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New Models for the New Healthcare

Health System Transformation through Research Innovation

Robyn Tamblyn, Meghan McMahon, Jessica Nadigel, Beth Dunning and Elizabeth Drake

Commentary from Luc Boileau, Stephen Bornstein, Bernard Candas, Barbara Hill Taylor, Katrina Hurley, Eric Litvak, Chris Power, Robert J. Reid, Denis A. Roy, Joan Sargeant, Ingrid Sketris and Jennifer Zelmer



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One of the challenges in establishing priorities for research investment is ambition and scope. At a time when research dollars are scarce, the wise advice provided by respondents in this issue will increase value for the investment. Indeed, there is consensus that the learning health system is the most ambitious goal, and it cannot be achieved by the research community alone.

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The Continuing Relevance of Academics to Health System Reform

INTRODUCTION

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In the drilly titled *Science and Government*, C.P. Snow (2013) describes the role of a former Oxford Chemistry Academic and a committee of academics and experts in ensuring that radar was installed in time for the Battle of Britain. Contrasting the story of success of radar with the strategic and humanitarian failure of strategic bombing, Snow argues for the importance of open policy, that is, policy developed and tested by experts. But throughout his narrative, the main characters are academics and experts who propose and argue for and against different policy options as Britain prepares for and fights the Second World War.

So why is *Science and Government* relevant today and why is it relevant to an

issue of *Healthcare Papers* describing how to move toward a learning health system? In short, it remains relevant precisely because of the important role played by academics and experts. Without Sir Henry Tizard (the Oxford chemist and chair of the Aeronautical Research Committee) and his committee of academics, Britain would likely not have had the early warning abilities of radar. Likewise, without the advice of Frederick Lindemann (Viscount Cherwell), Britain would likely not have opted for strategic or area bombing that Snow argues actually lengthened the war. But the role of academics in both cases goes well beyond the usual domains of knowledge creation and knowledge transfer. Both Tizard (and his committee) and Lindemann were called on to give advice in areas where there was incomplete evidence, but where the consequences of the wrong advice could be catastrophic. They had to advocate credibly for what they believed – based on limited evidence – to be the best advice and to work directly in the implementation of this advice. And beyond the case of radar, they also created a bridge to other academics and pockets of expertise that were critical to the British war effort.

Health reform should never be compared to war, but there are numerous lessons in Science and Government for current efforts to create a learning health system. The importance of academics interweaves throughout the 11 volumes of the Institute of Medicine's Learning Health System Series, often more implicit than explicit. Academics play the same implicit role across the papers in this issue. So what are the roles of academics, and why are they best positioned to fill these roles, in health system reform? Building off the history described in Science and Government and our own, much less dramatic, experience, we suggest that academics have three key roles in promoting health system reform.

The first role, as always for academics, is the creation of new knowledge and the sharing of knowledge through education, knowledge transfer and public engagement. Nothing should shake the academics' commitment to this role. At its best, this role extends what is known about health system performance and helps decision-makers navigate challenging spots in health system reform. It also provides the foundation for innovations from inside and outside of the academy that can improve health system performance. The collection of understandings about how radar could work was critical to convincing Tizard's committee that radar would work. However, the safety of this role requires academics to maintain their integrity and independence. Although they may have to work under oaths of confidentiality or

privacy when working with decision-makers, they need to protect their ability in these situations to speak truth to power and to pursue new avenues of knowledge.

The second role is the extension of knowledge. Academics should be at the leading edge of their science. What they and their peers have discovered is important, but equally important is their ability to reason based on this work and help describe the outlines of what is not yet proven. This ability was critical to the creation of radar. When Tizard and his colleagues first began advocating for radar, some of the critical components were still unproven. Academics are often reluctant to extend knowledge and this is an appropriate reluctance, but with the right framing and contextualization, advice that provides some guidance in the face of uncertainty about what works can be critical. But again, as Snow notes, it is best if this advice benefits from the input of multiple experts and academics so as not to push too far beyond the bounds of what is known. For this role, it is critical that academics maintain their collegiality and respect for diverse opinions, and to widen that collegiality to individuals working outside the academy.

The third role is the creation of bridges to other academics and among academics, decision-makers and practitioners in an environment that can foster debate. Once again, this re-enforces the open policy process advocated by Snow. Tizard's advice was better and more credible, because he engaged a group of other experts and he engaged decision-makers at all levels of the defense establishment. This made sure that the advice was the best it could be and grounded in the realities of the conflict that was coming. A number of papers have emphasized engagement as a powerful tool for policy development (Backstrand 2003). It is important for academics to realize that such engagement extends to their colleagues as well as to decision-makers and, increasingly often, to the broader public.

However, all of this also makes the argument for an inclusive definition of academics. As we struggle with the challenges of building learning health systems and improving health system performance, academics should find themselves regularly working outside of the scholarly or research setting. To the extent that they can maintain the roles noted above and, as importantly, maintain the relationships (Lomas and Brown 2009) with other academics and experts, they will be able to support the continuing development of learning health systems. The recommendations in this issue of *Healthcare Papers* could be extremely valuable,

but we must always keep in mind the importance of individuals in leading and supporting health system evolution.

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Health System Transformation through Research Innovation



INVITED ESSAY

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With the Institute of Health Services and Policy Research Advisory Board¹

ABSTRACT

The Canadian Institutes of Health Research's Institute of Health Services and Policy Research (IHSPR) has set out an ambitious direction for the next five years. We aim to build the scientific leadership for learning health systems in Canada, tap into the transformative potential of eHealth for Canadian healthcare, find a better system to support aging in the community, and provide research intelligence on the question of how to finance and fund the health system of the future.

Healthcare and Health Services and Policy Research in Canada

Healthcare spending in Canada is growing at an unsustainable rate, exceeding \$210 billion in 2013 (CIHI 2013). Canada invests \$5,446.50 per person on healthcare (OECD 2015), considerably more than other OECD countries, but ranks second to last in key healthcare areas, such as access, safety, and quality of care (Schoen et al. 2013). Key cost drivers include provider compensation, utilization of services and the emergence of new devices and technologies (CIHI 2013). Spending on healthcare delivery accounts for close to 50% of total budgets in a number of provinces and territories, crowding out spending on other important priorities, like education and social services. These financial pressures provide impetus for transformational change and an increasing pull for cutting-edge research that can pioneer innovations in health system delivery, which can lower costs, improve patient experience, quality of care and the health of Canadians. Canada's healthcare "system" provides a unique environment for health services and policy research in that it comprises over 13 distinct delivery systems – one in each of the 10 provinces and 3 territories, as well as federal systems for certain populations (e.g., First Nations and Inuit peoples, the military and prison populations). This rich arena of innovation and experimentation generates valuable opportunities for natural experiments

and cross-jurisdictional comparative analyses that can shed insight into the successful features of different service delivery models and areas for growth and improvement.

The Canadian Institutes of Health Research

Canada's health services and policy research enterprise has evolved significantly over the past 20 years and has witnessed growth in many areas, including funding and programs to support innovative research (Figure 1).

One of the seminal achievements of the health services and policy research enterprise was the formation of the Institute of Health Services and Policy Research (IHSPR) as one of 13 Institutes within the Canadian Institutes of Health Research (CIHR). Established in 2000, CIHR's mandate was to create new scientific knowledge and to catalyze its translation into improved health, more effective health services and products and a strengthened Canadian healthcare system.

In the first decade, based on application data to CIHR, health services and policy research grew under this new organization. Between 2001 and 2011, funding for grant applications for health services and policy research increased from \$12.6 to \$48 million (Figure 2); the annual number of applications increased from 327 to 1,137; and the number of principal investigators applying to CIHR increased from 290 to 659.

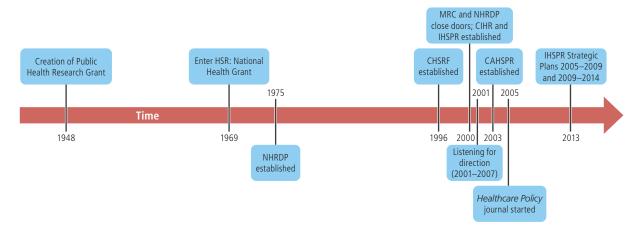
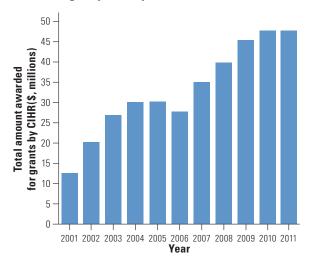


Figure 1. The history of health services and policy research in Canada

Figure 2. Total funding awarded grant applications for health services and policy research in the open and strategic by fiscal year (2001–2011)



However, health services and policy research continues to represent a very small proportion of the strategic and open operating grant funds awarded by CIHR: 3.2% of overall funding in 2001–2002 and 6.3% of all applications funded in 2011–2012 (Figure 3). A paradigm shift is needed if health services and policy research is to drive health system transformation. We will need to create alignment and synergy among health services research funders, researchers and end-users, build a vision of what we want to accomplish, establish what we need to do and build a strategy to get there.

A Common Vision and Strategic Direction for Health Services and Policy Research: Building a Canadian Alliance

Based on the success of the Canadian Cancer Research Alliance, the Canadian Health Services and Policy Research Alliance (CHSPRA) was established to foster collaboration, coordination and strategic investment among health services and policy research organizations in Canada. Aligning our vision and strategic direction creates the capacity to accelerate scientific innovation and discovery in health services and policy research, optimize the impact of research on health and health system outcomes and strengthen the research enterprise.

As an initial step, 27 organizations involved in funding health services and policy research (CIHR 2015) collaborated to create an asset map of the collective investments over a five-year period (2007–2012), by location, type of investment and content area. Overall, \$770 million was spent in health services and policy research over the five-year period (Figure 4). Funding was awarded to 225 organizations active in Canada's health services and policy research enterprise.

CIHR accounted for 37.7% of health services research funding, opening opportunities to increase synergy by collaborating on common priorities with provincial health research funders, health charities and other funders (Figure 5).

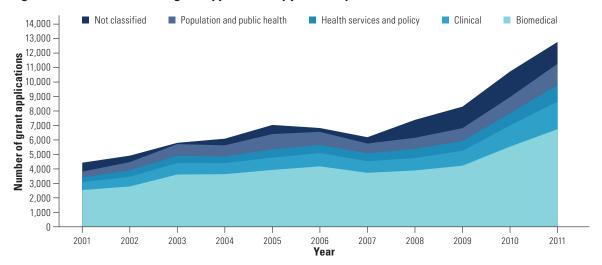


Figure 3. The number of CIHR grant applications by pillar and year

The top funded themes included access to appropriate care across the continuum (14.4%), managing for quality and safety (11.9%) and linking population and public health with health services (9.4%) (Figure 6). Very little investment had been made in healthcare financing and funding (1.6%) and change management/scaling up innovation (0.3%), even though they were hot topics identified by many policy think tanks (Health Services Research Europe 2011; Klein et al. 2013; WHO 2008, 2013).

To build a vision for the future, input was solicited through a web-based survey of 400 Canadian health services and policy researchers, 55 regional informants, including researchers and policymakers, the general public through a Café Scientifique for 117 participants and international leaders through a panel at the annual meeting of the Canadian Association for Health Services and Policy Research (CAHSPR). The collective input from stakeholders was presented at a national Priorities Forum of over 100 funders, policy and decision makers, researchers and endusers in April 2014, who established a vision and direction for the next five years. Seven foundational strategic directions and five priorities were identified for investment (Figure 7).

There was immediate interest in working collectively on two strategic directions where resources were already available and being used to address them: 1) measuring health services and policy research impact, and 2) accelerating the creation of a cadre of scientists that could work within the context of a learning health system.

Strategic Plan: Institute of Health Services and Policy Research 2015–2019

The Institute of Health Services and Policy Research (IHSPR) aligned its new fiveyear strategy with the pan-Canadian Vision and Strategy for Health Services and Policy Research (CIHR 2015). Both envision a future where research intelligence and strategic partnerships are necessary to drive health system transformation to improve health and health system outcomes for Canadians. IHSPR's Institute Advisory Board selected four areas that IHSPR was well positioned to advance based on an assessment of: 1) gaps and strengths; 2) potential for international leadership; 3) potential for partnering; 4) alignment with CIHR Health Research Roadmap II (CIHR 2015) and synergies with the Strategy for Patient-Oriented Research (SPOR); and 5) opportunities for inter-Institute collaboration.

Figure 4. Total health services and policy research investment in Canada (2007–2011)

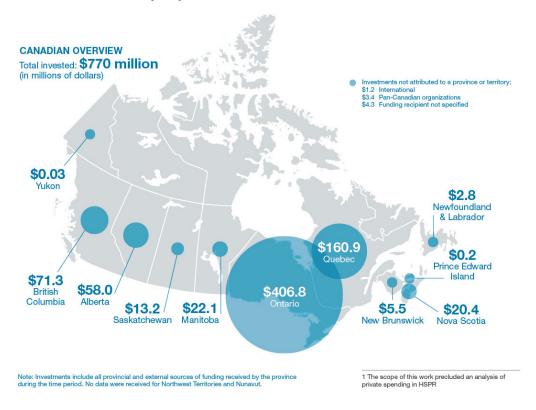


Figure 5. Leading funders of health services and policy research in Canada (2007-2011)

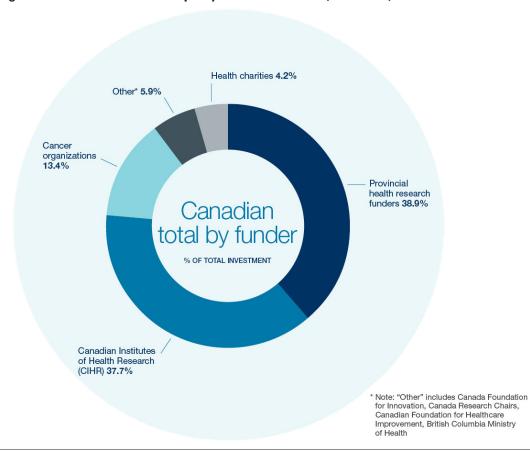


Figure 6. Total health services and policy research investment by research theme (2007-2011)

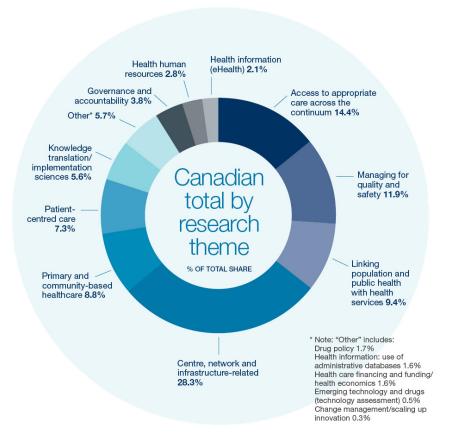


Figure 7. Health services and policy research priorities and foundational strategic directions



Strategic Priority 1: The Creation of Learning Health Systems and the Next Generation of Researchers with the Skills to Partner in Health System Learning and Transformation

Each day, millions of Canadians are seen within the healthcare system and trillions of bits of information are generated. Increasingly, the day-to-day use of health and social services is recorded digitally at the point of care. This information could be harnessed to understand the comparative effectiveness of different treatments, the causes of potentially avoidable adverse events, unnecessary costs, missed opportunities for prevention and to capture the collective wisdom on how to improve patient experience. However, for the most part, we have not used this information to produce knowledge on how we could do better (Gawande 2007). A major initiative that is gaining momentum in the US is to create "learning health systems," accountable care organizations that use their data in an intelligent fashion as a guide to improving care in a dynamic way (Committee on the Learning Health Care System in America, Institute of Medicine 2013). The learning health system emphasizes collaboration across all health borders to drive an efficient and effective system (Backus et al. 2001; Gooch et al. 2012; James and Savitz 2011).

The gap

There are many challenges to address before it becomes possible to move from the health system of today to a learning system of tomorrow. However, a fundamental requirement for success is capable scientific, clinical and policy leadership that will nurture the ability of a health system to experiment with innovation, learn from failure and scale up success. The skill sets required of scientists within learning health systems are different from those acquired in classic training. They need to be able to partner with clinical and policy leadership to identify relevant priorities for

research, develop new methods for rapid scientific investigation using point-of-care patient experience and digital health and social data, collaborate on the most effective use of emerging knowledge for clinical and policy decisions and implement and evaluate innovative solutions.

The objective

To train and fund a new generation of scientists who can provide scientific leadership in learning health systems.

Expected impact

In five years, there will be a new cadre of health system scientists. This group will develop methods of using point-of-care digital data to address priority policy and practice questions in a timely way through both experimental and observational approaches. There will be a corresponding increase in the adoption of new innovations and disinvestment in suboptimal models of care and interventions.

Each day, millions of Canadians are seen within the healthcare system and trillions of bits of information are generated.

Strategic Priority 2: eHealth

In the upcoming decade, digital platforms will be the backbone of a strategic revolution in the way health services are provided, affecting both healthcare providers and patients (Bahagon and Jacobson 2012). eHealth innovations are appearing in almost all areas of healthcare delivery: from prevention, diagnosis, acute through to long-term care and population health surveillance. Increasing evidence shows its contribution to efficiency (e.g., reductions in wait times, increased speed of referrals and decision-making), effectiveness (e.g., telehealth clinics for dermatology and psychiatric

assessment and counselling), patient education and empowerment (e.g., health experience portals) and safety (e.g., prescription drug dispensing) (Elbert et al. 2014).

The emerging potential of eHealth, and its impact on health research, is recognized worldwide, with many funding agencies placing it in the top five priorities for future investment (Viergever 2010).

The gap

Canada is lagging behind in efforts to take full advantage of the global trends in digitization that can transform this innovative knowledge into real benefits for patients and for healthcare systems (Schoen et al. 2012). Analysis of the problems in Canada has identified challenges on all sides (OHIC 2014) that limit the development of practical solutions and the adoption of proven eHealth interventions across clinical, administrative and policy settings. Important limitations include the lack of investment in formal evaluation of new technologies, particularly comparative clinical benefit, effectiveness and comparative cost analysis; insufficient alignment between information and communication technology (ICT) developments and those working to address significant health problems; and the challenges for ICT companies to access healthcare settings where their products and solutions can be tested in real-world contexts with patients and healthcare providers. eHealth innovations of the future will need to be integrated into client-focused solutions that can change outcomes of care by improving access, safety, quality and equity, at the same or lower cost.

The objective

To develop, integrate and evaluate eHealth innovations that will improve the effectiveness and efficiency of patient- and population-centred care; and to increase

Canada's competitive position in the healthrelated ICT industry to support continuing innovation in Canadian healthcare.

Expected impact

In five years, Canada will have more health innovation communities (local/regional health-care environments with leadership comprised of researchers, clinicians, patients and decision-makers), which are integrating eHealth innovations into real-world service delivery. These communities will have a dynamic and growing number of technology partners, which are creating and adapting eHealth technologies that reduce the cost of care while increasing access and quality. There will be new international partnerships, and Canadian technology innovators will see the uptake of their products and know-how internationally.

Strategic Priority 3: Healthy Aging in the Community

The Canadian healthcare system is not well designed for chronic disease management, particularly the management of multimorbidity that is most prevalent in the aging population. Canada spends \$5,446.50 per capita on healthcare – the fifth highest investment in healthcare among OECD countries (OECD 2015) – with the exception of the US, which has the worst performance in international comparisons.

With the expected demographic shift toward an increasing proportion of older adults, it is paramount that we create communities that can support healthy aging, including health systems that can more proactively manage multimorbidity across the continuum of care.

The gap

Denmark, the Netherlands and Japan are leading in innovative care models to support seniors (British Columbia Ministry of Health and Michael Smith Foundation 2014).

Integrated systems of care involving community-based primary care and home care are an important feature of these innovative systems. However, new models of care have gone beyond the re-configuration of traditional health services to engage communities in providing supportive environments and services for seniors with social innovations, such as age-proof dwellings (e.g., Apartments for Life [Tinker et al. 2013], Dementia Village [Dementia Village Architects 2015]) and volunteer networks (Dementia Friends 2015), SOS Wanderers Network (Johnson 2015). Regional health authorities in Canada are just beginning to experiment with new community-based models of care for frail seniors (City of Surrey 2014; Park et al. 2014; OMHLTC 2015).

The objective

To accelerate the experimentation and evaluation of community-based integrated care systems and social innovations to support the healthy aging of seniors in the community.

Expected impact

In the next five years, evidence to support policy options and action related to pharmacare, home care and long-term care would be available to support decision-making; new models of care for aging well in the community that delay long-term care admission and reduce avoidable emergency department use and hospitalization will be developed and evaluated.

Strategic Priority 4: Health System Financing, Funding and Sustainability

With healthcare accounting for almost half of provincial and territorial expenditures and delivering poor value for comparative investment internationally (The Commonwealth Fund 2011), it is essential to examine alternative mechanisms of financing and funding and evaluate their comparative effectiveness. In

particular, Canada will need to determine how it will finance community-based services that will be essential for effective chronic disease management, but are not covered under the Canada Health Act. Moreover, budget silos for health service sectors along the continuum of care (e.g., hospitals, rehabilitation centres, primary care clinics, home care) act as barriers to innovation and system transformation. Current mechanisms for financing and funding healthcare in Canada provide no incentives for better care at lower cost, improving the patient experience or ensuring the most efficient use of limited resources.

Canada will need to determine how it will finance community-based services that will be essential for effective chronic disease management

The gap

Various countries, including Canada, are experimenting with a variety of different approaches to financing and funding health-care. Private–public financing of services (e.g., drug coverage in Quebec) and infrastructure (e.g., new hospitals in Britain) is being employed as a means of improving access and reducing taxpayer costs, but questions about actual effectiveness, efficiency and convenience still remain unanswered (Torchia et al. 2015). There are fears that private–public systems will result in higher healthcare prices and sicker, poorer people being left untreated.

Activity-based funding approaches for hospitals aim to improve efficiencies, but results vary widely across studies: some suggest important benefits and others suggest harmful consequences (Palmer et al. 2014). The impact on the quality of care and outcomes of paying practitioners for performance rather than services remains largely uncertain, particularly as it

relates to unintended consequences (Houle et al. 2012). Recent experiments with Accountable Care Organizations (ACO) in the US are of considerable interest in Canada. Within this model, organizations are rewarded for achieving better outcomes and penalized for preventable morbidity, providing an incentive system for front-line innovation in improving health service delivery. The effectiveness of these new models of funding is currently unknown. An emerging approach to improving value for investment in healthcare is through professional engagement and leadership in reducing unnecessary use of resources (American Academy of Family Physicians 2013). The "Choosing Wisely" movement now encompasses the engagement of virtually all medical societies in the US and Canada, as well as Consumer Reports (2015). Choosing Wisely's impact on reducing preventable morbidity and costs from unnecessary use of drugs, diagnostics and procedures has not yet been evaluated.

The objective

Evaluate alternative approaches to performance-based funding that optimize quality, health outcomes and reduce costs; public-private financing models for providing community-based products and services (e.g., pharmaceutical, home and long-term care, allied health professionals); and new mechanisms for controlling costs through professional leadership and engagement.

Expected impact

In five years, there will be an increase in crossjurisdictional and international comparative research, which provides evidence about the important attributes of financing and funding that lead to positive and negative effects. Micro-level practice and policy interventions to reduce unnecessary use will be identified and scaled up in some jurisdictions to reduce unnecessary adverse effects and costs.

In summary, Canada has led the world with its pioneering efforts to create innovative cost-effective healthcare systems. The five-year research agenda focuses on key elements that will be necessary to address the challenges of effective health system management of an aging population. These key elements include financing and funding approaches that will either drive or create barriers to innovation; the creation of a new breed of scientists that can collaborate with health system stakeholders; and the co-creation and use of eHealth technologies that can improve the quality and efficiency of care. The Institute of Health Services and Policy Research is one player in this landscape. The creation of the Canadian Health Services and Policy Research Alliance and the national SPOR initiative (CIHR 2011) provides the vehicle and the connectivity to mine the natural experiments in Canadian healthcare and deliver on this ambitious mandate.

Note

1. Andreas Laupacis, Li Ka Shing Knowledge Institute of St Michael's Hospital; Stirling Bryan, Centre for Clinical Epidemiology & Evaluation Vancouver Coastal Health Research Institute; Ivy Bourgeault, University of Ottawa; David Buckeridge, McGill University; Rick Glazier, Institute for Clinical and Evaluative Sciences; Mimi Lowi-Young, Alzheimer's Society of Canada; Jacques Magnan, Canadian Partnership Against Cancer; Tom Noseworthy, University of Calgary; Amélie Quesnel-Vallée, McGill University; Marcel Saulnier, Health Canada; Vasanthi Srinivasan, Ontario Strategy for Patient-Oriented Research SUPPORT Unit; and Christina Weise, Research Manitoba.

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Healthcare Papers

The Necessary – but Not Sufficient – Leadership of Research to Transform the Health Systems



COMMENTARY

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ABSTRACT

Building on its remarkable achievements, the Institute of Health Services and Policy Research (IHSPR) is leading the reflection on the strategic orientations that should prevail over the next five years in this domain. IHSPR's first priority calls for a significant paradigm shift to establish learning health systems, while the three others are addressing the challenges of the aging population, integration of eHealth technologies and financial sustainability.

Transitioning towards a learning health system will require that dynamics among all actors be leading to a culture of continuous quality improvement. Training a new generation of researchers will not be sufficient, as all health systems stakeholders need to be engaged. In our view, it calls for a political impetus to create the conditions that will bring research and the health systems leaders together, including through concerted actions and financial incentives.

There are reasons to be optimistic, particularly when we consider the context of natural experiments emerging from 13 Canadian healthcare systems and the existence of several public organizations bridging research with the health system acting as change agencies. Hopefully, policymakers will join the research community to better understand how to achieve this paradigm shift toward learning health systems.

In this publication, Tamblyn et al. (2016) review some of the impressive achievements of the Institute of Health Services and Policy Research (IHSPR), which has contributed, in a relatively short time, to a significant increase in the capacity for health services and policy research in Canada. Rather than being satisfied with the status quo, the Institute has continued to demonstrate outstanding leadership by helping to build a Canadian Health Services and Policy Research Alliance (CHSPRA), which has led to the formulation of a common vision and a consensus on strategic priorities for research.

Aligning itself with the results of the rigorous process that was followed to achieve this consensus, the IHSPR plans to focus efforts on four strategic priorities during its next activity cycle: the first priority is aimed at building the capacity to transform the health system by increasing the number of researchers and scientists better prepared to support the move toward a learning healthcare system. The other three are aimed at supporting the development of new models of service

delivery that will meet the needs of an aging population, at taking advantage of technological developments (eHealth) and at examining new funding mechanisms that are more effective and better aligned with system objectives.

We believe that the IHSPR's first priority reflects a significant paradigm shift in the health system – the maturation of a movement toward cooperative exchange between research and health systems that began with knowledge transfer and has continued with co-construction. The integration of research projects within healthcare organizations has indeed become the norm. Even the training of health executives has benefited from this same momentum, as illustrated by the FORCES/EXTRA (http://www.cfhi-fcass.ca/WhatWeDo/extra) program, a unique environment to learn how to integrate knowledge management within their work.

Through this strategic priority, the IHSPR plans to support change by redefining the role and the contribution of researchers. In a sense, research would aim to transform the system by changing the nature of research

itself in order to induce a move toward a learning health system that develops and applies relevant knowledge in all its activities, rigorously and efficiently. Thus arises the question as to whether or not research should reach out to assist other agencies and actors within the health system who must also redefine their roles, responsibilities and accountability? How can research assist others in adopting the same project and vision and in transforming the way the health system itself functions so that it truly becomes a learning system?

A learning health system must have a strong capacity for uptake, given the constant influx of new knowledge. It also requires the ability to organize and manage complex bodies of knowledge that are rapidly evolving, as well as the capacity to apply this knowledge through the implementation of small- and large-scale changes, so as to continuously improve its activities. The adoption of innovations by health agencies involves complex dynamics within and between their components as well as with the political, social and knowledge contexts (Damschroder et al. 2009; Greenhalgh et al. 2004). Its many facets call for the involvement of a broad range of actors, including organizations that evaluate new technologies or produce guidelines, along with the leaders, managers and clinicians who apply them.

It is well documented and widely recognized that health systems are complex adaptive systems, with an intrinsic potential for adaptation and continuous improvement. However, channelling this potential to produce more health more efficiently requires that the political, managerial and practice environment must change. Models of innovation adoption have shown that for a learning system to take root, internal capacity for adaptation and continuous improvement must be developed (Baker et al. 2008), as demonstrated by several examples (Intermountain Health, Kaiser-Permanente, Veterans

Administration, etc.). In Canada, certain organizations have succeeded in building this internal capacity for change, but we have not yet succeeded in generalizing it throughout our system.

A learning health system must have a strong capacity for uptake ...

Therefore, we must also continue to strengthen our health system's internal capacity. It is only if this internal capacity exists that we can expect to create real synergy between a new generation of researchers and the actors engaged in policymaking, system governance and service management and delivery. This synergy must ultimately become embedded in our values and culture, in the functional dynamics of agencies and of the system, and not just crop up within a succession of disconnected projects.

Indeed, multiple research, development and partnership initiatives and programs have attempted to foster greater internal capacity for integrating innovations and redefining service provision models, with varying success. In this regard, we believe that health services and policy research should aim not only to develop the next generation of researchers but also to help develop the next generation of decision-makers, managers and clinical champions. The call for a new paradigm cannot be carried forward only by researchers and scientists producing new knowledge on health services and policies. It necessarily requires a significant and substantial convergence of decision-making within the system.

In addition to changing the research ecosystem – essentially driven by its funding mechanisms of projects and the structure of its programs – that of the health system must also evolve. We submit that it has become essential, as for instance with the Strategy for

Patient-Oriented Research (http://cihr-irsc. gc.ca/e/41204.html), for the governing bodies of the health system and those of research funding to collaborate more closely, to develop strategic partnerships for concerted action, focused on service and policy innovation and performance improvement.

Such a project is beyond the scope of research funding agencies alone. It requires a political impetus to establish objectives and mandate such a transformation. In our view, the policymakers alone can breathe the required energy into the co-construction of a relationship between research and the health system that will embody the paradigm shift toward learning systems. Recently, several countries that have initiated an overhaul of their system have been broadly inspired by the Triple Aim approach (Berwick et al. 2008). This concept distils within it the key principle of balancing three essential goals of a learning system that must emerge from such a transformation: it must simultaneously ensure population health, the quality of the patient experience and value for money. The adoption of such a vision and the resulting realignment of the levers of change could prompt adjustments in the research and management ecosystems, and thereby create the conditions that will encourage researchers, managers and policymakers to engage in concerted actions likely to lead to profound change.

Canada has several assets that can facilitate the paradigm shift ...

It has become common knowledge that financing and funding mechanisms play an essential role in the dynamics of the health system. This is the focus of the Institute's fourth strategic priority. However, here again, we need to go further than examining the benefits and adverse effects of different alternatives, such as performance versus activity-based funding. Identifying value-aligned financing modalities is definitely needed, but being able to lead change toward such a fundamentally different environment is critical (Conrad et al. 2014). It is imperative that we comprehend, and ultimately overcome, the reasons why we do not succeed in moving away from our current approaches to adopt better ones. What are the political and organizational factors that hinder the integration of funding mechanisms aligned with the improvement of the quality of care and services? These are other important questions on which research should shed light.

Despite the above mentioned significant challenges, there are reasons to remain optimistic. Canada has several assets that can facilitate the paradigm shift contemplated by the IHSPR and many actors of the health system. First, as Tamblyn et al. indicate, the 13 provincial and territorial health systems within Canada provide an environment amenable to natural experiments, offering a much broader range of opportunities for innovation than would a single system. Moreover, each of these systems is structured according to diverse forms of regionalization, the *de facto* common denominator of health policy in Canada. Based on a recent study, a vision emerges for learning, highperforming regionalized health systems and for territories where healthy public policies can be implemented (Bergevin et al. 2016). Managing integrated, regionalized health systems as resultsdriven health programs, as well as involving professional – including physicians – and citizens in clinical governance and leadership, as partners for accountability and for experimentation with new payment models, appear particularly timely. Regionalization thus provides both an impetus and a context for greater collaboration between research and health policy, emphasizing the need for bringing together these two worlds if we are to develop a learning health system in Canada.

How can research and the health systems jointly take full advantage of this potential for experimentation? What effective research coordination and knowledge adoption mechanisms should we promote? This conversation ought to include provincial and federal health research funders and health charities, as well as non-governmental organizations, academia and health industries. The Canadian Health Services and Policy Research Alliance might also act as a catalyst in this endeavour. Another of our critical assets is the existence, across Canada, of several well-established public organizations that support the management of information and knowledge. We can draw on the expertise of numerous organizations, including Canadian Institute for Health Information, Canadian Foundation for Health Improvement, Canadian Patient Safety Institute, Accreditation Canada, Provincial Quality Councils, Provincial SUPPORT Units, Health Quality Ontario, Institute of Clinical Evaluative Sciences, Institute of Health Economics Alberta, McMaster Health Forum, etc. This is also the type of work that we strive to do more of at the INESSS in Quebec. The health systems that set examples for the efficacy of their transformation have relied on such structures and have demonstrated the essential role they play, as is eloquently illustrated by the example of the National Institute for Health and Care Excellence (NICE) in the United Kingdom. The contribution of public agencies devoted to knowledge management and its integration in the transformation of the system is, in our view, essential to the emergence of a learning system and the sustainability of the desired linkage between the worlds of health research and decision-making.

The vision pursued by the IHSPR reflects its bold ambitions regarding the contribution of research to health services and policy. It is hoped that the next federal/provincial/territorial health agreement will integrate these issues

and invite stakeholders to commit to working toward modernizing the health system, with the invaluable insights of research, to allow the system to learn from innovation and continuous quality improvement. Research doubtless has an essential role to play in producing knowledge that sheds light on how to improve health services and practices. We believe it has to contribute significantly to assisting political leaders, managers and professionals in the health system in better understanding not only what must be done but also how can we can get there, working together.

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"If You're Riding a Horse and It Dies ..." A Commentary on *Health System*Transformation through Research Innovation



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ABSTRACT

In the words of Goethe, "Knowing is not enough; we must apply. Willing is not enough; we must do." If health services and policy research is to be a major driver of health system transformation, the conditions for creating that change platform need to be initiated today. It is clear that we need a different approach to the way in which we develop and utilize evidence and the paper by Tamblyn et al. (2016) provides us with four strategic priorities that could help us find our way. There is no silver bullet that would awaken us to a transformed system. But we have long studied the problems and continue to arrive at similar solutions. It's time to stop talking and, together, take action. If you're riding a horse and it dies, simply get off and try something new. In this commentary, there is general agreement with the directions proposed, but they will not be enough to create sustainable change unless leaders are willing to work to create a culture where answers to relevant research questions are adopted, spread and scaled within their healthcare organizations.

I was once given a wonderful book by a dear colleague entitled, If You're Riding a Horse and It Dies, Get Off, by Jim Grant and Char Forsten (1999). It is about the education system, but I found that it had many similarities to healthcare. The story is set in 1918 and depicts a man riding into a town, when his horse suddenly drops dead. People come from miles around offering suggestions by which the dead horse could be revived, such as getting a bigger whip, visiting places that ride dead horses, a more experienced driver, assembling a committee, team riding, more money, federal assistance, and the list goes on. Sound familiar? Finally, someone has a bright idea and says, "If you're riding a horse and it dies, get off and try something new." And in comes the car!

As I read the paper, Health System Transformation through Research Innovation, I thought of this book; not because it felt like the wheel was trying to be re-invented but because there seemed to be emerging clarity that somehow the worlds of researchers, decision-makers, care providers and patients needed to be joined in a fresh, new way to move healthcare toward the transformation that it requires to be a safe, highly effective and efficient system. We've studied the dead horse long enough! Let's take what was great about riding a horse and build on it, but try something new.

Some of the good things about being engaged in healthcare as long as I have are that you get to learn from your mistakes, see what works and doesn't work and come to understand that there is no silver bullet – no one thing that will transform the healthcare system on its own. In this complex environment, I believe that many complementary initiatives will be required to bring about the necessary changes, and we must solve these issues collaboratively if we are to be successful. Research is, and will continue to be, an enabler to provide the evidence required to

effect change. The four strategic priorities outlined in the paper are all valid contributors to creating the necessary knowledge for change to happen. But simply acting on these priority areas will not have the desired result if we don't pay attention to creating the climate for change that is required to bring these initiatives into being. In the field of patient safety, the evidence is clear that, despite our best efforts, patients continue to experience preventable adverse events in hospitals and the community at an alarming rate. What we have come to learn is that, although hugely important, it is not enough to focus on specific clinical interventions to improve patient safety. Leadership is required to create a culture of patient safety so that the lens of safety is applied to all that takes place. This is not dissimilar to research innovation. Developing researchers who can work in a learning system is an excellent idea, but without creating learning systems in which they can work, we will be no further ahead. So, although I support the objective of training and funding a new generation of scientists, we will need to start today to begin the journey toward a learning system.

... there is no silver bullet – no one thing that will transform the healthcare system on its own.

In June 2000, I had the opportunity to hear a futurist talk about a digital world where people enter their homes and a computer detects heart rate, blood pressure, oxygen saturation levels, air quality, etc. and is able to connect with the physician's office to change medications, make appointments and counsel people on steps they need to take to remain healthy. And by then, this technology was already available for use. Yet, in 2016, we have

not been able to mainstream these concepts. The strategic priority two, eHealth, that is outlined in the paper, is an essential component of moving forward in healthcare, so why are we so slow to act on what's available to us today? During my tenure as CEO of Capital Health in Halifax, it was not that we didn't see the value or necessity of moving in this direction. Our clinicians were the first to tell us that they were frustrated with the lack of easily retrievable data to assist them in providing high quality care. We met with many vendors who had what appeared to be great products and seemingly easy solutions to assist us in turning data into useable information to inform diagnosis and care. Yet, our hands were tied as we waited for provincial solutions and the necessary resources to invest in the technologies at hand that never seemed to materialize. And, with precision medicine at our doorstep, the healthcare system is poorly positioned for uptake. Our industry partners are frustrated with the inability to co-design and implement IT solutions in Canada. I believe that this eHealth strategy, creating health innovation communities to develop, integrate and evaluate eHealth solutions is a solid way forward.

our hands were tied as we waited for provincial solutions and the necessary resources to invest ...

There is no conference, conversation or service delivery planning happening today that doesn't touch on our aging population and the potential effect on our healthcare system. Many innovative ideas are being fostered throughout the country, but with little scale and spread. Perhaps additional research is needed in this area, but why can't we simply learn from what is already happening around

the world to enhance current programs or try new approaches? Learning from this paper that only 0.3% of research funding nationally has been dedicated to scaling and spreading of ideas as well as change management, was disturbing but eye opening. There are so many great initiatives happening in this country in small pockets that are rarely evaluated and are even more rarely spread and scaled. It is disappointing to me that this area did not surface as a priority for research innovation, as I believe it could assist us greatly in learning from each other across the country.

And last but not least, health system finance. Funding and sustainability as a strategic priority is a much-needed focus. As an example, I once heard a family physician saying that she had no idea how many patients with diabetes she had in her practice, and that she had never received any tangible evidence, through data, of whether or not she was providing good care. What were her outcomes? She had no idea about what was cost-effective in her practice and what wasn't. The same can be said for most healthcare systems in this country. We know the rolled-up figures for providing care but, generally speaking, we have no idea about what procedures cost us, where we get good return on investments, what are lost leaders, etc. Few organizations have developed robust case-costing systems that provide them with real-time knowledge of how they are spending their scarce dollars. What other industry would work this way and survive?

And are we incenting the right behaviours? In countries where health outcomes are improving and spending reducing, payment models have evolved to reward outcomes and performance. The fee-for-service model has been long gone, but in Canada remains alive and well. There is no question that new reimbursement models are required if we are to improve health outcomes in a sustainable

system. This priority has merit and will provide much-needed information for decision-makers. Hopefully, there will be the courage required to implement the necessary changes.

In conclusion, I think that overall, the direction that the Institute of Health Services and Policy Research is heading is a sound one. However, the expected impacts will not be achieved without complementary work on creating the culture to embrace these changes with a focus on helping people through the change process. Leadership is required to be engaged in a significant way on this journey along with a solid partnership with patients and families. And the missing link so often is turning the new knowledge generated through research into useful information that helps effect change. Let's create models that not only study questions relevant to the field but also have a component of adoption, scale and spread that is so sorely lacking on many fronts. Perhaps partnering with interested leaders to develop a learning health system that can

receive scientists who have the necessary skills to work in these new environments would be a great start in demonstrating to the country how science and practice, harmoniously, can lead to improved healthcare and outcomes. And, as the strategic priorities are implemented, we need to look to the "unusual suspects" for the change that it required to propel us forward, like partnerships with industry, utilizing the expertise available to us through organizations such as CADTH and Canada Health Infoway, and engaging patients to help us define their needs to better manage care.

In the words of Goethe, "Knowing is not enough; we must apply. Willing is not enough; we must do."

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Embedding Research in the Learning Health System



COMMENTARY

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ABSTRACT

To make research more impactful in the evolution of Canadian healthcare, the Canadian Institutes for Health Research have prioritized creation of learning health systems where research rapidly informs healthcare finance and delivery and vice versa. To make this vision a reality, substantial changes are needed in how researchers are trained, the environments in which they work, and the reward systems that are in place. Attention is needed on training researchers with a broader array of skills, the creation of partnered environments, the evolution of our ethical frameworks, and the creation of integrated funding.

THERE ARE PRESSING needs for impactful health services and policy research in Canada. Canadians face challenges every day in receiving safe and effective care that is reliable, timely and coordinated. They also increasingly expect, and deserve, excellent care experiences, all at a cost we can afford. Recent cross-country studies suggest that Canadian healthcare is lagging in many respects (Osborn et al. 2014; Schoen

et al. 2013). Not only can scientists help discover better ways to deliver and finance care, they also serve another key role – as informed change agents who collaborate with leaders, managers and clinicians as they learn. The rich data landscape, now enabled by advanced health information technologies (HIT) and paired with cutting-edge analytic techniques, opens up unprecedented opportunities for

rapid-cycle learning that we have not seen before. The opportunities, too numerous to list, are layered at all levels – from the way that clinicians interact with patients and each other clear through to large-scale changes in provincial and federal health policies.

In this issue, Tamblyn et al. (2016) from the Institute of Health Services and Policy Research (IHSPR), part of the Canadian Institutes of Health Research (CIHR), outline their five-year research funding priorities. Their first priority is the most meaningful and ambitious: the creation of learning health systems and a new generation of researchers skilled in promoting rapid, on-the-ground health system transformation. IHSPR also places funding priority on eHealth innovations, community-based healthy aging and novel funding and finance mechanisms – all key learning themes needed to achieve the outcomes that Canadians want from their systems.

Almost a decade ago, the Institute of Medicine (IOM) first proposed the vision of the learning health system and defined it as "one in which progress in science, informatics and care culture align to generate new knowledge as an ongoing natural by-product of the care experience and seamlessly refines and delivers best practices for continuous learning in health and healthcare" (IOM 2007). They conceptualized a future where data collection, advanced analytics and learning is routinized within health systems that are then charged with externally disseminating and sustaining learnings and best practices. Supported by big data analytics, this vision challenges current thinking and calls for the fundamental integration of health services research, clinical operations, quality improvement, decision support and patient engagement. The products are learnings that are of immediate value for systems and their stakeholders. While much has been written about its potential (Etheredge 2007; Slutsky 2007; Smith et al.

2012), the concept is still largely hypothetical with only a few practical examples (Abernethy 2014; Flum et al. 2014; Greene et al. 2012; Psek et al. 2015; Solberg 2009), where research units, health systems, academic intuitions and funding bodies have deliberately partnered to embed researchers within health systems to promote rapid learning.

The opportunities, too numerous to list, are layered at all levels ...

Health System Learning and the Relationship to Research

To ground the role of research in health system learning, Greene et al. (2012) proposed a virtuous learning cycle with six nodes, where researchers partner with health system leaders, managers, analysts, improvement experts and clinicians. The utility of this model is because it underlays the needs for new training platforms and learning infrastructures. The first node, surveillance, is one in which the Canadian health services research community has traditionally excelled – assisting health system partners in identifying, scoping and understanding the nature of health service delivery issues and, at the same time, identifying and synthesizing the evidence base of potential solutions. At the second node, design, researchers assist health system partners to apply key lessons and then, cognizant of contextual realities, assist them to innovate, redesign and modify delivery system or financing mechanisms. Since improving patient experience is a core value, researchers also have a role in applying the emerging evidence in patient engagement methods (Absolom et al. 2015; Shippee et al. 2015) and human factors engineering (Wu et al. 2015). Not only do solutions need to be practical but they also must be cognizant of system capabilities, timelines, externalities and culture.

At the third node, implementation, researchers draw on methods from the emerging fields of implementation (Damschroder et al. 2009; Greenhalgh et al. 2004), complexity (Chandler et al. 2016) and improvement science (Berwick 2008) to assist health system partners successfully execute, iterate, spread and sustain changes in care delivery, finance and policy. Researchers play a particularly important role at the fourth node, evaluation. Strong evaluation designs are required that can be seamlessly inserted into regular care settings, use the data collected as part of regular operations and produce preliminary and final results on timelines needed for decision-making. Researchers are challenged to use realistic evaluation designs (Pawson and Tilley 1997) and exploit naturally occurring heterogeneities in populations and design fidelity. Evaluations also need to accommodate and enable iterative learning and continual improvement represented at the fifth node, adjustment. At the final node, dissemination, researchers partner with health system colleagues to share learnings with other organizations and systems. While there are many activities currently occurring in Canada at each of these nodes, the promise of sustained partnerships between researchers and health across these nodes has yet to be realized.

What Will the Next Generation of Researchers Need in Learning Health Systems?

New skills and approaches

Tamblyn et al. (2016) correctly point out that research embedded in the complexities of everyday care and decision-making requires new methods and approaches. Not only do researchers need advanced skills in areas such as realist evaluation and change management, they also need solid familiarity with other disciplines and approaches, including information science, leadership and management, industrial

engineering and human-centered design. To embrace the possibilities of big data, researchers also need more training in inductive reasoning and pattern recognition (Krumholz 2014). In addition to new science skills, researchers must also perfect other "softer" skills, including leadership and communication abilities, so that they can effectively partner with personnel ranging from frontline clinicians to mid-level managers, to senior healthcare executives (Selby and Slutsky 2014). Appreciation for the roles that others play in a learning enterprise is essential. These players include quality improvement experts, health informatics specialists, business intelligence analysts and strategic planners. To address these new training needs and skills development, some high-performing health systems have created embedded post-doctoral positions with structured and experiential learning opportunities (Academy Health 2016).

... researchers must also perfect other "softer" skills, including leadership and communication abilities ...

Partnered environments

To be most effective in learning health systems, researchers must be fully integrated into their internal environments where health problems are articulated, priorities and plans set, new initiatives developed and launched, and resultant changes managed. As organizational leaders set learning priorities, they need to deliberately partner researchers with internal teams focused on strategic planning, finance, healthcare operations, quality improvement, HIT, business intelligence and patient engagement (Psek at al. 2015). Development of both partners is needed: researchers need intimate familiarity with decision-making processes, organizational requirements and culture; and health systems

need to adjust their work streams to effectively accommodate research. Linking researchers with external partners is also key, including patient groups, community organizations, academic institutions and other health systems. External partnerships have many benefits, including raising funds, promoting cross-institutional collaborations and providing dissemination portals for learning.

... privacy concerns and data use limitations are heightened and challenges magnified.

Big data and advanced analytics

Canadians have been historical world leaders in the development and access to large, population-based data repositories for use in health services and population health research (Chamberlayne et al. 1998; ICES 2016; Manitoba Centre for Health Policy 2016), but others are catching up (Dartmouth Institute 2013; McGlynn et al. 2014; Wallace et al. 2014). These investments provide the foundation for the big data needs of a learning health system, but more investments are needed. To fully realize learning opportunities, the big data need to be bigger with the addition of electronic clinical data (e.g., blood pressure readings and clinical notes), health service operations and financial data (e.g., workflows, staffing patterns, labour costs and web hits), information from other relevant sectors and programs (e.g., physical activity programs) and patient-reported data on outcomes and experiences. Not only do these data resources need to be hierarchically arranged but they also need to be easily aggregated at the appropriate learning unit, such as the operating room, physician's office or health region. The data also must be made available to researchers in time frames required for iterative learning and

organizational decision-making. Collaborators with expertise in big data analytics are required, including experts in data science, machine learning and data mining (National Research Council 2013). Not only are the big data resources relevant to the IHSPR community but they also have broad applicability to clinical effectiveness (McGlynn et al. 2014; Rosenthal 2014) and population health research (Bernstein et al. 2015).

Ethical frameworks and privacy protection

Because the concept of the learning health system deliberately blurs the boundaries between clinical practice, quality improvement, research and innovation, tensions are created to the extent of ethical oversight of research and governance structures. Since the release of the IOM report, healthcare ethicists have begun to challenge traditional divisions between research, quality improvement and clinical practice as no longer tenable. They have proposed new ethical principles that value continuous learning as a moral obligation (Faden et al. 2011, 2013). Likewise, with the prospect of even bigger data, privacy concerns and data use limitations are heightened and challenges magnified. Privacy concerns aside, many cultural barriers continue to exist in using everyday clinical and operations data to serve the public good through research (Larson 2013). Without deliberately addressing these issues, progress on creating a learning health system is sure to be slow.

Integrated funding streams and reward systems

Research funding bodies in Canada, including CIHR, have been at the forefront of developing novel ways to support researchers consistent with health system learning needs, such as adding requirements to integrate decision-makers, end-users and patients. However,

more refinements are now needed to make review times faster and more flexible, prioritize learning needs of health system partners at various levels and support young and midcareer professionals in learning new skills. In the new world of health system learning, it is reasonable to expect that health organizations themselves will directly invest research monies when research brings them near-term value in organizational efficiency, patient experience, quality of care or population health. For researchers to succeed in this learning environment, reward systems for researchers must also be rethought. Tenure-track career ladders need to change from valuing not only peer-review publications, grants and teaching but also contributions to rapid-pace learning, non-traditional dissemination activities and, importantly, demonstrable improvements in health and health systems.

It is encouraging to see that Canadian health research funders, particularly IHSPR, are willing to invest time and money into promoting the concept of the learning health system. To achieve this goal, however, health system leaders must also share the same vision and do their part in creating sustained partnership opportunities, infrastructures and funding streams. In the end, adopting a common learning culture is likely to be the most formidable challenge.

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Digital Drivers in a Learning Health System: Considerations for Research Innovation



COMMENTARY

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ABSTRACT

Research innovation has the potential to speed progress towards seamless services, empowered patients, and safer care, including by guiding and bolstering new directions in digital health. Coordinated approaches to gain consensus on strategic directions and priorities would help to maximize the value of research innovation investments and minimize the risk of overlaps and gaps. Deep and active stakeholder engagement can facilitate co-creation and accelerate use of digital health to improve care, not just at the time of initial implementation but also on an ongoing basis. Likewise, we need research and innovation related to complementary policy, practice, and other enablers of progress, not only the technology itself. There are also opportunities to adapt the research enterprise so as to more effectively generate and apply knowledge related to fast-paced and complex interventions.

Ensuring that Canada's health system works effectively for every Canadian and is sustainable for future generations means persistently improving the patient experience, stepping up access to care, raising quality, driving out inefficiencies and waste and focusing on

social determinants of health. This may mean abandoning some status quo positions and making difficult choices. Continual innovation is needed. Progress depends on nurturing conditions for change, then scaling and spreading promising approaches.

There is no single silver bullet solution, but the most promising ideas have the potential to simultaneously rein in costs while improving access, quality and patient experience. In the lead article of this issue of *Healthcare Papers*, Tamblyn et al. (2016) suggest that key elements required for health system transformation include "financing and funding approaches that will either drive or create barriers to innovation, the creation of

a new breed of scientists that can collaborate with health system stakeholders and the co-creation and use of eHealth technologies that can improve the quality and efficiency of care."

This article focuses on the latter. It explores four key considerations that influence how and how well we can foster and leverage research innovation to enable progress toward better health and healthcare using digital solutions.

Digital Health: Where We Are Today

Hospitals were among the first organizations in Canada to implement internal health information systems, although only a minority initially included electronic patient records (Jha et al. 2008). Physician offices began to automate in the 1990s – in most cases, initially to support electronic billing and administrative functions, with some also using electronic medical records instead of paper charts. Meeting administrative and operational needs at the point of care was also one of the drivers for the early introduction of health information technology into pharmacies.

In 2001, Canada's First Ministers recognized the need to invest in electronic health record systems to drive clinical value and leverage the power of information to improve health and health-care. The intent was not to develop a single massive structure but rather to connect a "network of networks," building on a number of initiatives that were already in place or under development.

Since then, use of digital health has grown tremendously. Digitization of lab test results, medications and other core elements of the shared electronic health record was 91% complete as of 2015 (Canada Health Infoway 2015). Likewise, three in four family physicians now use electronic medical records, a rate that has tripled since 2006 (Osborn et al. 2015), and use of telehealth for clinician-patient consultations has grown by more than 180% since 2010. International comparative studies show that Canada leads globally in use of telehealth and electronic sharing of information, such as diagnostic imaging. However, in spite of recent growth, we are not at the top of international league tables in the use of point-of-care solutions in primary care or patient online solutions (OECD 2015).

Independent studies estimate that investments in digital imaging, drug information systems, telehealth and electronic medical records have led to access, productivity and quality benefits valued at \$13 billion since 2007 (Canada Health Infoway 2015). These types of results led provincial/territorial ministers of health to declare electronic health records to be "one of the most transformational innovations in healthcare in a generation" (Canadian Intergovernmental Conference Secretariat 2014).

While much has been accomplished, adoption gaps remain at some points of care, there is uneven connectedness to shared information and the maturity of solutions and their use varies across the country. Much more remains to be done to fully harness the potential. Progress has been – and will be – woven by cultural, political, structural and policy stepping stones, as much as by new technologies themselves. Research innovation has the potential to be most effective when it is embedded in and responsive to this complex environment.

Coordinated Approach to Identify and Address New and Important Questions

In their article, Tamblyn et al. (2016) suggest that for health services and policy research to drive system transformation, "we will need to create alignment and synergy among health services research funders, researchers and endusers." This is definitely the case for digital health. Alignment among the types of organizations captured in the lead article's scan of research funders is clearly important, just as the Advisory Panel on Healthcare Innovation (2015) called for a "whole-of-government" approach to accelerate value from innovation.

In addition, there are wider opportunities to seek and promote alignment, including engaging patient/citizen and clinical organizations, healthcare providers, non-governmental organizations, private sector companies and industry associations, economic development agencies and more. Many of these stakeholders are also making significant investments in digital health research, development and innovation. For example, more than two in five of Canada's domestic health information communications and technology companies predict that their research and development investments will increase over the next three years, while a further 35% expect no change and 21% are unsure (Information and Communications Technology Council 2015).

While this environment is complex, experience shows that consensus on strategic directions and priorities can be achieved. For example, a process of engaging stakeholders around key benefits and evaluation priorities for digital health, with the guidance of an advisory panel, led to the creation of a Benefits Evaluation Framework (Lau et al. 2007) and supporting indicator sets. These resources, and subsequent updates and extensions, have guided evaluation of many digital health investments in Canada since 2006, enabling easier synthesis of findings and collective learning.

Listen, Learn and Adapt: Co-Creation and Use of Digital Technologies to Improve Care

Deep and active engagement is also needed within specific digital health initiatives. Highly usable, readily adoptable solutions that integrate well with workflow are more likely with strong co-design and iterative approaches (Pan-Canadian Change Management Network 2013). This principle is applicable whether end-users are clinicians or patients/ citizens. For instance, the primacy of the public interest and strong user engagement was built into Nova Scotia's trial of personal health records and patient online services. Adoption was strong and participants report that the digital solutions empowered them to play a more active role in managing their own health (Stylus Consulting 2014).

Thus, research and innovation efforts must address how best to engage end-users in system design and deployment, how to optimize the use of digital solutions in different contexts and how to scale and spread those that are most promising. There are rich opportunities to leverage and learn from natural experiments based on experiences from across the country and around the world.

These opportunities also extend well beyond initial development and implementation. A number of studies from Canada and elsewhere have documented rising benefits as use of digital health matures (e.g., Leung et al. 2013; PwC 2013). This may occur for a variety of reasons, including clinicians gaining experience with the use of the solutions, changing workflows or new applications of existing solutions/new analytics on existing data that add further value. As a result, there is also strong utility in research and innovation that identifies potential additional sources of value or how to shorten the time and effort to achieve greater value.

Research Innovation and Enablers of Change Beyond Technology

The uptake and use of digital health solutions mirrors the progress of other large-scale changes in the health system. To harness the transformative potential as vigorously in practice as in theory, a solid understanding of facilitators and barriers to progress is required. For example, new clinical workflows, processes and practices may be needed; healthcare providers and their clients/patients may interact in new ways; policy and regulatory changes may be required; and cultural shifts may prompt improved results. This, too, is an area where innovative research can deliver value.

Tamblyn et al. (2016) note that Canada's main research funders have not invested large sums in research on change management and scaling up innovation in recent years, but others have addressed this area. As a result, key dimensions important for transformation – governance and leadership, communications, training and education, workflow analysis and integration, stakeholder engagement and monitoring and evaluation – are well documented (Pan-Canadian Change Management Network 2013). Nevertheless, further research and innovative approaches to these and other broader enablers of change promise to complement a focus on the technologies themselves.

... innovation will be required to harness the possibilities in a timely, privacy-sensitive way.

From Research Innovation to Innovating and Adapting the Research Enterprise

Just as digital health is transforming the health sector, so too is it creating new possibilities for research and innovation. Perhaps the most obvious way that this is occurring is in the growing range of data available. In a digital world, there is more data than ever before, from streams of data generated by continuous monitoring and wearable technology to possibilities for population-wide disease surveillance from analysis of social data.

This offers rich potential for research innovation that improves health and health-care, but innovation will be required to harness the possibilities in a timely, privacy-sensitive way. Currently, access to health-related data, their use and the capacity to generate and apply knowledge from them is uneven across Canada and around the world (Expert Panel on Timely Access to Health and Social Data for Health Research and Health System Innovation 2015). Addressing current gaps and issues offers opportunities to accelerate progress.

In addition, the opportunities that digital health offers go beyond knowledge generation. For instance, the potential for narrowing the gap between what we know and what we do is significant. There is growing evidence that clinical decision support can improve outcomes, but there is still much to learn about its effective design and deployment (Bright et al. 2012). Likewise, with smarter electronic systems, studies show that primary care clinics can identify patients who may benefit from proactive outreach for preventive or follow-up care, such as screening for diabetes complications or cancer, 30 times faster than clinics with paper records (Leaver et al. 2013).

In order to fully realize these types of transformative opportunities, the research enterprise will also need to adapt. As Tamblyn et al. (2016) point out, new methods for rapid scientific investigation that use point-of-care patient experience, digital health and social data are needed. For example, Lau et al. (2013) argue that electronic medical records should be evaluated as complex interventions. Likewise,

the challenges of navigating ideas through testing to widespread adoption and diffusion have been well documented (Advisory Panel on Healthcare Innovation 2015; Ontario Health Innovation Council 2014). Other examples include:

- Adapting research funding mechanisms to better support rapid innovation cycles, the need for broad engagement, opportunities for embedding knowledge into practice and the possibility of quickly scaling successful innovations;
- Exploring new approaches to research publication and knowledge synthesis that better respond to the importance of sharing and incorporating the latest evidence in rapidly developing fields; and
- Capacity building, not just within the research enterprise but also among endusers, policymakers, research ethics boards, research and innovation funders, technology developers and others who play important roles in the process.

Research innovation has the potential to guide and bolster bold new directions ...

Conclusion

Modern healthcare relies on teams, from the patient and family to an increasingly complex mix of healthcare providers. Effective communication among these teams is essential, but in a 'system' that has historically operated in silos, information sharing, even among the immediate circle of care, isn't assured (Osborn et al. 2015).

Seamless services, empowered patients and smarter care are among the potential benefits that effective use of digital health can deliver, accelerating the transformation of healthcare. Research innovation has the potential to guide and bolster bold new directions with a focus on patients, access to care, quality and value for money. Opportunities to accelerate progress include:

- Coordinated approaches to gain consensus on strategic directions and priorities so as to maximize the value of investments in research innovation and minimize the risk of overlaps and gaps;
- Deep and active stakeholder engagement to facilitate co-creation and use of digital health to improve care, not just at the time of initial implementation but also on an ongoing basis to identify potential additional sources of value or how to shorten the time and effort required to achieve greater value;
- A focus on research and innovation related to complementary policy, practice and other enablers of progress, not just the technology per se; and
- Adapting the research enterprise including, but not limited to, capacity building, funding, methods, knowledge exchange and approaches to scale and spread of innovation in order to effectively generate and apply knowledge related to dynamic, fast-paced and complex interventions with the potential to enable health system transformation.

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Community-Engaged Scholarship to Catalyze Innovation: A Case Study of the Uptake of Metered-Dose Inhalers with Spacers to Deliver Respiratory Medication in a Pediatric Emergency Department in Nova Scotia



COMMENTARY

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ABSTRACT

This commentary, in response to Tamblyn et al. (2016), provides a case study of the uptake of metered-dose inhalers with spacers to deliver respiratory medication in a pediatric emergency department in Nova Scotia. Our objective was to demonstrate the opportunities and challenges in engaging researchers and their trainees in planning and evaluating a clinical practice change to improve drug therapy. We document the use of community engaged scholarship (including experiential learning) to increase the capacity and capability of researchers in academia and healthcare organizations, healthcare providers, and managers. We note lessons learned from Dalhousie University's Drug Use Management and Policy Residency and four individual research projects conducted between 2006–2016.

Introduction

The optimal use of pharmaceuticals is a key component of a safe, effective and sustainable healthcare system, yet prescribing, medication management and pharmaceutical policy often lag in implementing recommendations from scientific evidence. Tamblyn et al. (2016) note the high level of healthcare spending in Canada compared with other Organisation for Economic Co-Operation and Development (OECD) countries. Canada spends US\$761 per capita on pharmaceuticals. This is higher than the OECD reported average (2015) of \$527 USD per capita, and ranks 29th of 30 countries. The Canadian Institute for Health Information (CIHI) reports (2015) that 15.7% of healthcare spending is directed toward pharmaceuticals (\$959 CAD per capita). Canada, without a comprehensive national pharmaceutical strategy with quality indicators, has identified and unidentified performance gaps in prescribing and pharmaceutical use in areas such as access, safety, quality and value for money.

Tamblyn et al. (2016) note the need for conducting and learning from natural experiments in health service delivery in Canada. Various approaches are being implemented by Canadian public and private sector organizations to improve prescribing and medication use focusing on the patient, provider, organization and/or system levels; however, these

are often implemented for a specific patient population or jurisdiction with limited spread across the country (Sketris et al. 2009).

This paper presents a case example, a series of studies around the uptake of metered-dose inhalers with spacers (MDIs) for respiratory medication delivery in a pediatric emergency department (PED) in Nova Scotia. Throughout this case, we sought to increase capability and capacity of health services researchers, and innovation in the healthcare system using community-engaged scholarship including experiential learning. Our approach paired scientists in academia with policy, clinical, managerial and research leaders in the health system to co-produce research.

The case highlights two strategic directions identified by the Canadian Health Services and Policy Research Alliance: (1) accelerating the creation of a cadre of scientists working in a learning health system and (2) measuring research impact (CIHR Institute of Health Services and Policy Research 2014). The case also highlights two themes that have received limited health services research funding, identified by the Alliance's 2007–2012 scan of 27 federal and provincial health research funding agencies and health charities: managing for quality and safety (receiving 11.9% of total health services research funding) and change management (receiving only 0.3%) (Tamblyn et al. 2016).

DUMPR and DEANS

In 1999, the Canadian Health Services Research Foundation (CHSRF) in partnership with the Canadian Institutes of Health Research (CIHR) launched the Capacity for Applied and Developmental Research and Evaluation in Health Services and Nursing (CADRE program) with \$6.5 million in annual funding (Grudniewicz et al. 2014; Potvin and Armstrong 2013; Tamblyn et al. 2016). Under this program, Ingrid Sketris received a Chair, which allowed her to form partnerships to conduct pharmaceutical policy research in Nova Scotia. This Chair used community-engaged scholarship and operated in Mode 2 research (co-production of research with relevant provincial government departments and healthcare organizations). One component was the Dalhousie Drug Use Management and Policy Residency (DUMPR), an experiential learning approach that embedded trainees (38 in total) with the support of their academic advisors in organizations to conduct research of relevance to their decision-making preceptors (Conrad et al. 2005, 2013).

Some of the key components of community-engaged scholarship and the experiential learning program used in the case are noted below. While they are presented linearly, academics and healthcare decision-makers interacted frequently with multiple planning iterations and processes that may or may not have occurred concurrently.

Establishing Key Partnerships

DUMPR leveraged the Drug Evaluation Alliance of Nova Scotia (DEANS), which was established in 1998 by the Nova Scotia government to provide a secretariat for and funding of pharmaceutical prescribing and use improvement interventions. DEANS identifies and prioritizes critical drug therapy issues, analyzes scientific evidence and connects

with local clinical expertise to understand and improve drug therapy. Along with partners, DEANS develops, implements and evaluates interventions to increase the uptake of evidence-informed practices and policies (Sketris et al. 2006).

Lessons learned and future considerations

Many trainees' research topics originated from issues identified by DEANS. As trainees presented research results to DEANS, they received feedback from a broad group of practitioners and policy makers, advice on research dissemination channels and suggestions for future research. More formal and long-term approaches to developing research priorities could be developed, taking into account the priorities of both the academic and decision-maker organization.

DEANS identifies and prioritizes critical drug therapy issues ...

Utilizing the Academic Health Sciences Network

Our case example was set at the IWK Health Centre, which has a memorandum of understanding with Dalhousie University for student placements and a mission of patient care, education and research (Brimacombe et al. 2010). Tamblyn et al. (2016) discuss the need for research in geriatrics. However, our case addresses children who are similarly vulnerable because randomized controlled trial (RCT) evidence can be limited (Council of Canadian Academies 2014).

Lessons learned and future considerations

The IWK Health Centre and Dalhousie University partnership facilitated experiential education to allow trainees and their academic advisors, especially those without clinical backgrounds, to conduct or participate in research in healthcare settings. Canada's Strategy for Patient-Oriented Research (SPOR) may involve rural, primary and continuing care organizations, and these partnerships could be expanded to improve drug use outside academic settings. Further ties (both formal and informal), and mechanisms to integrate research strategies of the health system and academia could be developed, such as those in the UK's academic health sciences centres' networks, and Collaborations for Leadership in Applied Health Research and Care (CLAHRC) and other partnerships (Graham and Tetroe 2009; Rycroft-Malone et al. 2011; Sibbald et al. 2014; Soper et al. 2015; Spyridonidis et al. 2015).

Identifying the Drug Policy Issue for Intervention

With over 15,000 marketed drug products and many gaps in optimal prescribing, the research teams identified priorities (Sketris et al. 2009). The initiative to increase the uptake of MDIs in the delivery of respiratory medications for children who wheeze was noted as a priority by the clinical leadership at the IWK PED. One of the members of our clinical leadership, Dr. Douglas Sinclair (then Chief of Emergency Medicine), had been part of the earlier DEANS initiative to increase the uptake of MDIs in adults and was able to build on this experience. For adults, DEANS developed and evaluated educational, drug reimbursement policy and financial incentives to hasten the uptake of MDIs (Bowles et al. 2007; Kephart et al. 2005; Lowe et al. 2008; Murphy et al. 2005). The evaluations noted that the interventions resulted in a three-fold decrease in respiratory medication delivered by nebulization and approximately \$1 million in annual drug cost savings to the Nova Scotia Seniors' Pharmacare Program (Kephart et al. 2005; Sketris et al. 2006). This approach had not yet been taken up in pediatric patients.

Lessons learned and future considerations

Experience in adults related to increasing the uptake of MDIs could be adapted for children. In the future, gaps in optimal prescribing identified by other organizations (e.g., National Prescription Drug Utilization Information System) and pan-Canadian approaches to improve drug therapy (e.g., Canadian Agency for Drugs and Technologies in Health, Choosing Wisely Canada) could be better leveraged to improve drug use in Nova Scotia.

Assembling a Research Team

Conducting research often requires multiand transdisciplinary teams and collaboration across academic and healthcare organization boundaries (Denis et al. 2003; National Research Council (NRC) 2015). We had access to and employed the skills of 14 researchers with diverse backgrounds (Table 1). The team had multilevel learners: one Masters student in health informatics and one in library and information sciences, one PhD student in economics and one medical student. While we worked with our DUMPR trainees, the IWK Emergency Department hosts about 150 medical students per year and many medical residents and students of other health professions who may have also been exposed to the intervention.

Four pediatric respiratory medication research projects were conducted from 2006 to 2016 (Table 2). Healthcare practitioners were interested in improving quality quickly to enhance safe and effective care. Researchers were also interested in applying theories and rigorous methods to produce generalizable knowledge (Bauer et al. 2015). The team established common objectives, invested time to build trust, and negotiated approaches, timelines, priorities and financial and human resources to improve healthcare quality and advance science.

Table 1. Skillsets for multi- and transdisciplinary team involved in research on intervention to increase uptake of salbutamol metered-dose inhalers (MDIs) and spacers for a pediatric emergency department

Skillset	Team member
Emergency medicine, clinical leadership	Ducharme, J.
Psychology, organizational behaviour, statistics	Duffy, J.
Pharmacy, library and information science	Hill-Taylor, B.
Emergency medicine, health informatics	Hurley K,.
Statistics, including time-series analysis	O'Connell, C.
Qualitative research, learning theory	Sargeant, J.
Emergency medicine, clinical leadership	Sinclair, D.
Pharmacy, health services research	Sketris, I.
Pharmacy, Pharmacy Information Management Systems	Smith, J.
Health Economics	Spin, P.
Health Informatics, Statistics	Stewart, S.
Health Economics	Ward, C.
Medical Student Researcher	Wing, A.
Health Economics	Xu, K.

Table 2. Timeline for experiential learning related to intervention to increase uptake of salbutamol metered-dose inhalers (MDI) and holding chambers for a pediatric emergency department

Event	Year
Hurley begins Drug Use Management and Policy Residency Program and studies barriers to intervention	2006
Intervention begins at the emergency department of IWK Health Centre	2006
Hurley et al. publish information on barriers identified using focus groups and interviews	2008
Hill-Taylor begins Drug Use Management and Policy Residency Program and evaluates the uptake of salbutamol MDI and holding chambers as a result of intervention	2010
Wing begins Osman Medical Student Summer Research Studentship and examines quality of salbutamol dispensing data using automated dispensing machine	2010
Spin begins studentship and conducts economic analysis of the conversion from salbutamol nebulization to MDI and holding chambers	2011
Wing et al. document the discrepancies between paper and electronic records from automated dispensing machine	2012
Hill-Taylor et al. document rapid uptake of MDI and holding chamber	2013
Spin et al. document an estimated \$270,000 CDN per annum cost savings as a result of the intervention	2016

Lessons learned and future considerations

The teams' methods of operation were facilitated by the DUMRP, which defined roles and responsibilities for trainees, preceptors

and faculty advisors, and provided trainees with frequent in-person and electronic communication and an ongoing support network; however, team science has developed and provides further research and training guidance (Conrad et al. 2005, 2013; Forrest et al. 2009; Morgan et al. 2010; National Research Council 2015). Patients, families and voluntary health organizations had limited involvement in the research process and this could be strengthened.

... researchers need to understand the context in which to apply evidence and conduct research ...

Identifying Evidence Sources and the Gap between Evidence and Practice

Multiple sources of evidence were gathered and critiqued: scientific literature, an environmental scan of PEDs (Osmond et al. 2007; Scott et al. 2009) and a site visit to the Saint John Regional Hospital, New Brunswick, where the switch to MDIs had already been adopted, and where Dr. Katrina Hurley, who was a DUMPR trainee, had trained as a resident. As early as 1984, there was evidence that MDIs were at least equivalent to nebulization in children with acute asthma (Freelander and Van Asperen 1984). By 1997, there were recommendations that MDIs be considered the preferred mode of treatment in children with acute exacerbations of asthma and over the next years evidence was strengthened as multiple trials, syntheses and guideline recommendations were published. (Appendix 1 [available at: http://www.longwoods.com/content/24726] contains a record of publications related to the use of MDIs versus nebulization in children with acute wheezy illnesses. This literature search was conducted by another DUMPR trainee, Barbara Hill Taylor.) Following this literature scan, investigators appraised and synthesized relevant articles for specific presentations. By 2006, when the intervention was being planned, evidence showed that the two treatment methods could no longer be considered equivalent for most pediatric

asthma emergency cases. There was established evidence that MDIs offered clinical and societal benefits, with potential for a better comfort and safety profile (Hill-Taylor et al. 2013).

Lessons learned and future considerations

Multiple evidence sources needed to be acquired, synthesized and exploited to plan the intervention and research (Zahra and George 2002), and teams were needed as the task would be daunting for a single clinician (Greenhalgh et al. 2014). This speaks to the ongoing need for communities of practice comprising healthcare practitioners and researchers to collaboratively identify and address gaps between evidence and practice.

Understanding the Context

Health services researchers need to understand the context in which to apply evidence and conduct research and then determine which aspects will facilitate or hinder their quality improvement and research efforts (Bowen and Graham 2015; Greenhalgh and Fahy 2015; Jackson and Greenhalgh 2015; Sargeant et al. 2008; Squires et al. 2015). There are various definitions of context, for example, from Tuen van Dijk, the "situational, historical, geographical, social or cultural environment of a phenomenon being studied" (Bate 2014: 4).

Our teams included embedded clinician researchers, who practiced in and understood the changing context, and could develop tailored interventions and adapt these over time.

One team examined perceptions surrounding the use of MDIs for delivering respiratory medications in the PED, using focus groups and interviews. Four main themes that needed to be addressed prior to implementing the intervention were identified: workload, misconceptions related to cost, need for education, and clarity related to professional roles (Hurley et al. 2008).

The team also needed to understand the decision-making structures, operational processes (e.g., role of the Quality and Operations Committee), clinical and policy levers and resources available to support the intervention. They needed to determine sources of local support and/or resistance for the intervention as well (Bate 2014).

Lessons learned and future considerations

Our teams learned the difficulties of working in the real world context. We echo Donald Berwick and Paul Bate who note "the punishing contextual terrain," which "so clearly labels the facts on the ground for ambitious even courageous clinicians, managers, executives and others in healthcare who seek to make care far better" (Bate 2014: 12).

Future work needs to use emerging frameworks and theories in understanding context and provide greater community supports for embedded researchers (Bate 2014; Damshroder et al. 2009).

The embedded researchers were able to develop a practical intervention...

Development of the Intervention

The intervention was developed by identifying the scientific evidence and leading practices as well as understanding the local context through qualitative interviews and informal consultations with clinicians and managers (Hurley et al. 2008). The embedded researchers were able to develop a practical intervention, which recognized the clinicians' strong internal motivations to improve care, and provided them with their own quantitative data, myths uncovered during qualitative research and opportunities to share experiences. It used clinical managers to leverage authority and provided

numerous opportunities to refine the intervention (Pannick et al. 2015; Wieringa and Greenhalgh 2015).

The intervention included the development of an asthma care map (with MDIs as one component) and educational sessions with healthcare providers and patients. The implementation of the care map took over two years – discussions began in 2006. The map was introduced as a pilot in January 2008 and became standard practice in July 2009. Piloting the intervention was key and recommended by the clinical leader, Douglas Sinclair. The intervention also included public service announcements to request that parents bring in their child's holding chamber when seeking emergency care.

The intervention adhered to the characteristics of simplicity, trialability, observability, reinvention and risk minimization (Ganz et al. 2009), and the team understood that changing clinician mindlines required the incorporation of both scientific knowledge and an understanding of factors that influence practice and decisions to change practice such as leadership, relationships, and personal and group beliefs.

Lessons learned and future considerations

The strong preparation related to understanding the context and assembling multiple sources of evidence as well as involvement of clinicians and managers helped make the intervention successful. We used grounded theory, knowledge translation principles and some aspects of learning theories (Graham et al. 2006; Hurley et al. 2008). Newer theories, models and approaches have much to offer in developing and implementing interventions (Bate 2014; Damschroder et al. 2009; Helfrich et al. 2010; Jagosh et al. 2012, 2015; Riley et al. 2015; Rycroft-Malone et al. 2013; Soper et al. 2015; Swanson et al. 2012; Waltz et al. 2015). Mechanisms need to be put in place for continued learning and adaptation of care maps as evidence and guidelines change over time (Fleiszer et al. 2016; Kastner et al. 2015).

For our intervention, the information technology infrastructure could not be harnessed to provide electronic clinical decision support tools and continues to remain a challenge, making it an avenue for further work.

These interventions were developed within a single institution and knowledge translation opportunities across the province have not been fully exploited; however, care maps are faxed on request to other institutions and Translating Emergency Knowledge for Kids (TREKK) is used as a national knowledge sharing network. Other jurisdictions employ national networks (e.g., Quality Enhancement Research Initiative (QUERI and NPS MedicineWise) to develop and share interventions for large systems with the potential for increased efficiency and effectiveness (Graham and Tetroe 2009).

Developing the Evaluation

There were three evaluation components. Hill-Taylor et al. (2013) examined PED inventory data for salbutamol inhalation formulations and received patient data from decision support services. They found a 1,215% (95% CI 1032 to 1396, p less than 0.001) increase in the proportion of salbutamol delivered as MDIs following the intervention.

To understand medication dispensing data quality, Wing et al. (2012) explored the agreement between salbutamol administration records abstracted from the paper-based emergency department charts and electronic records generated by an automated dispensing device. While they noted substantial agreement (kappa 0.71), there were still many discrepancies to address.

Spin et al. created a model for evaluating the cost-effectiveness of both salbutamol inhalation methods (MDIs vs nebulization) using local IWK Health Centre patient chart review and inventory data, Nova Scotia

wages and salaries, and Canadian data from the National Ambulatory Care Reporting system, the Canadian Institutes of Health Information Discharge Abstract Database and Patient Cost estimator, and Statistics Canada (consumer price index) for patient costs, length-of-stay in the PED and hospital (if admitted) and the probability of admission combined with a time and motion study from the UK. (Spin et al. in press) They confirmed that use of MDIs was associated with a lower average patient cost.

Lessons learned and future considerations

Each study contributed not only to the overall evaluation of this intervention but also to the building of datasets and methods for future intervention evaluations. Other aspects that could have been evaluated include documentary evidence related to the implementation process and fidelity, resources and costs used in the development of the intervention, qualitative approaches to determine clinician satisfaction with the intervention and remaining barriers and patient perspectives.

In future projects, we could better use theory-based evaluation, evaluate contribution of the research process to the outcome and determine endurance and adaptations of the innovation (Bate 2014; Fleiszer et al. 2016; Soper et al. 2015).

Incentives and Disincentives for Community-Engaged Scholarship and Experiential Learning

Tamblyn et al. (2016) note the need for incentive systems for health system innovation and the need to align incentives to further the engagement of practitioners in the innovation process. Our case provided value to the healthcare system by facilitating, documenting and evaluating the switch to a more cost-effective approach to deliver drug therapy in pediatric patients who wheeze.

It was facilitated by a studentship award to Katrina Hurley and others and a chair award to Ingrid Sketris. Physician compensation models, which include not only clinical care but also quality improvement and research, may assist in their involvement in community-engaged scholarship to improve healthcare system performance, but accountability frameworks and performance measurement systems may be difficult to establish as these new payment models emerge (Damschroder et al. 2014; Hanney and Gonzalez-Block 2014; Soper et al. 2015; Wilsdon et al. 2015). Clinician scientists need time for practice reorganization, quality improvement activities and/or research and incentives to move up the clinical scientist or managerial ladder and to continue to engage in communityengaged scholarship (Belkhodja 2014; Harvey et al. 2015).

Our teams produced five papers, received best oral presentation awards at local departmental and faculty-wide research days, and a poster award at the 2015 CAPHC (Canadian Association of Paediatric Health Centres) national conference. We also presented our research over 20 times to various decisionmaking audiences, locally and nationally. These awards, presentations and publications can be used by academics in their submissions for tenure and promotion files, and salary and operational grant competitions. Our teams conducted evaluations consistent with the human and financial resources available, but did not comprehensively examine research impact (Bauer et al. 2015; Panel on Return on Investment in Health Research 2009; Soper et al. 2015).

... accountability frameworks and performance measurement systems may be difficult to establish ...

Conclusion

This case, which examined an intervention and its evaluation between 2006 and 2016, has been used to illustrate how community-engaged scholarship including experiential learning can catalyze the improvement of healthcare, specifically in the improved delivery of medication for children with acute exacerbations of asthma in a PED, and can decrease overall healthcare costs.

Creating and maintaining a collaborative learning system and trusting partnerships across academic and health services delivery organizations, and engaging embedded health service researchers, were key to the success of our intervention. A vision, strategy and process could be developed to expand relationships to other patient populations and across other healthcare and social care organizations. The result of these productive relationships between academia and the health system can lead to increased health services researcher capacity and ongoing rigorous and relevant research and knowledge translation so needed in meeting the challenges of healthcare transformation, as outlined by Tamblyn et al. in their paper.

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Modernizing our Doctoral and Postdoctoral Training Programs: Bold New Initiatives



COMMENTARY

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ABSTRACT

As Robyn Tamblyn and her colleagues (2016) note in this issue, the Institute of Health Services and Policy Research (IHSPR) of CIHR has identified one of its key strategic goals for the 2015–2019 period as "the creation of learning health systems and the next generation of researchers with the skills to partner in health system learning and transformation." As part of its effort to realize that goal, the Institute led the creation of a multi-sectoral "alliance" of organizations concerned with health systems and policy research (HSPR) and that Alliance spawned a "Working Group on Training Modernization" whose role was to examine the ways in which our current models of doctoral training in HSPR need to be enhanced and updated to meet the Institute's strategic goal. As co-chair (alongside Dr. Adalsteinn Brown of the University of Toronto), I am submitting this commentary to inform the readers of this journal about the activities, outputs and plans of that Working Group. I will focus on the report we submitted to the Alliance on December 7, 2015, and on the steps that have followed in moving forward on our recommendations (located at http://ihpme. utoronto.ca/wp-content/uploads/2014/12/CHSPR-Alliance_Final_Dec7.pdf).

FIRST, A BRIEF outline of the process that generated our report and subsequent actions. The Working Group was constituted by Dr. Tamblyn in consultation with the Executive of the Alliance. The membership was a mix of academics, leaders of national and provincial health research funding organizations, graduate students, representatives of health systems organizations and leaders of major national health charities. A list of the members is provided as an appendix to our report. Institute of Health Services and Policy Research (IHSPR) staff kick-started the Working Group's deliberations with a white paper synthesizing the available literature on the challenges facing doctoral education in Canada and across the world, as well as efforts to respond to those challenges. The Working Group then used a combination of telephone consultations with its individual members and key informants, conference call meetings and one face-to-face meeting to draft, revise and finalize our 19-page report.

... most of Canada's HSPR doctoral programs have not yet done very much to modernize their contents or their approaches ...

Our report started with a consensus on a set of findings about the conditions affecting Canadian doctoral training and trainees in general and in health systems and policy research (HSPR) in particular. Our literature review and consultations found that the environment for training and trainees has been changing rapidly in recent decades. The number of regular, tenure-track academic positions in Canada and in the universities of other industrialized countries has become limited, whereas the number of doctoral graduates being produced has continued to

grow. As a result, an ever smaller percentage of these doctoral graduates, including in HSPR and related fields, will join university faculties as regular staff members. A significant and growing share of the employment opportunities available for the graduates of HSPR doctoral programs is now in the non-academic public sector (federal and provincial ministries and agencies and health system organizations) and in the private sector (industrial firms and associations, consultancy firms, polling organizations, the media, think tanks, non-governmental organizations and health charities). Career patterns for HSPR doctoral students increasingly focus on such non-academic jobs or on combinations of, and movement back and forth among, non-academic and academic jobs. These various non-academic employers would seem to have a growing need for advanced research expertise to address the increasingly complex issues they confront. HSPR doctoral graduates ought, we would think, to be in great demand for employment in these kinds of positions, but this doesn't appear to be the case. Employers often seem to find master's graduates more appropriate.

Despite this clear set of trends, however, we found that most of Canada's HSPR doctoral programs have not yet done very much to modernize their contents or their approaches in an effort to provide the kinds of skills and competencies required by these non-academic positions and these new career patterns. We continue to train our doctoral students as if a conventional academic career were the only possibility. Students in most of these graduate programs continue to see their careers as focused on tenure-track academic positions. Professors and career advisers continue to regard positions outside the university, even secure and well-paid ones, as second-best alternatives and they convey this assessment to their current and prospective students.

To address this worrisome misalignment between the supply conditions of HSPR doctoral graduates and the demand conditions for their services, the Working Group recommended three strategies.

- I. The first involved a substantial reconfiguration of the contents and delivery modalities of Canada's HSPR doctoral programs. Based on an analysis of the types of additional competencies likely to be required by new, non-academic jobs and new career patterns (outlined in Table 3 of the report), we recommended that Canada's HSPR doctoral programs modernize their approach to student recruitment and orientation to better reflect these new realities and that they upgrade and supplement their programs to include components focusing on each of these additional competencies. To support such efforts, we proposed the development of a set of new, online, pan-Canadian curriculum modules. These modules, involving a combination of in-class, online and mixed teaching approaches, would be developed by a team of experts with representation from across the country. They would be designed to build on the strengths and best practices of existing programs and to serve as supplements, rather than replacements, for current course materials.
- 2. Our second proposal involved another program innovation. We recommended that HSPR doctoral and postdoctoral programs include significant practicum opportunities. Including a requirement that each student spend a certain amount of time on an internship with a non-academic organization, and especially with organizations that are regular or potential employers of HSPR graduates, will not only enhance students' understanding of

- the needs and preferences of such public and private organizations but also provide them with contacts that could prove useful after they graduate. Such internship programs, particularly if developed with the direct and continuous engagement of a range of employers, would also help employers increase their familiarity with the capacities and limitations of HSPR doctoral students and enhance their ability to use the skills of doctoral graduates more effectively. These internships would be supported by a new IHSPR suite of fellowships, possibly borrowing from the approach used by MITACS, and involving a requirement for partial funding from CIHR and from the host employer.
- 3. Our third recommendation was that our HSPR graduate programs work together with IHSPR and with the Student Working Group of the Canadian Association for Health Services and Policy Research's (CAHSPR) to develop a standardized methodology for tracking the career movements of all graduates who are willing to be tracked. This could be done using software such as LinkedIn. Anonymized results of the tracking could be made available to individual programs and to IHSPR. Being able to understand where the graduates of our programs go for their first and their subsequent jobs will be essential for evaluating the performance of our training programs and for adjusting them to future changes in market conditions. In addition, the existence of such a pool of registered students and graduates could, especially if connected to information about potential employers and positions, serve as a sort of virtual marketplace or community of practice for internships and longer-term employment opportunities that could be used by students, graduates, universities, program advisers and employers.

... there was strong support for working towards modernizing doctoral curricula and funding programs ...

To follow up the submission of our report, IHSPR convened a workshop in Toronto on March 31, 2016. The event was very well attended by representatives of all the potential stakeholder communities – research funders, researchers, university administrators, graduate students, and employers from both the public and the private sectors. A broad consensus emerged in the panel presentations and the discussion sessions about the background findings of our report and the three recommendations. While there was strong support for working towards modernizing doctoral curricula and funding programs, the group agreed that the best way to get the ball rolling on a comprehensive set of reforms was to begin at the postdoctoral level by launching a program of one-year fellowships for students with recently completed doctoral degrees in HSPR and related fields.

In early May, a face-to-face meeting of the Working Group on Training was held in conjunction with the annual meeting of the Canadian Association for Health Services and Policy Research in Toronto. The group agreed to focus on the creation of a new fellowship program, involving a significant internship component, to be entitled the "Health System Impact Fellowships" and to begin at the post-doctoral level. A smaller working group was created to develop the program. A set of meetings of that group during the month of June

reached agreement on the basic features of the new program to be crafted by IHSPR and launched by CIHR in early fall 2016. It will be called the Training Modernization Start-Up Grants in HSPR and will be the first component of a multi-year fellowship program at the postdoctoral and doctoral levels. IHSPR will provide funding to successful Start-Up Grant applications to foster partnerships between university training programs and employer organizations and create the conditions necessary for successful training modernization. Specifically, Start-Up Grants will be co-led by Canadian university doctoral programs in HSPR and employer partners from the public or private sector and will enable them to co-develop novel fellowships that involve an internship placement at the employer organization for at least 50% of the time, professional development training, and mentorship and networking opportunities. Co-leads of the Start-Up Grants will also begin collaboration on one of the other key recommendations of our report – a modernized doctoral curriculum with enriched competencies that include the professional skills required to make meaningful and impactful contributions within and outside of academia.

The Start-Up Grants will be followed by a second competition for Health System Impact Fellowships, likely in Winter 2017, for postdoctoral individuals and, eventually, for doctoral trainees.

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White Water Ahead



THE AUTHORS RESPOND

Robyn Tamblyn, Meghan McMahon, Jessica Nadigel, Beth Dunning and Elizabeth Drake

One of the challenges in establishing priorities for research investment is ambition and scope. At a time when research dollars are scarce, the wise advice provided by our respondents will increase value for our investment. Indeed, there is consensus that the learning health system is our most ambitious goal, and it cannot be achieved by the research community alone. We fully agree with Roy (2016), Power (2016), Reid (2016), and Zelmer (2016) that a key requirement for a paradigm shift will be the establishment of successful stakeholder partnerships - with policy makers, managers, patients and clinical champions. Ideally, as Roy suggests, this coalition of sector leadership will rally around a common vision such as the Institute for Healthcare Improvement's Triple Aim – better population health, patient experience, and value for money (IHI 2016).

Fortunately, the Institute of Health Services and Policy Research and the research community have had some success in stakeholder engagement through workshops and funding opportunities that foster health system and private sector partnerships. The evaluation of the longstanding "Partnerships for Health System Improvement" and "Evidence on Tap" funding programs (CIHR 2009; McLain and Tucker 2013) were considered a great success by stakeholders. The more recent eHealth Innovation Partnership Program was able to spawn partnerships among health delivery organizations, clinical, patient, and policy champions, researchers, and the private sector. The Strategy for Patient Oriented Research (SPOR) steps up the level of engagement to an entirely unprecedented scale – with CIHR partnering with healthcare system policy makers to change the paradigm for how research relates and is used as the R&D shop for healthcare.

Within this context, we believe we should invest in people. Why? Because it is people who lead transformative change, foster innovation, and adapt to the ever-changing landscape of

complex systems (Olsen, Aisner and McGinnis 2007). As Reid (2016) and Sketris (2016) point out, engagement is not easy – it takes time, it is not rewarded by our standard academic masters, the means to achieve the ends are not even well supported by the research funding cycles or the ethics that guide our processes. When faced with these complexities, our best hope is to recruit and fund the research leadership so that they can engage in the goal of system change. There is low hanging fruit. As pointed out by Powers (2016), there is scant data on the very intelligence needed to guide health system decision-making – case costing, quality, and benchmarking of performance – surveillance and evaluation skills, as Reid (2106) points out, are where researchers excel. Moreover, as outlined by Bornstein (2016), we need to systematically change doctoral and post-doctoral research training. An estimated 80% of graduate trainees in all areas of science are finding careers outside the university (Edge and Munro 2015). Not surprisingly, this transition to working outside the academy is not specific to Canada, and many lessons can be learned from international models and initiatives. Graduate training programs need to consider the skill-sets needed for these new environments. Of interest, the new competencies outlined by Bornstein (2016) line up with those Reid (2016) identified as needed for the learning health system of the future – skills in leadership, team building and communication. Frankly, both basic and applied science must adopt these skills to succeed in large scale networked science – the new norm for investigation supported by national and international platforms.

... our best hope is to recruit and fund the research leadership so that they can engage in the goal of system change. I found our work on training reform, led by Brown and Bornstein, provided a clear image of the future. As suggested by Dr Gery Ryan at the Rand Institute, future researchers need to get into the white water to acquire solution-oriented skill-sets around real-world problems.

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