable results” and wanted to import the best ideas and practices from around the globe to front line health care in Alberta. Picard predicted that the Duckett direction would lead to Alberta’s research stars leaving for other provinces.³

¹ Murphy, Kevin M., and Topel, Robert H., eds. *Measuring the Gains from Medical Research: An Economic Approach*. Chicago, IL, USA: University of Chicago Press, 2010. ProQuest ebrary. Web. 24 May 2015.

² “Alberta has, in the past decade or so, created the best, most innovative health system in Canada. Regionalization allowed health authorities to shape services to local needs, created better continuity of care, made the health system more responsive, improved public health and led to strong alliances between university researchers and health regions.” André Picard’s Second Opinion. *The future of medicare is in his hands*. Globe and Mail. Published Thursday, Jun. 11 2009. <http://www.theglobeandmail.com/life/health-and-fitness/the-future-of-medicare-is-in-his-hands/article786786/>

³ “He speaks of physicians primarily delivering front-line care, which suggests that Alberta’s alternative payment plans that encourage balancing research, teaching and patient care are in the crosshairs. He wants to fund only research with “measurable results” - presumably immediately. Other provinces must be licking their chops at the prospect of wooing back all the research stars they lost to Alberta in recent years.” André Picard’s Second Opinion. *The future of medicare is in his hands*. Globe and Mail. Published Thursday, Jun. 11 2009. <http://www.theglobeandmail.com/life/health-and-fitness/the-future-of-medicare-is-in-his-hands/article786786/>

To address these conflicting viewpoints, we examine if health research in Alberta is better for patient outcomes. While a link between research engagement and healthcare performance is feasible, there is currently little in the way of empirical evidence. A systematic review suggested that when clinicians and health-care organisations engage in research there is the likelihood of a positive impact on health-care performance.⁴ The Duckett/Prentice direction of using Alberta monies for research with measurable, or perhaps commercializable benefit, presumes that the production of knowledge locally is unnecessary since the diffusion of knowledge and best practices for patient care can be costlessly imported to the province. If this is the case, then the gamble with monies for health research being re-allocated to front line care is that there is no measurable negative effect of the changes to the health research workforce on patient care in the province and ultimately the health of Albertans. Is there any evidence to support this expectation?

We specify the Duckett/Prentice position as a testable hypothesis that the presence, size and quality of the health research workforce are uncorrelated with patient health outcomes. This assumes that the market for ideas and diffusion of knowledge is frictionless in the sense that once ideas and knowledge are in the public domain, they are available for adoption. It follows that the impact of ideas and knowledge is independent of where the ideas originate and who produces them. The policy concern in this state of the world is ensuring that the conditions that create ideas and knowledge are such that the production of global knowledge is maximized.⁵

The alternative hypothesis is that the market for ideas and knowledge has frictions, which means that knowledge is not transferred without cost from producers to users. Diffusion theory identifies key components of the innovation process to include the innovation, the social system through which the innovation moves, the communication channels of that system and the adoption of the innovation by the intended recipients.⁶ This suggests that the ability for patients to benefit from knowledge production requires local production and/or clinicians who seek out knowledge and apply it locally. Even though ideas and knowledge are freely available to the world, there are still local benefits from the attraction of the specialized human capital workforces which foster a culture of innovation in clinical practice. Research funding and opportunities for clinicians may attract a higher quality physician, or a different culture of physicians, that leads to better treatment, better practices and innovation in service delivery.

Testing the Duckett/Prentice hypothesis requires the selection of available measures of health outcomes thought to be correlated with the presence or absence of health researchers. It is not obvious what measures are available to use. Health and patient outcomes will be influenced by many factors, many of which have nothing to do with medical treatment or health researchers. There is little in the way of available data for health outcomes that can

⁴ Hanney S, Boaz A, Jones T, Soper B. Engagement in research: an innovative three-stage review of the benefits for health-care performance. *Health Serv and Deliv Res.* 2013;1(8).

⁵ Governments may have a secondary goal of seeking to capture the rents/profits from knowledge production through the promotion of research with commercial potential. This objective is more for economic diversification than improving health outcomes in the local population.

⁶ Rogers EM. *Diffusion of innovations*, 4th ed. New York: Free Press, 1995.

be directly tied to health research, resulting in the use of proxy measures – health outcomes that change in ways that may signal the influence of local health research findings and health researcher personnel.

Advances in medical knowledge can be considered as “technological progress” in that the increase in the stock of knowledge improves health outcomes for given amounts of medical treatment inputs. In this study, we use trend rates of reduction in mortality from potentially avoidable causes as a health outcome measure that will be sensitive to the contributions of technological progress in medical treatment. We use a mortality measure because it is estimated that about one-third of improvements seen in mortality over the past few decades comes from high-tech invasive treatment, one-third from low-tech pharmaceutical innovation and the final third from behavioural changes such as reduced rates of smoking.⁷ While these proportions can be debated, it is clear that medical research is at the heart of all of these factors impacting health outcomes.

Measures of avoidable mortality⁸ are useful in their ability to capture causes of death where the mechanisms of mortality reduction are known as alterable with decision maker actions and potentially sensitive to the presence of a health research workforce and a culture of innovation. Estimates of avoidable mortality in Canada are used as a potential measure of health care system performance that “serves to focus attention on the portion of population health attainment that can potentially be influenced by the health system.”⁹ Mortality rates from avoidable causes have many determinants;¹⁰ however the diffusion of new knowledge into clinical practice will affect the rate of decline in these rates. The impact of health research on avoidable mortality can be inferred from trend changes in this outcome measure.

In this study we look at whether avoidable mortality is impacted by this shift in provincial research funding in Alberta compared to other provinces. Provincial funding for medical research, which varies greatly over time and among provinces, is used as a proxy for medical treatment inputs.¹¹ As a large and rapidly developed medical research intervention, AHFMR experienced several unanticipated fiscal shocks and periodic shifts in its mission that were not clearly related to concerns or even awareness over health outcomes in the Alberta population. This “plausibly exogenous” variation in research inputs affords us an opportunity to infer the causal impact of medical research investment on avoidable mortality outcomes.

⁷ Cutler, David M. and Kadiyala, Srikanth. *The Return to Biomedical Research: Treatment and Behavioral Effects*. Chapter 4 from *Measuring the Gains from Medical Research: An Economic Approach*. Chicago, IL, USA: University of Chicago Press, 2010.

⁸ Deaths that could potentially have been avoided through disease prevention or healthcare services. Canadian Institute for Health Information. *Health Indicators 2012*. Ottawa, Canada: Canadian Institute for Health Information; 2012.

⁹ Avoidable mortality is apportioned into mortality from preventable deaths and mortality from treatable causes. Canadian Institute for Health Information (2012) *Health Indicators 2012* (Ottawa: CIHI).

¹⁰ including access to treatment, health behaviors, environmental conditions and technical change in medical treatment, the levels of the rates will differ across locales and it will not be possible to attribute an impact of medical research in explaining these cross sectional differences

¹¹ Murphy, Kevin M., and Topel, Robert H., eds. *Measuring the Gains from Medical Research: An Economic Approach*. Chicago, IL, USA: University of Chicago Press, 2010. ProQuest ebrary. Web. 24 May 2015.

Our analysis in this study demonstrates that research has payback for Albertans in terms of improved health outcomes. The trend declines seen in age standardized MPAC rates in different Canadian provinces may be impacted by shifts in provincial research funding investment. When interpreting the changes in funding allocation and mandate for AHFMR throughout its 30 years, the difference in mortality from potentially avoidable causes (MPAC) in Alberta compared to other provinces suggests that knowledge is not transferred without cost from producers to users, as was postulated in the Duckett/Prentice hypothesis.

ALBERTA'S INVESTMENT IN MEDICAL RESEARCH

The unique features of AHFMR funding in Alberta compared to other provinces suggests a “natural experiment” style of analysis may be appropriate to look at the impact of health research funding on health outcomes. Natural experiments are opportunities to assess causal influences on outcomes of interest arising from plausibly exogenous variation in determinants of interest. One of the main advantages in using a natural experiment to test our hypothesis is the ability to minimize effects caused by selectivity.¹² We look at AHFMR over its history as a natural experiment that provides an opportunity to identify the effect of a health research workforce on health outcomes of Albertans.

Among the provinces, Alberta was unique in its early establishment and investment in medical research with AHFMR being the only provincial medical research-funding agency prior to 1999, when Quebec and then BC established provincial agencies.¹³ Figure 1 presents the expenditure information in nominal dollars from Alberta, Quebec, Manitoba, Saskatchewan and British Columbia medical research funding agencies since the 1980s. The stated AHFMR purpose of investing in medical research was to improve the quality of health care in Alberta by attracting high quality researchers and trainees to Alberta¹⁴ as well as support facility upgrades and renovations to improve the availability and adequacy of space for medical research.

The AHFMR investment attracted world-class scientists to Alberta and was thought to have a real impact on the health research culture, as described by Dr. Cy Frank in 1989, “When I graduated in orthopedic surgery I reached the great fork in the road- whether to pursue these things and try to solve problems or simply apply technology to the clinical setting. It didn’t take me long – about one second- to decide the excitement is in answering the questions. I knew it could be done and I started believing maybe it could be me. AHFMR was the major pathway to fulfilling these dreams.”¹⁵ By 1995 Alberta was a leader among

¹² In a natural experiment the treatment is random and not by design. To state it differently, the treatment is administered “by nature” and not by the experimenter. Natural experiments can be helpful when a well- defined subpopulation experiences a change in treatment. *How Economics Shapes Science*. Paula Stephan. 2012

¹³ Note that Ontario doesn’t have one central comparable provincial agency and weren’t included in this comparison

¹⁴ In the 1992 AHFMR annual report it was noted that high housing costs in Alberta was one factor that inhibited the recruitment of new personnel to Alberta.

¹⁵ *On the edge of discovery*. Third Triennial Report. 1989. AHFMR.

Canadian provinces for provincial funding of medical research and was identified as one of the top 10 medical research centers in North America (Figure 2).¹⁶

As a large and rapidly developed medical research intervention, AHFMR experienced several unanticipated fiscal shocks and periodic shifts in its mission that were not clearly related to concerns or even awareness over health outcomes in the Alberta population. Less favorable financial market conditions squeezed the asset value of the endowment and the annual income that it was generating in the 1990s (Figure 3)¹⁷ resulting in reductions in AHFMR funding (Figure 4) and the size of the medical research workforce supported by AHFMR (Figure 5).¹⁸

With the financial challenges came pressures from the provincial government for AHFMR to shift some of its emphasis on biomedical research to health and clinical research which were considered to be closer to front line care of Albertans and more profitable through commercialization.¹⁹ Eventually, in response to these financial pressures AHFMR broadened its mandate to include applied health research.²⁰ This culminated in AIHS in 2010, developed with the goal of pursuing opportunities and delivering support for health research and innovation that creates more health and socio-economic benefits for Albertans rebalancing “curiosity led” to “solutions-driven” research.^{21 22} This move from AHFMR’s early mandate supporting talented researchers towards AIHS’s goals of supporting solution driven projects with potentially commercializable outcomes, would suggest that the beliefs of the earlier era in the spillover benefits for patient care from basic research was not

¹⁶ *Window on Future Health*. Alberta Heritage Foundation For Medical Research Annual Report. Edmonton 1995.

¹⁷ Endowment Fund Net Assets on a cost basis had been maintained at a steady level; however market or realizable value was reduced due to the high level of interest rates in Canada in the late 1980’s. This depressed the market value of the government and government-guaranteed debt instruments, which were a significant part of the Endowment Fund assets. In 1990 the \$500 million in the endowment looked healthy compared to the \$300 million initial value; however its value in 1980 dollars was only \$278 million. Inflation had continuously decreased the purchasing power of the endowment’s assets. *We’re learning a few secrets*. Alberta Heritage Foundation for Medical Research Annual Report. Edmonton 1991.

¹⁸ The fourth (1990/93) triennial report of the AHFMR international review board details the large contraction in health research personnel from 1986 to 1992, particularly amongst trainees and fellows, and the scheduled further reductions in supported faculty positions, particularly at the University of Calgary. As of 1993, 220 investigators had been recruited to AHFMR funded institutional positions since 1980, 72% of which (159) were still supported by the foundation in 1993. “42 left the left the system spontaneously” The report of the 1993 International Board of Review. A review of the operation of the Alberta Heritage Foundation for Medical Research for the period of 1987-1993. Edmonton 1993.

¹⁹ Former Alberta Premier Don Getty appointed Lou Hyndman to chair the Rainbow Commission to examine health care services and costs in the province. The commission identified health priorities for Alberta in their *Rainbow Report*, to which the government responded with the *Partners in Health* report published in 1991. The reports identified that there was a shortage of well-trained clinical investigators and a need for more support systems for funding clinical researchers/physicians with basic research training who can help take new knowledge to the bedside. *Rainbow Report*, Premier’s Commission on Future Health Care for Albertans, Hyndman, Louis D. 1989. *Partners in health: the Government of Alberta’s response to the Premier’s Commission on Future Health Care for Albertans*. Government of Alberta. Edmonton 1991. Push towards commercialization outlined in a White Paper called “*Proposals for an Industrial and Science Strategy for Albertans 1985-1990*”

²⁰ Backing a range of applied health care related research in cancer, diabetes, arthritis, infections, ulcers, Alzheimer’s disease, high blood pressure and maternal and baby care. *It’s nice to know...* Alberta Heritage Foundation For Medical Research 1993-1994 Annual Report. Edmonton 1994.

²¹ AIHS was interested in focusing on “the strengths of teams of people to tackle complex, real life problems” Alberta Innovates Health Solutions Annual Report. 2011-2012.

²² This involved the closure of some programs and the launch of an implementation process to develop new initiatives focused on the new mandate. Most notable in the transition, AIHS closed the AHFMR Independent Investigator program to new entry and implemented a final cohort of 34 seven-year AHFMR Investigator Awards from the September 2009 competition. Alberta Innovates Health Solutions Annual Report 2012-2013.

shared. This health research policy shift in Alberta suggests that funding for biomedical research carries the opportunity cost of less innovation and improvement in patient care in Alberta. To test if this is the case, empirically the goal is to measure the contribution of technological progress to the improvement in health outcomes such as reduced death rates.

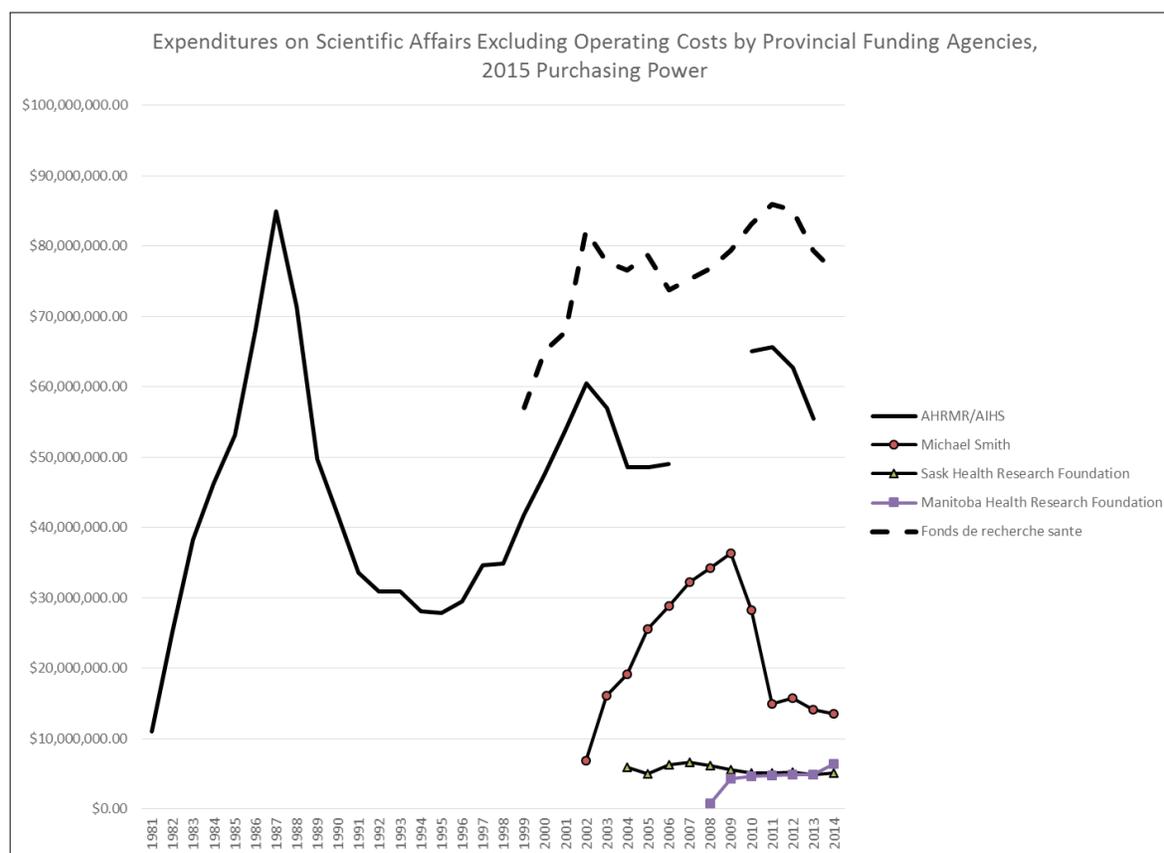


Figure 1. Provincial Health Research Funding Agencies' Expenditures on Scientific Affairs (excluding operating costs) by 2015 Purchasing Power. Alberta was unique in its early establishment and investment in medical research with AHFMR being the only provincial medical research-funding agency prior to 1999. Once funding agencies were developed in Quebec and BC, expenditures on health research rose steadily in the early 2000s while funding in Saskatchewan and Manitoba remained relatively stable at a much lower level. One impact of this other provincial funding was on the competition for federal funding. For example the development of the Michael Smith Foundation resulted in a greater percentage of CIHR funding being attracted to BC (9% to 14 %) between the years 2001 to 2012 compared to Alberta (12% to 9%), respectively.²³ Expenditure information from annual financial statements from AHFMR/AIHS, Michael Smith Foundation, Saskatchewan Health Research Foundation, Manitoba Health Research Foundation and Fonds de Recherché Sante since 1981. Ontario was not included as there are several different agencies.

²³ *British Columbia Health Research Strategy*. Health Research in BC. An overview. July 2013

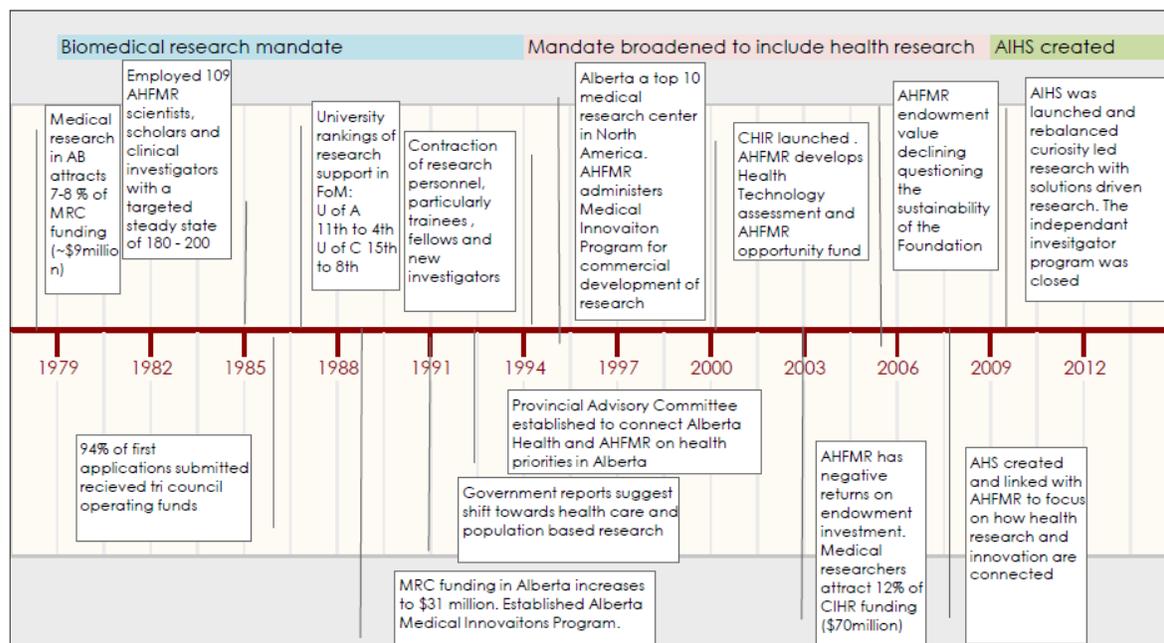


Figure 2. Timeline of AHFMR activity and mandate. AHFMR was established to improve the quality of health care in Alberta by attracting high quality researchers to Alberta. Prior to AHFMR Alberta had a shortage of researchers considered to be competitive for federal health research funding, which was thought to negatively impact the quality of medical education and the application of new knowledge to patient care.²⁴ With the development of AHFMR, Alberta's medical research began to develop national and international recognition for work in better understanding the mechanisms of disease as it applies to prevention, early detection and management. There was also a growing push towards technology transfer through commercializing research.²⁵ These dual objectives remained a source of debate throughout the lifespan of AHFMR. In 2008 AHFMR transformed its approach to focus on how health research and innovation are linked, with the objective of capturing the benefits of health research for the health system and the health and wellbeing of Albertans.²⁶ The redesign²⁷ resulted in Alberta Innovates Health Solutions (AIHS) developed with the goal of taking advantage of the AHFMR legacy, but created more health and socio-economic benefits for Albertans rebalancing "curiosity led" (basic biomedical) to "solutions-driven" (health services and population health) research.^{28, 29} Information compiled from AHFMR annual reports 1981 to 2009 and AIHS annual reports 2010 to 2014.

²⁴ A review of the operations of the Alberta Heritage Foundation for Medical Research for the period 1980-1986. Second Triennial Report Part II. Alberta Heritage Foundation for Medical Research. Edmonton 1986.

²⁵ As outlined in a White Paper called "Proposals for an Industrial and Science Strategy for Albertans 1985-1990"

²⁶ Alberta Innovates Health Solutions Annual Report. Edmonton 2010-2011.

²⁷ Guided by the Alberta Health Research and Innovation Strategy (AHRIS) Alberta Health and Research Innovation Strategy. Government of Alberta Innovation and Advanced Education. Edmonton 2010.

²⁸ AIHS was interested in focusing on "the strengths of teams of people to tackle complex, real life problems" Alberta Innovates Health Solutions Annual Report. 2011-2012.

²⁹ This involved the closure of some programs and the launch of an implementation process to develop new initiatives focused on the new mandate. Most notable in the transition, AIHS closed the AHFMR Independent Investigator program to new entry and implemented a final cohort of 34 seven-year AHFMR Investigator Awards from the September 2009 competition. Alberta Innovates Health Solutions Annual Report 2012-2013.

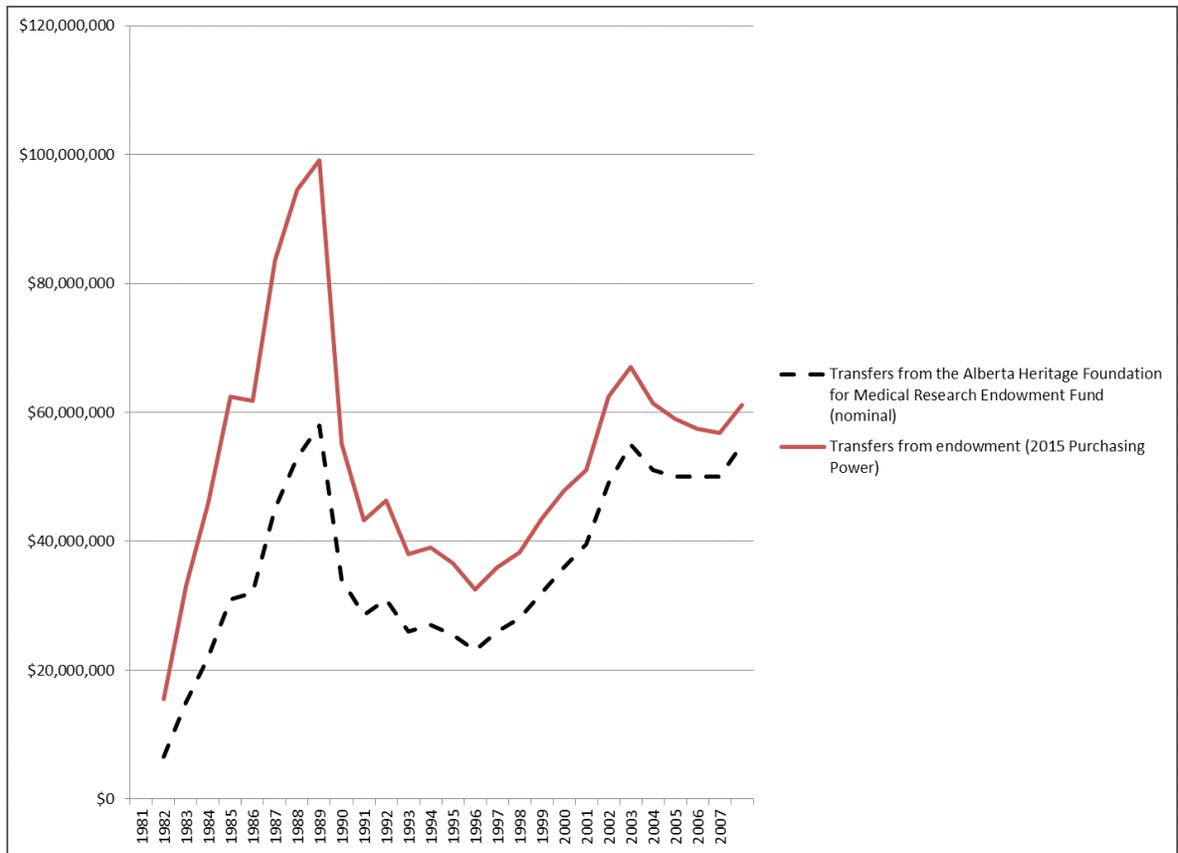


Figure 3. Alberta Heritage Foundation for Medical Research Endowment fund annual transfers. The AHFMR was established in 1979 and funded with a \$300 million endowment expected to generate \$30 million annually to strengthen Alberta’s medical research capability. Transfers from the AHFMR Endowment Fund peaked by 1989. Construction of two buildings to house multi-disciplinary AHFMR teams and the less favorable financial market conditions squeezed the asset value of the endowment and the annual income that it was generating, resulting in a decline in transfers after 1989. Endowment Fund net assets on a cost basis had been maintained at a steady level; however market or realizable value was reduced due to the high level of interest rates in Canada in the late 1980’s. The trustees of the foundation agreed that the endowment would require supplementation of the AHFMR endowment with the rate of growth in spending on research expenditures and infrastructure, however this did not occur. From 1997 to 2003 transfers increased. By 2004 the Foundation was once again at a tipping point created by a decline in the value of the Foundation’s endowment due to a combination of a lowered rate of return on investment, less purchasing power of the investment income as a result of continuing inflation in health sector salaries and other costs and the Foundation’s ongoing salary support of more increasingly senior research personnel.³⁰ In the 2005 spring session of the Alberta Legislature, the government announced its commitment to increase the endowment for AHFMR by an additional \$500 million over 3 years. By 2009 AIHS was created and a total of \$118 million from the AHFMR Endowment Fund was approved in the February 2011 budget of the Government of Alberta to be allocated to AIHS over eight years. Information compiled from AHFMR annual reports 1981 to 2009.

³⁰ Alberta Heritage Foundation for Medical Research International Board Review. Edmonton 2004.

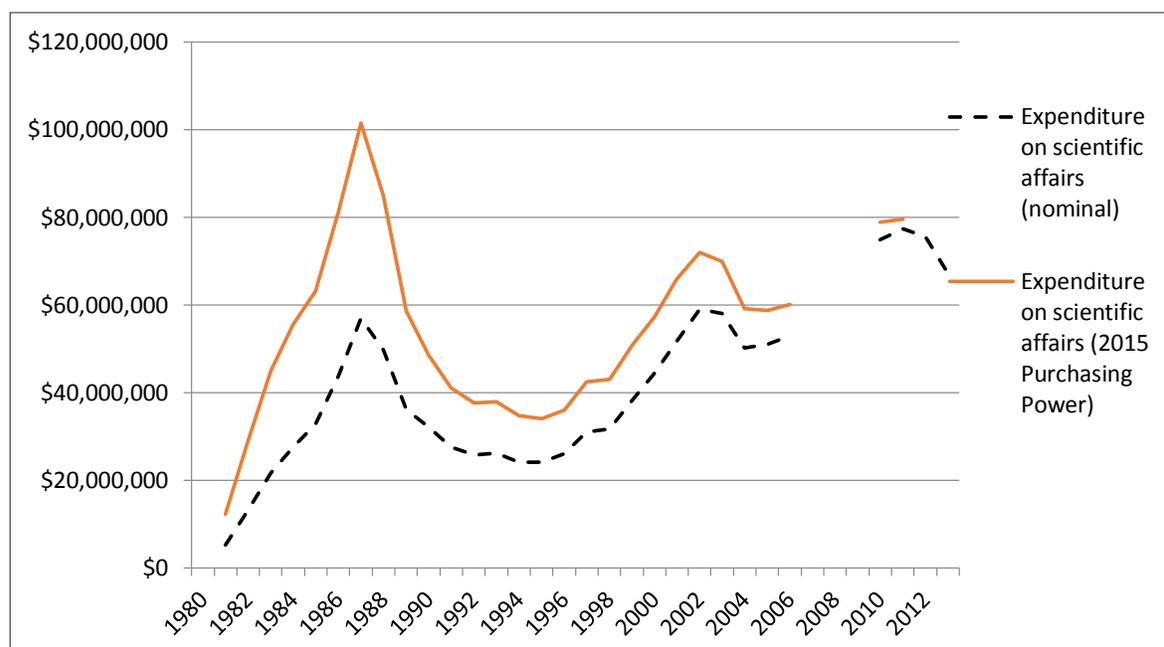


Figure 4. Alberta Foundation for Medical Research expenditure on scientific affairs (administration and building costs excluded). The initial AHFMR objective was to both support the recruitment of medical researchers and trainees³¹ as well as support facility upgrades and renovations to improve the availability and adequacy of space for medical research. From 1985 to 1990 the foundation projected to spend \$300 million, including \$54.8 million for two medical research buildings in Edmonton and Calgary.³² Expenditures increased until 1989 when expenditures sharply declined as inflation continuously decreased the purchasing power of the endowment's assets.³³ In a long term plan for growth of the foundation in the early 90's, it was determined that the AHFMR objectives would require supplementation of the foundations endowment however this did not occur. AHFMR then broadened its mandate from biomedical research to include health research.³⁴ Between 1992 and 1996 spending on health research quadrupled from \$208,615 to \$906,087, 3% of AHFMR expenditures³⁵ By 1995 Alberta was a leader among Canadian provinces for provincial funding of medical research and was identified as one of the top 10 medical research centers in North America.³⁶ However by 2004 low rates of return on investment and large salary and other expenditure demands put AHFMR in financial trouble that threatened its sustainability. AHFMR was redesigned to become AIHS in 2009 with an emphasis placed on the application of knowledge to improve health, health systems, and health care. Information compiled from AHFMR annual reports 1981 to 2009.

³¹ In the 1992 AHFMR annual report it was noted that high housing costs in Alberta was one factor that inhibited the recruitment of new personnel to Alberta.

³² Alberta Heritage Foundation for Medical Research 5th Annual Report. Edmonton 1985.

³³ We're learning a few secrets. Alberta Heritage Foundation for Medical Research Annual Report. Edmonton 1991.

³⁴ Backing a range of applied health care related research in cancer, diabetes, arthritis, infections, ulcers, Alzheimer's disease, high blood pressure and maternal and baby care It's nice to know... Alberta Heritage Foundation For Medical Research 1993-1994 Annual Report. Edmonton 1994.

³⁵ In 1995 AHFMR entered a collaborative agreement with Alberta Health to conduct health technology assessments for Alberta, administer health research funds in the Department and coordinate the development of a provincial health research agenda. This resulted in additional revenue for the 1995/96 period in excess of \$2.2 million. AHFMR also took on administering the Medical Innovation Program (\$500 000 in 1996) on behalf of the Minister of Economic Development and Tourism, targeted at funding early stages for commercial development of medical and health related technologies. These funds contributed to the growth in AHFMR funding in the late 1990s with the Medical Innovation Program in excess of \$4 million in funding and the Health Research Collaboration in excess of \$8 million in funding. *Progression and Excellence*. Alberta Heritage Foundation for Medical Research Triennial Report Edmonton 1999. *Crossing the Gap*. Alberta Heritage Foundation for Medical Research Triennial Report. Edmonton 1996,

³⁶ *Window on Future Health*. Alberta Heritage Foundation For Medical Research Annual Report. Edmonton 1995.

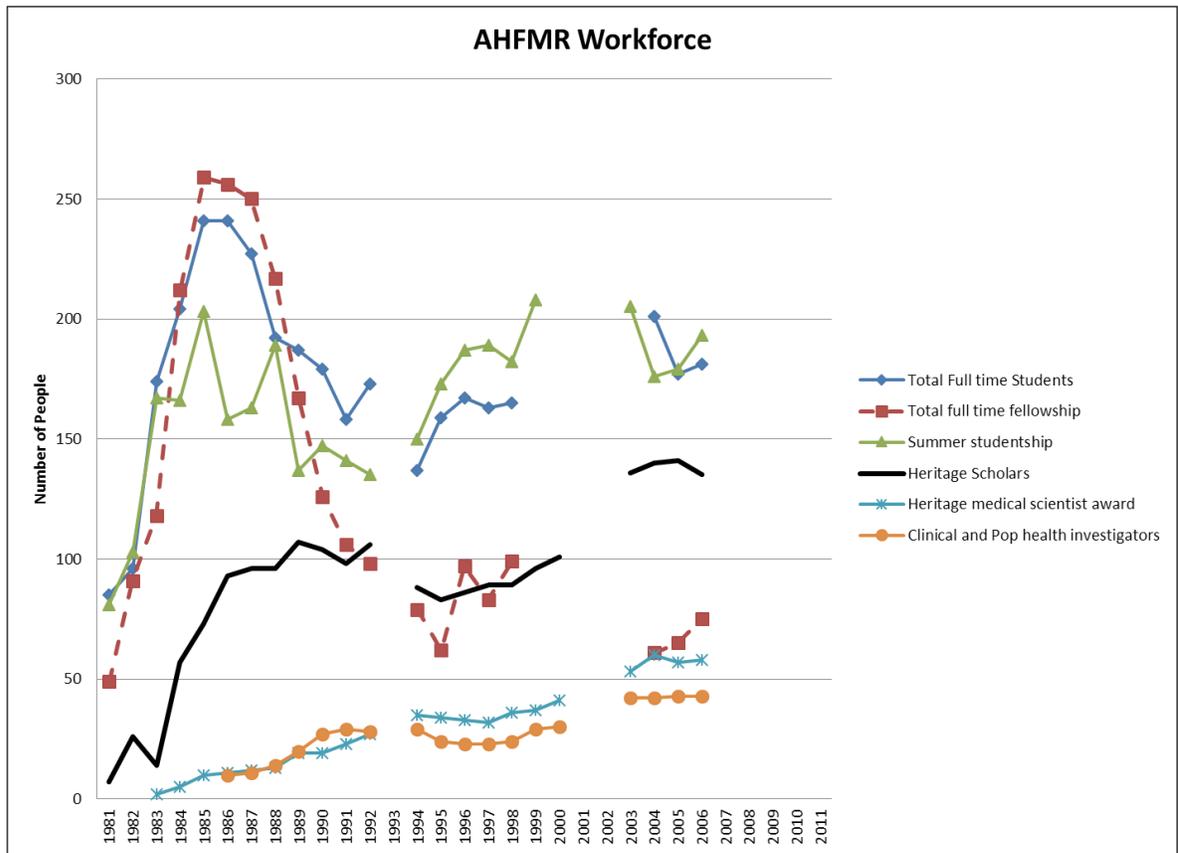


Figure 5. AHFMR Scientists, fellows and students based on salary award allocations. Developing and supporting high quality researchers was a priority for AHFMR. In 1986 the international review board supported the Foundation's target of a steady state of 180 to 200 Scholars.³⁷ By 1995, AHFMR supported 109 AHFMR Scientists (11), Scholars (92) and clinical investigators (6).³⁸ These positions at the U of A represented 14% of the medical school's 250 full time equivalent faculty and 27% of the University of Calgary's 240 medical school's full time equivalent faculty positions. Over 70% of trainees and 50% of the medical researchers were attracted to Alberta from outside the province and former Albertans who returned to the province. With the decreased expenditure in the 90's the international review board stated that the expectation moving forward was that the personnel support positions should be capped at 140 to 150.³⁹ In the late 90s the number of career biomedical and health researchers receiving AHFMR support began to rise from the dramatic decrease seen in the late 80s. Trainees funded by AHFMR increased slowly, although the number of fellowships remained under half of the level seen in the 80s.⁴⁰ Information compiled from AHFMR annual reports 1981 to 2009.

³⁷ *On the edge of discovery*. Third Triennial Report on the Alberta Heritage Foundation for Medical Research Part II. Edmonton 1989

³⁸ Ibid

³⁹ Not only was this new steady state target below the 200 supported by the IBR in 1986, the high proportion of scientists recruited since 1980 still receiving AHFMR support suggests that retention of established scholars was a priority over the recruitment of new scientists.

⁴⁰ Alberta Heritage Foundation for Medical Research International Board Review. Edmonton 2004.

DOES PROVINCIAL HEALTH RESEARCH FUNDING IMPACT MORTALITY RATES?

Over the past 30 years Canada has seen steady advances in reducing the national rate of avoidable mortality in half from 373 to 185 per 100,000 in 1979 and 2008, respectively.⁴¹ The overall trend in reductions of mortality from avoidable causes in Canada has continued largely without interruption; however between provinces and territories the distribution of avoidable mortality is varied. Using fitted time trends for mortality from potentially avoidable causes (MPAC) comprised of mortality from preventable causes (MPC) and mortality from treatable causes (MTC), we look at structural breaks in the trend decline in mortality by province. These mortality rates are age standardized per 100,000 people.

In analyzing the impact of Alberta research funding on MPAC, we use Quebec, Ontario and British Columbia as comparator provinces with strong provincial research funding agencies and Saskatchewan and Manitoba counterfactual (supporting the Duckett/ Prentice hypothesis) provinces without much provincial research funding. We look at the impact of health research funding by attributing trend declines in age standardized MPAC rates that are not explained by changes in medical treatment inputs such as per capita health spending and numbers of physicians.

Overall, the provinces with the fastest and steadiest rates of decline in MPAC and MTC are also the provinces that have the majority of federal research funds from CIHR (Ont, Que, BC, AB), suggesting federal research funding may have an impact on this health outcome measure. Quebec, Ontario and BC will dominate the Canadian trends by virtue of their share of total Canadian population. The prairie provinces (particularly Saskatchewan and Manitoba) have slower rates of decrease than the other five provinces since 1979 and now have some of the highest avoidable mortality death rates in the country⁴² (Figure 6 and Figure 7).

Up until the mid-1980s, Alberta had the most rapid rate of decline in MPAC and MTC compared to the other provinces. This is striking given the large and unique investment in medical research funding in Alberta in the early 1980s through AHFMR (Figure 2 and 3). While it is unlikely that biomedical research would have such an immediate impact on a health outcome like MPAC, it is possible that the attraction of world-class researchers and clinician scientists to Alberta impacted MPAC. In 1986 there is a structural break for both MPAC and MTC in AB, where the rate of decrease comes closer to Ontario, Quebec, British Columbia and Manitoba. This transition point for AB maps with the dramatic reduction in transfers from Foundation and expenditure on research and personal in Alberta (Figure 3 and 4). It is possible that the shift in mandate and focus of AHFMR may have had a role in the reduced improvements in the rate of MPAC decline (Figure 2). By the mid-1990s the decrease in MTC in Alberta moves closer to Saskatchewan and Manitoba, which lags that of Quebec, Ontario and British Columbia, in 1994 by 10 per cent (Figure 7).

⁴¹ Canadian Institute for Health Information (2012) Health Indicators 2012 (Ottawa: CIHI).

⁴² Pi L, Gauvin FP, Lavis JN. *Issue Brief: Building Momentum in Using the Avoidable Mortality Indicator in Canada*. Hamilton, Canada: McMaster Health Forum, 15 February 2013.

For Alberta another setback occurs around 2000 where the rate of decrease in MPAC and MTC occurs at a rate slower than the other provinces with provincial medical research funding agencies (Quebec, Ontario and BC). Notably this was also around the time CIHR was introduced; suggesting again that federal funding has an impact on MPAC. Alberta's trend decline was the best of the three Prairie Provinces, however since the early 2000s the gap between Alberta and Quebec, Ontario and British Columbia has not closed.

In this analysis, BC is a good comparator province to Alberta with roughly similar population sizes and a similar health research-funding agency (Michael Smith Foundation). Despite the similarities between Alberta and BC, in 2011 Alberta had 21 and 6.8 more deaths per 100,000 people from MPAC and MTC, respectively compared to BC. At the population level, this means Alberta has 850 and 62.2 deaths per year that could have been avoided if Alberta had matched BC's trend in MPAC and MTC respectively. Compared to Saskatchewan as a counterfactual, in 2011 Alberta had 62.2 and 15.9 fewer deaths per 100,000 from MPAC and MTC causes respectively. At the population level, Alberta would have 2,489 and 635 more deaths per year if it had matched Saskatchewan's slower rate of MPAC and MTC reduction, respectively (Figure 6).

Notably, by 2011 the gap between the Prairie Provinces and Ontario, Quebec and BC doubled. Reductions in MTC in Saskatchewan lagging British Columbia's rates by approximately 20 years, while Manitoba and Alberta's lags from BC are around 10 years. In terms of Potential Life Year's Lost, Saskatchewan's lag in MTC causes represents 1,540 lost life years in 2011.⁴³ If a life year is worth \$100,000⁴⁴, the value of this mortality gap is \$154,000,000. Alberta's failure to achieve a reduction in age standardized rates of MTC comparable to British Columbia, Ontario or Quebec after 1985 represents 240 unnecessary deaths in 2011 and 48,250 Potential Life Years Lost worth around \$4.8 billion.

⁴³ if Saskatchewan had matched BC's rate of decline in age standardized rates of mortality from treatable causes after 1994, Saskatchewan would have had 8 per 100,000 population lower mortality rate in 2011, or 80 fewer deaths from treatable causes.

⁴⁴ *Are we finally winning the war on cancer?* Cutler, D.M. Journal of Economic Perspectives Volume 22 Number 4 Fall 2008. Pg 3-26.

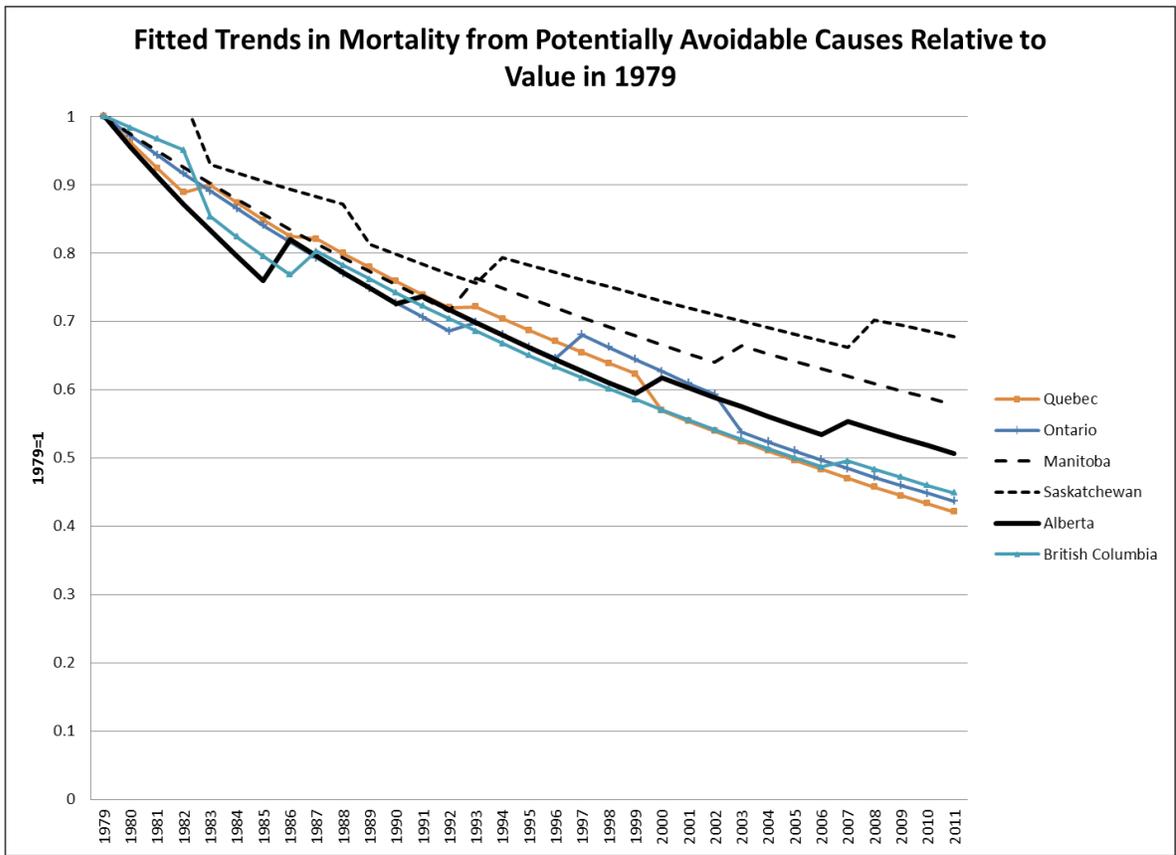


Figure 6. Fitted time trends by time period for Mortality from Potentially Avoidable Causes (MPAC) per 100,000 people. Values indexed as a percentage of 1979's MPAC rates. We use Quebec, Ontario and British Columbia as comparator provinces with strong provincial research funding agencies and Saskatchewan and Manitoba as counterfactuals. Quebec, Ontario and British Columbia have the fastest and steadiest rates of decline in MPAC. Alberta MPAC declines at the fastest rate in the 1980s. Alberta's trend decline in MPAC since the early 2000s has slowed compared to Quebec, Ontario and British Columbia. (MPAC data from CIHI)

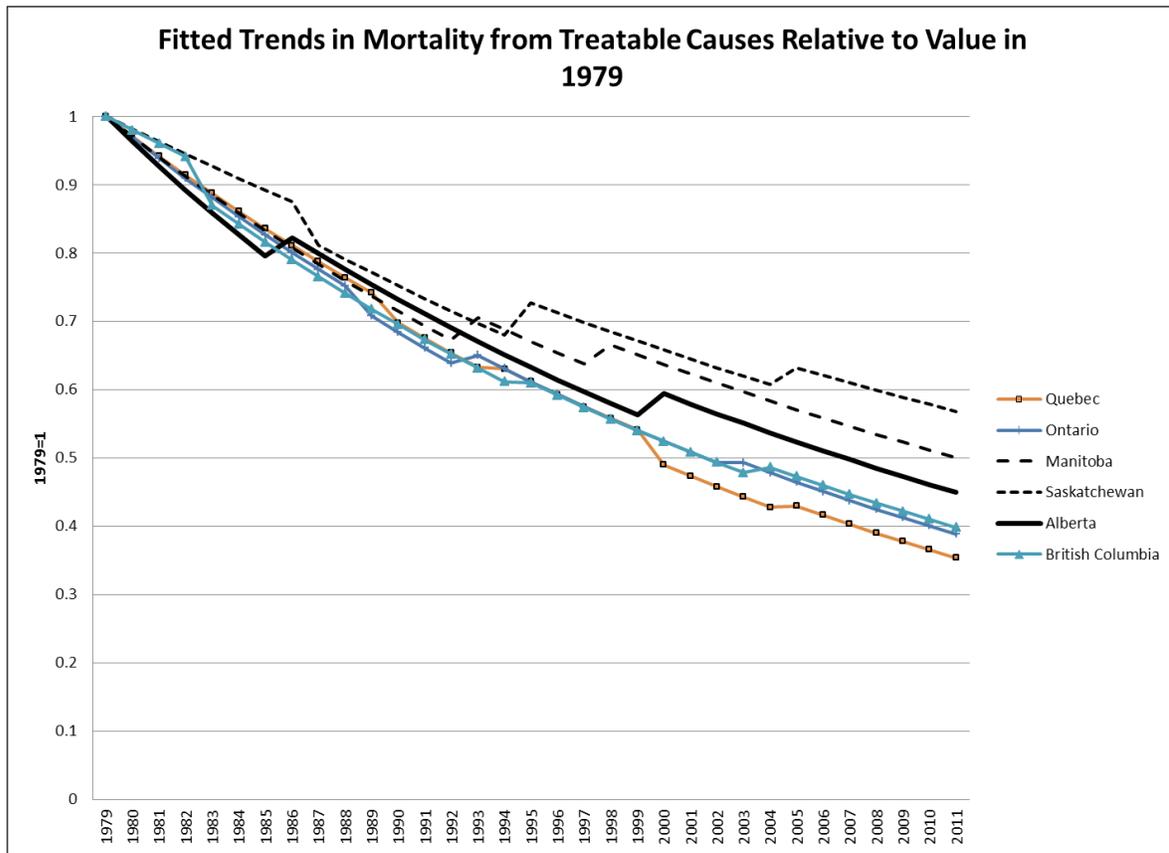


Figure 7. Fitted time trends by time period for mortality from treatable causes (MTC) per 100,000 people. Values indexed as a percentage of 1979's mortality from treatable causes rate. We use Quebec, Ontario and British Columbia as comparator provinces with strong provincial research funding agencies and Saskatchewan and Manitoba as counterfactuals. Quebec, Ontario and British Columbia have the fastest and steadiest rates of decline in MTC. Alberta MTC declines at the fastest rate in the 1980s. By the mid-1990s the decrease in MTC in Alberta moves closer to Saskatchewan and Manitoba, which lags that of Quebec, Ontario and British Columbia, in 1994 by 10 per cent. Alberta's trend decline in MPAC since the early 2000s has slowed compared to Quebec, Ontario and British Columbia. (MTC data from CIHI)

HEALTH RESEARCH IMPACTS HEALTH OUTCOMES

The findings from our study suggest that some of the divergence in the rates of reduction in MPAC between provinces may be due to differences across provinces in the capacity to adopt new effective interventions and/or differential access to the treatments and interventions. This supports findings from a recent UK study which found an association between level of research activity in NHS Trusts and risk-adjusted mortality.⁴⁵ While health indicators such as MPAC are the result of complex interactions between the patient, treatment and the healthcare system, as well as socioeconomic and demographic factors, this analysis suggests that that different capacity for health research within the provinces has an impact. The Duckett/Prentice hypothesis suggests that local investments in health research are inefficient, as the best ideas and practices from around the globe can be imported to front line health care in Alberta. The inter-provincial trends describing MPAC

⁴⁵ Ozdemir B.A., Karthikesalingam A., Sinha S., Poloniecki J.D., Hinchliffe R.J., Thompson M.M., Gower J.D., Boaz A., Holt P.J.E. Research activity and the association with mortality. *PLOS ONE*. Feb 26;10(2).

are puzzling if the Duckett/Prentice theory holds. If there were no local benefits to research, we would expect no differences across provinces in the MPAC regardless of differences in medical innovation capacity.

Contrary to this hypothesis, the variance in MPAC across provinces suggests that the investment needs to occur locally in provinces. Investment of CIHR and provincial funding agency dollars seems to impact MPAC rates with provinces with higher rates of funding having lower MPAC rates. One explanation for this finding is that research investment has an impact on the culture and quality of the medical workforce. An important factor for knowledge utilization is the organizational capacity to engage with and use the evidence.^{46,47} The AHFMR natural experiment suggests that investing in a medical research workforce may be important in influencing health outcomes. This medical research workforce acts as a knowledge translation strategy in itself, with the local researchers having the expertise to uptake and implement medical innovation.

Other indicators such as physician numbers, physician compensation and per capita health spending represent quantitative proxy measures for access to treatments. Thus if it were the case that technologies, therapies and treatments were available for free to all provinces to apply, then we should have seen that variations in measures of access to physicians and medical treatment should have explained variations and trends in mortality from treatable causes. The lack of compelling correlation on the access measures suggests that the variability in declining mortality rates in different provinces cannot be explained by these factors.

The findings from this analysis are limited by the lack of data related to research funding and health research workforce. If ability for patients to benefit from the knowledge production of research requires local production and/or clinicians who seek out knowledge and apply it, then the health research workforce should be correlated with local patient outcomes, such as MPAC. Unfortunately, data tracking the health research workforce by province is not available. This is a serious limitation for provincial and federal decision makers' informed policy development around assessment of impact and future allocation of funding for health research.

⁴⁶ Scott, C. and N. Gall. August, 2006. *Knowledge Use in the Calgary Health Region: a Scan of Initiatives That Support Use of Evidence in Practice. Final Report.* Calgary, AB: Calgary Health Region.

⁴⁷ Scott, C., Seidel, J., Bowden, S. and Gall, N. *Integrated Health Systems and Integrated Knowledge: Creating Space for Putting Knowledge into Action.* Healthcare Quarterly. 13: Oct 2009.

Despite the lack of data available, it is possible that research improves services and outcomes for patients because the opportunity to do research attracts a higher quality physician, or a different culture of physicians or health care providers that leads to better treatment, better practices and innovation in service delivery as a collateral benefit of research oriented physicians. Research funding could be considered an alternative to higher income, in the sense that offering a contract of income plus research support attracts a different type of clinician or professor to the province.

We suggest that this type of qualitative difference in the physician workforce that influences the adoption and use of effective therapies and treatments is likely to have the largest impact on MPAC. Consider that the rate of decline in MTC causes seems to be more rapid in the provinces with the largest cities. People living in large metropolitan areas in Canada have the longest life expectancies and disability-free life expectancies.⁴⁸ While this is often attributed to differences in lifestyle and socioeconomic factors, the diffusion, dissemination, utilization and integration of medical research regionally is also likely to be a factor.⁴⁹ Medical schools conducting research in larger cities may afford scale opportunities for providing treatment that lead to better outcomes, or greater likelihood of adoption of new therapies.

CONCLUSION

The initial AHFMR objective was to both support the recruitment of high quality medical researchers and trainees⁵⁰ as well as support facility upgrades and renovations to improve the availability and adequacy of space for medical research to improve the quality of health care. In the late 1980's major contributions to Alberta's patient care programs were identified to be due to attracting clinical and basic scientists with special expertise.⁵¹ ⁵²Trustee Dr. Gordon Swann emphasized this stating, "I've talked to people in the medical community and they say the quality of medical care has been enhanced by the influx of medical researchers. The presence of the people makes a quality of health care available to

⁴⁸ Shields,M, and Tremblay,S. *The Health of Canada's Communities*. Statistics Canada, Catalogue 82-003. Supplement to Health Reports, volume 13, 2002.

⁴⁹ Green,L.W, Ottoson,J.M, Garcia,C, and Hiatt,R.A. Diffusion Theory and Knowledge Dissemination, Utilization, and Integration in Public Health. *Annual Review of Public Health*, Vol. 30: 151 -174

⁵⁰ In the 1992 AHFMR annual report it was noted that high housing costs in Alberta was one factor that inhibited the recruitment of new personnel to Alberta.

⁵¹ New programs developed and supported by AHFMR funded investigators included examples such as the Alzheimer's Clinic in Calgary, Islet Cell Transplantation program in Edmonton, diagnostic and therapeutic investigations of cardiac arrhythmias in both cities, introduction of nuclear magnetic imaging to Alberta, new initiatives in the rehab of stroke patients, therapy for autistic children, expertise in infectious disease and AIDS On the edge of discovery. Third Triennial Report on the Alberta Heritage Foundation for Medical Research Part II. Edmonton 1989.

⁵² The IBR noted that a number of the researchers were expert clinicians in areas not well covered in Alberta; that their research was having an impact on the prevention, diagnosis and treatment of disease, and that AHFMR clinical teams integrated technical expertise of non-clinical researchers which advanced the quality of patient care. A review of the operations of the Alberta Heritage Foundation for Medical Research for the period 1980-1986. Second Triennial Report Part II. Alberta Heritage Foundation for Medical Research. Edmonton 1986.

Albertans never available before, health care as good or better than that found in famous clinics like the Mayo clinic”.⁵³

The value of AHFMR as a provincial funding agency according to some was the provision of long term stable funding which was necessary for “solid progress” in advancing medical research in the province. AHFMR president Lionel McLeod argued that to maintain the morale and motivation of top quality scientists and trainees attracted to Alberta, and to maintain a flow of new young scientists to Alberta, stable funding needed to be assured into the next century.⁵⁴ McLeod cautioned that:

How Alberta will respond to these pressures and opportunities will greatly influence our province’s importance to medical research. Failure to respond positively and aggressively will signal unwillingness to remain on the leading edge of research and patient care and reduce the province’s attractiveness to the best and the brightest scientists and their trainees; both those from within and without the province!⁵⁵

Our analysis suggests that provincial investment in medical research funding has payback in terms of measurable health outcomes. However, knowledge is not transferred without cost from producers to users. If patients benefit from medical research knowledge production, local production and/or clinicians who seek out knowledge and apply it locally is better for health outcomes. While this analysis has important implications for health research funding allocations, it also highlights the lack of longitudinal public data available on the health research workforce. It is clear that this information is necessary to inform future health research funding allocation decisions.

⁵³ Alberta Heritage Foundation for Medical Research 4th Annual Report. Edmonton 1984.

⁵⁴ *On the edge of discovery*. Third Triennial Report on the Alberta Heritage Foundation for Medical Research Part II. Edmonton 1989

⁵⁵ Ibid

APPENDIX

This time series data was examined for structural breaks. Structural breaks are an economic condition that occurs when there is a changes in how an industry functions or operates. A model was developed to detect the structural break points in the trend decline in the mortality measure for each province.

$$\ln(m_{it}) = \alpha_i + \beta_{i1}(D_1 \cdot Time_t) + \beta_{i2}(D_2 \cdot Time_t) + \beta_{i3}(D_3 \cdot Time_t) + \varepsilon_{it}$$

where $\ln(m_{it})$ is the logarithm of three different mortality rates in province i at time t ; $Time_t$ is a time-trend variable taking values as 1, 2, ...33 while $t = 1$ denotes the first year 1979; D_1 is a dummy variable that equals 1 in year $t \leq T1$ otherwise it is 0; D_2 is a dummy variable that equals 1 in year $T1 < t \leq T2$ otherwise it is 0; D_3 is a dummy variable that equals 1 in year $t > T2$ otherwise it is 0; α and β are parameters of interests. ε_{it} is the model's error term which is assumed to have a Normal distribution with mean 0 and constant variance.

There are 33 years (1979-2011) in the sample and we assume the structural break dates occur in the middle of the sample. Assuming trimming percentage is 15%, a Stata program was built to loop over x from 5 to 28 when running model (1). x is then identified as a structural break point when the β coefficient estimates are statistically significant. We expect α to be negative but the β 's can be positive (trend decline slows after break date) or negative (trend decline accelerates after the break date). The model is estimated using Generalized Least Squares methods to correct for potential autocorrelation.

TABLE 1 STRUCTURAL BREAKING YEARS FOR THREE MORTALITY RATES

Region	Breaking years in MPC	Breaking years in MTC	Breaking years in MPAC
Alberta	1986, 1990, 2000, 2007	1986, 2000	1986, 1991, 2000, 2007
British Columbia	1986, 1990, 2001, 2007	1983, 1995, 2004	1983, 1987, 2007
Manitoba	1984, 1994, 2003	1993, 1998	1993, 2003
Ontario	1993, 1997, 2001	1989, 1993, 2003	1993, 2003
Quebec	1985, 2000	1990, 1994, 2000, 2005	1985, 2000
Saskatchewan	1983, 1989, 1994, 2008	1987, 1995, 2005	1983, 1989, 1994, 2008

We find multiple structural break points in Alberta the three mortality rates (Table 1)⁵⁶. For Alberta MPC, MTC and MPAC 1986 and 2000 are structural break years. The structural break in 1986 is stronger than it is for the breaks in later years. In British Columbia and Alberta, the structural break points in MPC, MTC and MPAC are around 1983 -1986. In the case of British Columbia, the marginal changes in mortality rate for MPC declines faster prior to 1985. For MTC the marginal change in mortality rate declines more slowly in Alberta and Manitoba after the structural breaks in the late 80s early 90s whereas in other provinces the rate declines faster after the first break points.

⁵⁶ Note that MPAC is the sum of MPC and MTC, the results in MPAC (the last column) largely depend upon which mortality rate has a stronger structural break than the other.