Quantifying the Benefits of Digital Health Investments in Canada

Calculating the cumulative quality, access and productivity benefits on a national scale

Short Paper

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***Abstract* - Capturing the benefits generated from investments in digital health is key towards demonstrating accountability to funders as well as to encouraging widespread adoption by clinicians and other health care professionals. The cumulative benefits calculation, developed by Canada Health Infoway, is a macro-level indicator trended since 2007. It represents estimated benefits accruing to various health care system stakeholders, as driven by component technologies and their associated adoption across the country. In-depth studies, validated by external experts in relevant fields, have been completed for diagnostic imaging systems, primary and ambulatory care electronic medical records, drug information systems and telehealth. The financially quantifiable aspects of each study are aggregated, trended over time, and indexed to inflation. From 2007 to 2016 benefits accrued to the Canadian health care system exceeded $19B. These benefits were driven by improvements such as clinician and clinical practice productivity; avoided health system utilization due to improved patient safety; reduced patient time and expense and fewer duplicate tests. Cumulative benefits represent the aggregated value accrued to various health system stakeholders that has been realized or could be harvested through re-organized business processes.**

Keywords-electronic health record (EHR); adoption; digital health; health system benefits; productivity; efficiency; telehealth; electronic medical record (EMR).

I. INTRODUCTION

This paper is an extended version of work published in [1]. We extend our previous work by updating data for an additional year (2016), elaborating on the studies supporting the findings, and further detailing the methods, inputs and limitations of the study. Federal and provincial/territorial governments across Canada have been investing in the creation of interoperable electronic health records (iEHRs) and other means for connecting health care providers with patient information for more than a decade [2]. While deployment progress and rates of usage vary across provinces and territories, the initiative has reached mainstream adoption by clinicians and other health care professionals. An iEHR is a secure, integrated view of a person's medical records from all systems in the network; it provides a comprehensive view of a patient's medical history. It is designed to facilitate the sharing of data across the continuum of care, health care delivery organizations, and geographical areas [3]. The potential benefits of the iEHR are substantial – improved quality of care, health system and provider efficiencies, improved access to care and use of health data to better manage the health system and facilitate research. Typically, the iEHR integrates diagnostic imaging, laboratory, and medication data, along with clinical notes, to provide a longitudinal view of a patient's clinical history. As such, it is a similar concept to that of a Health Information Exchange (HIE) [4]. Across Canada, iEHRs are at various stages of implementation and maturity and have evolved according to provincial/territorial strategies and priorities. As of 2017, each province and territory in Canada has an iEHR in place [5].

The iEHR acts as a complement to point of service applications such as EMRs in physician offices or hospital information systems. It is accessed through integration with clinical systems or through standalone, web-enabled viewers. Figure 1 illustrates the relationship between point of service applications and the iEHR infostructure (clinical data repositories in blue boxes) [6].

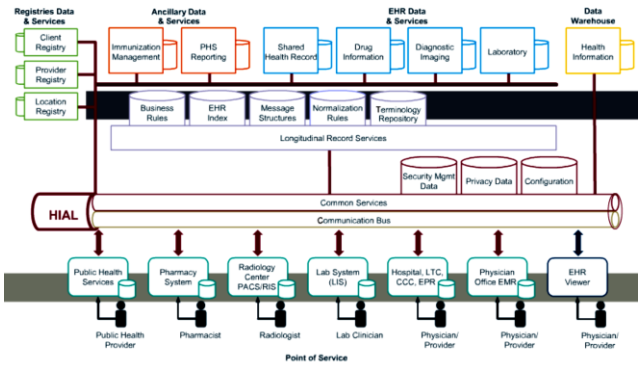

Figure 1. iEHR jurisdictional infostructure based on the Electronic Health Record Solution Blueprint.

Regular measurement of adoption and maturity for these technologies has made progress easy to follow and manage. For example, in the 2015 Commonwealth Fund Survey, 73% of all family physicians reported they do use electronic records to enter and retrieve clinical notes [7]. They form part of the 301,000 health care professionals (more than half of estimated potential users) who were accessing one or more of the following sources for patient information needed to provide care (lab, DI, drug) in 2017. Of these, more than 162,000 were actively accessing two or more of these clinical information sources [8][9]. As the trend in Figure 2 illustrates, the number of active users has accelerated greatly in the past three years as adoption of connected health information reached a critical mass.

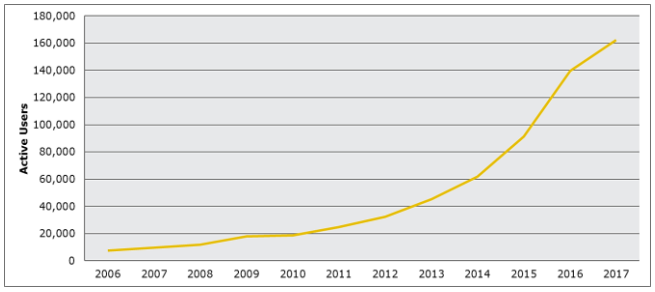

Figure 2. Trending iEHR systems use (2+ clinical domains). Active users have accessed the system a minimum of one time per month.

The rapid increase in adoption is partially attributed to the integration of iEHR data into point-of-care systems in hospitals and clinics over the last two years. Healthcare practitioners and leaders report that this integration is allowing providers to incorporate iEHR data into clinical workflows [8].

In the interest of accountability for the public funds under its management, and optimizing the value accruing from investment of those funds, Canada Health Infoway (Infoway) has developed approaches to evaluate and systematically model the estimated value of outcomes related to select digital health solutions nationally [10]. The cumulative benefits model contains estimates for benefits generated through the use of diagnostic imaging systems, drug information systems (DIS), ambulatory and primary care electronic medical records (EMR), and telehealth.

The rest of this paper is organized as follows: Section II describes the methods used for calculating cumulative benefits. Section III describes the most recent results based on data up to the end of 2016. Section IV addresses the assumptions and limitations of the model. The conclusion, Section V closes the article.

II. METHODS

The cumulative benefits calculation is driven by individual quantitative estimates obtained from pan-Canadian studies commissioned by Infoway for each of the clinical domains mentioned above. The concept of pan-Canadian studies to estimate national value was developed in 2006 to summarize results across diverse data domains, settings, evaluation methods, and time periods. The studies aim to generate estimates, which are as comprehensive as possible, peer reviewed by expert panels, and reflecting best available evidence. The cumulative benefits studied cover a subset of digital health solutions, and as such represent a portion of the value from digital health at large. The studies explored domains where federal funds directed through Infoway have been invested. A fulsome methodology, published in 2015, provides an assessment of gaps and recommendations for increasing and optimizing the use and spread of technologies in order to increase value over time [10]. Estimates are calculated in Canadian dollars realized on an annual basis and base assumptions to current contexts are applied and documented. Not all outcomes represent direct financial savings, but where possible, a value is expressed financially to allow comparison of magnitudes. Where the literature does not provide sufficient evidence to quantify the current dollar value of a specific outcome, the value is omitted from quantitative modeling. In instances where a range of estimated benefits is provided, the mid-point value was used as a base estimate. The mid-point estimate for each domain-specific benefit is highlighted in Table I and corresponds to the year in which the study was carried out. Simplicity is a core principle of the specification of the quantitative benefits model, with most discrete value estimates derived by multiplying the magnitude of outcome observed per unit x value of outcome x extent of adoption across Canada. Adoption maturity variation (e.g., functionalities used, frequency of use, etc.) is an important driver of value in digital health deployment, so the extent of the adoption used in the model must be matched to the maturity required to achieve the magnitude outcome applied.

TABLE I. YEARLY BENEFITS BY DOMAIN

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
DI	$511	$646	$715	$724	$841	$850	$878	$888	$908	$968
DIS	$233	$369	$436	$441	$462	$487	$551	$579	$593	$865
TH	$52	$70	$95	$128	$158	$187	$266	$340	$407	$580
EMR	$131	$162	$193	$227	$270	$302	$347	$414	$419	$424
AMB-EMR	$45	$53	$59	$71	$82	$106	$141	$167	$196	$199
TOT.	$973	$1,300	$1,498	$1,590	$1,812	$1,932	$2,183	$2,387	$2,523	$3,036

Adoption is determined by examining data from surveys of clinicians and patients, usage data from digital health solutions, and operational data sets collected by Infoway's partners. Specific definitions of adoption are designed to suit distinct kinds of solutions, and trended over time [10]. Adoption is measured differently for each domain or technology. This is both due to the practicality and feasibility of collecting the data and the way in which benefits were initially modelled. Adoption metrics are applied in the model as drivers of the benefit magnitude. For example, telehealth

benefits are driven by the number of clinical sessions—defined as consultations involving a clinician and a patient [11] whereas EMR benefits are driven by the number of Canadian physicians who reported using an EMR to document patient information as shown in Figure 3. EMR benefits largely accrue to physicians and their practices, and as a result, it is fitting for physician adoption to be a driving factor.

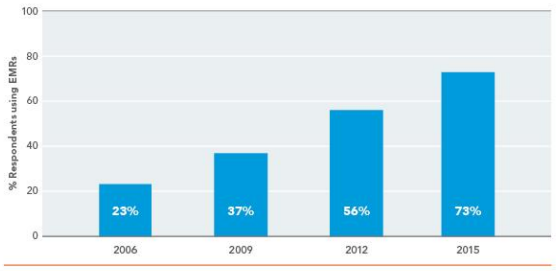

Figure 3. Family physicians in Canada reporting EMR use: Commonwealth Fund Surveys.

Conversely, telehealth benefits largely accrue to patients and the health care systems that fund patient expenses, such as the Northern Travel Grant in Ontario, which subsidizes patient and caregiver travel costs [12]. Diagnostic imaging benefits are driven by the adoption of picture archiving and communication systems (PACS) by radiologists, physician specialists, and emergency department nurses since they are the professions who would be the most likely to benefit from the workflow improvements facilitated by these systems. While other clinicians and health professionals are likely to benefit, it was preferable to be conservative in the adoption estimate, in line with Infoway's overall reporting principles [10]. Drug information system benefits are driven by a combination of the percentage of pharmacies connected to a DIS across a given province and the percentage of connected physician EMRs. This reflects the distributed nature of DIS benefits where significant portions accrue to pharmacies, physician practices, and health system funders among others.

Table II summarizes the various types of benefits measured for each respective study:

TABLE II. BREAKDOWN OF BENEFITS (DUPLICATE BENEFITS REMOVED)

		Health system use	Clinician/staff productivity	Patients
Tele-health	personal travel			$325
	subsidized travel	$158		
	ED avoidance	$3		
	hospital avoidance	$65		
DI	patient transfers	$15		
	radiologist productivity		$261	
	technologist productivity		$135	
	referring physician productivity		$175	
	duplicate exams	$-		
	film costs		$518	
DIS	community adverse drug events (ADE)	$79		
	admission ADEs	$42		
	printed/typed Script ADEs	$48		
	medication abuse	$139		
	medication compliance	$182		
	pharmacist/technician efficiency		$157	
	call-backs		$117	
	drug cost management	$88		
EMR	improved lab and DI test management		$127	
	reduced or eliminated chart pulls		$115	
	reduced lab or DI test duplicates	$136		
	reduced ADEs due to prescription legibility	$-		
AMB-EMR	avoided delays for patients			$4
	reduced or eliminated chart pulls		$95	
	reduced lab or DI test duplicates	$83		
	reduced ADEs	$-		
TOTAL ($M)	$3,067	$1,038	$1,700	$329
		34%	55%	11%

III. RESULTS

Between 2007 and 2016, over $19 billion in quantifiable benefits have accrued to various parts of the Canadian health care system as shown in Figure 4.

The diagnostic imaging study completed in 2008 documented benefits totaling an estimated $600M as a result of improved productivity for doctors and technologists (by more than 25%); improved remote reporting capabilities; improved access to care; and quicker turnaround time (by 30-40%), meaning patients get diagnosed twice as fast and are able to start treatment sooner [13].

The Generation 2 Drug Information Systems Pan-Canadian Study, completed in 2010, demonstrated benefits

totaling $436M through improved safety and quality of care, fewer adverse drug events, reduced prescription abuse,

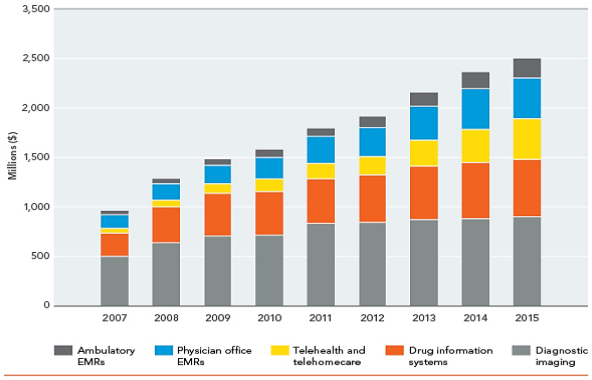

Figure 4. Cumulative benefits of investments in digital health across Canada.

increased medication compliance) along with increased provider productivity (greater pharmacist efficiency and fewer call-backs) and improved drug cost management [14].

From 2006 to 2012, the growth of EMRs in Canada resulted in cumulative efficiency and patient care benefits valued at more than $1.3 billion--$800 million in administrative efficiencies and $584 million in health system level benefits, such as reduced duplicate tests and adverse drug events [15].

Lastly, use of EMRs in ambulatory care clinics across the country has resulted in benefits estimated at $196 million in 2015 due to clinic efficiencies (improved chart management, reduced duplicate tests and reduced transcription costs); increased clinic capacity; fewer emergency department visits and hospitalizations as a result of adverse drug events; and avoided costs for patients due to avoidable delays in care [16].

Coloured cells in Table I represent base calculations in the years when each respective study was completed. Benefit estimates for previous and subsequent years are dependent on the changes in adoption of each technology by health care professionals and/or practices in each year as compared to the base years. Each year's estimate is adjusted for inflation according to the Statistics Canada Consumer Price Index for Health Care [17]. In 2016, the estimated value to the overall healthcare system in aggregate exceeded $3B. These benefits accrue to various stakeholders within the system, as shown in Figure 5. The largest piece (54%) accrues to health delivery organizations (HDO) such as hospitals, clinics, pharmacies along with their respective clinicians and other staff. The next largest piece (36%) accrues to health system funders such as ministries of health and other government organizations as a result of reductions in reimbursable health system utilization and subsidies. Lastly, 10% of quantified benefits accrue to patients and their families largely through time saved in accessing care and avoided travel.

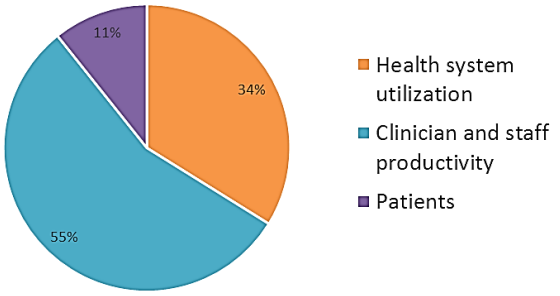

Figure 5. Distribution of benefits across the Canadian health care system

It is expected that future pan-Canadian studies, examining incremental benefits related to other components of the iEHR such as patient access to health information and/or electronic prescribing, will expand the model according to the same overarching methods described above.

IV. ASSUMPTIONS AND LIMITATIONS

The pan-Canadian studies completed to date, which drive the cumulative benefits calculation, were completed independently, over a number of years (2008 to 2015). As such, benefits calculated as part of one study, may also be reflected in another. For example, the Generation 2 Drug Information Systems study tracked patient safety benefits related to printing out prescriptions from physician EMRs—this benefit was also included in the EMR pan-Canadian study. These benefits were included only once when aggregating totals in order to eliminate double counting. However, due to differing methodologies in each study, double counting cannot be eliminated completely.

Significant limitations were noted in the availability of data upon which to model and quantify certain kinds of benefits. For example, anecdotal evidence exists to support the idea that productivity and quality improvements in healthcare delivery would result in benefits for patients in terms of time saved, avoided losses in productivity, and improved convenience among others; however, insufficient data was available upon which to make evidence-based estimates. As a consequence some types of benefits are understated in the cumulative analysis, such as value to patients, which is estimated at only 10% of the total. Another important example relates to improved compliance with quality of care guidelines. Physicians with EMRs are more proactive in caring for their patients, but the long-term financial implications of these improvements could not be modelled or included with quantitative estimates. As such, these benefits are largely addressed only qualitatively in the pan-Canadian studies.

While it would be desirable to calculate return on investment (ROI), benefits and costs accrue to multiple stakeholders, making these calculations complicated, and best assessed on a stakeholder by stakeholder basis. Furthermore, while some stakeholders may see quantifiable benefits from a digital health investment, others may have to bear additional costs. Such an example can be found with PACS where productivity gains for physicians may increase access for

patients, but result in additional costs to the health system since more clinical procedures and/or patient visits can be completed with the same inputs. Nonetheless, this is a useful analysis at a macroeconomic level since it can demonstrate the positive effects of investing in digital health. An important limitation of this analysis and digital health progress as a whole is the gap between value created and hard savings. This limitation was also identified in analysis conducted by the RAND Corporation. In 2005, researchers estimated that rapid adoption of health information technology could save the United States more than $81 billion annually [18]. In 2012 RAND revisited the topic and found mixed results and growing health expenditures. The factors that limited achievement of value were "sluggish adoption of health IT systems, coupled with the choice of systems that are neither interoperable nor easy to use; and the failure of health care providers and institutions to reengineer care processes to reap the full benefits of health IT" [19]. In the Canadian context, similar issues apply, but steps are being taken to address these. Adoption incentives, focus on interoperability, and attention to change management have been important for driving mature adoption of solutions. The pan-Canadian studies apply metrics of adoption and maturity as drivers to model benefits, so estimated value reflects actual changes in clinical practice. In contrast, however, there are aspects of reengineering care processes and more broadly, health system organization and financing that are not addressed. For example, time savings that accrue to providers who operate on a fee for service basis are gains to the specific providers, rather than the health system. Reductions in ER and hospital utilization can add capacity, but for hard-savings, Canadian health systems must look at how different sectors of the system are financed. As digital health becomes the norm, health systems leaders are increasingly aware of the need to be proactive in the harvesting of benefits.

V. CONCLUSION

The cumulative benefits calculation has been and continues to be a useful tool for demonstrating the benefits of digital health investments for the purpose of accountability to funders and taxpayers. In addition, it is a useful tool to persuade clinicians and other health care professional to adopt new technologies, and to encourage partners, such as jurisdictions and health care provider organizations to continue to invest in digital health. Its main limitation is that while the total figure represents aggregate value to various stakeholders, it does not represent actual dollar savings, since other workflow, policy, and personnel changes may need to be implemented in order to fully harvest the benefits.

As connected health information continues to become more accessible across a number of clinical domains, it is contributing to the continued improvement of quality, access and productivity for patients, health care professionals, and the health system overall.

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