The performance of health systems and hospitals in Canada

Studies on outcomes measurement

Fekri, O.

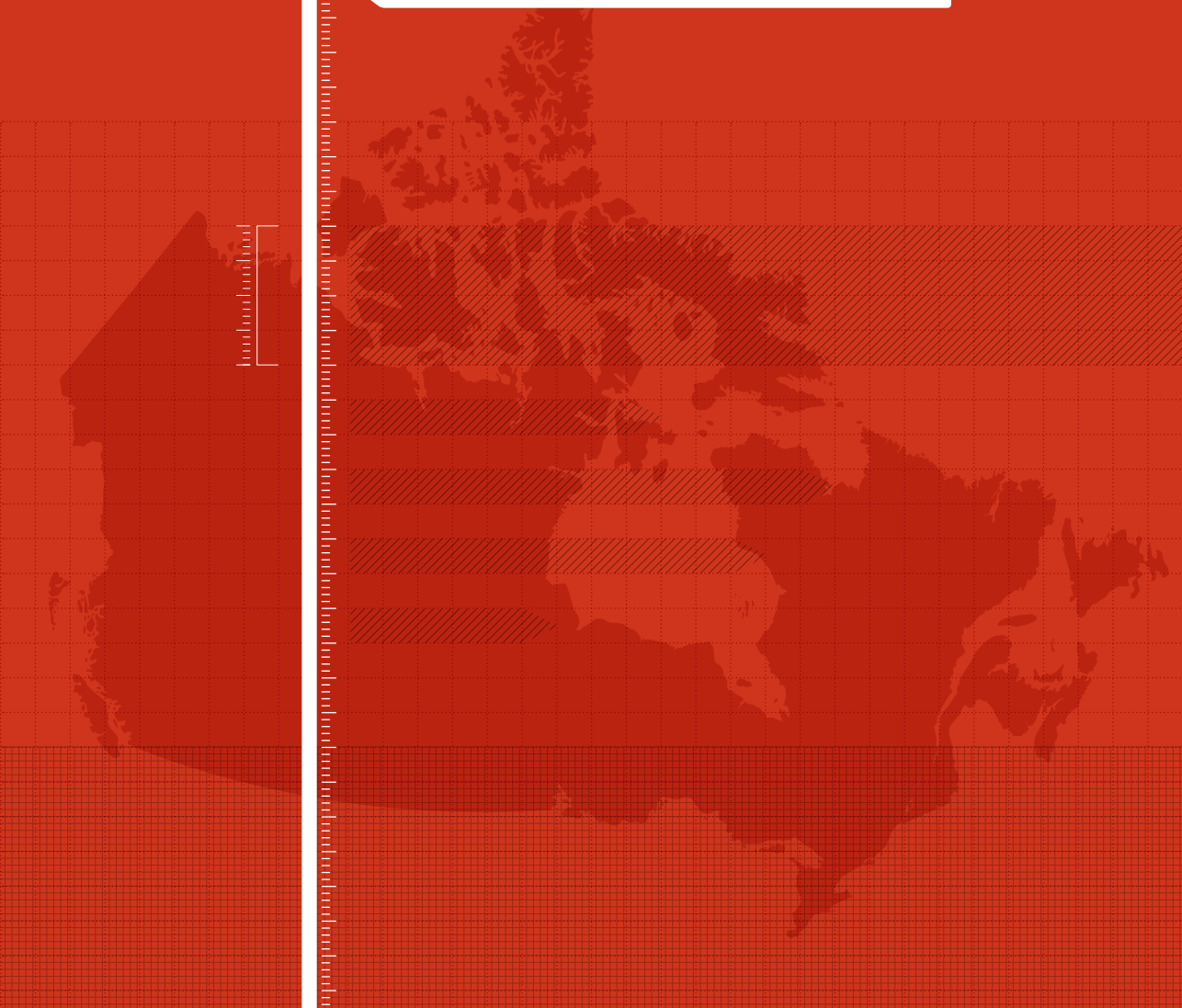
Publication date
2021

Document Version
Final published version

OMID FEKRI

THE PERFORMANCE OF HEALTH SYSTEMS AND HOSPITALS IN CANADA

STUDIES ON OUTCOMES MEASUREMENT



THE PERFORMANCE OF HEALTH SYSTEMS AND HOSPITALS IN CANADA

Studies on Outcomes Measurement

Omid Fekri

THE PERFORMANCE OF HEALTH SYSTEMS AND HOSPITALS IN CANADA

Studies on Outcomes Measurement

Design & Layout: Gabriel Bonța/Pointer Creative

THE PERFORMANCE OF HEALTH SYSTEMS AND HOSPITALS IN CANADA

Studies on Outcomes Measurement

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Amsterdam
op gezag van de Rector Magnificus
prof. dr. ir. K.I.J. Maex
ten overstaan van een door het College voor Promoties ingestelde commissie,
in het openbaar te verdedigen in de Agnietenkapel
op donderdag 18 november 2021, te 13.00 uur

door Omid Fekri
geboren te Tabriz

Promotiecommissie

Promotor:	prof. dr. N.S. Klazinga	AMC-UvA
Copromotor:	dr. J.E. Amuah	Universiteit van Ottawa
Overige leden:	prof. dr. A. Abu-Hanna	AMC-UvA
	prof. dr. J. van den Heuvel	Universiteit van Amsterdam
	prof. dr. C.T.J. Hulshof	AMC-UvA
	prof. dr. G.P. Westert	Radboud Universiteit Nijmegen
	dr. H.F. Lingsma	Erasmus MC
	dr. S. Allin	Universiteit van Toronto

Faculteit der Geneeskunde

Contents

GENERAL INTRODUCTION

The performance of health systems has been an area of concern in many countries over the years[1]. The WHO's 2000 World Health Report[2] provided the first comprehensive evaluation on the performance of national health systems. The methodology used to evaluate and rank health systems garnered much debate; equally challenging was the ability to account for the fact that the attainment of health was not solely within the realm of health systems, but through a multitude of policies from other sectors[3]. The use of composite measures to arrive at health system rankings were also contested[4], and naturally spurred greater interest and scrutiny on the performance of health systems.

Hospitals constitute a significant component of health systems, however, the evaluation of hospital performance long preceded the notion of health system performance. Scrutiny of hospital performance has roots in the United States from the early 1900s, which spurred the notion of hospital accreditation[5]. Although these early standards centered around administrative aspects of hospitals, the paradigm eventually expanded to include the clinical outcomes of patients.

In the assessment of both health systems and hospitals, progress has been made away from rudimentary measures of resources and output performance towards more meaningful measures of outcomes[6]. Within health systems, this is reflected through the overall contribution of health care to the health of populations (rather than solely on the provision of services); likewise, hospital outcome measures needed to improve from a simple binary outcome of in-hospital mortality to more complex measures capturing the degree with which a patient's health improved or worsened, as related to the quality of care a patient received.

Scrutiny on the performance of health systems and hospitals in Canada has increased in recent years. In 2019, total expenditure on health reached $265 billion (~12% of GDP), with hospitals accounting for the largest government expenditure on health[7]. While the nation's 13 provincial and territorial governments are responsible for the provision of health services, the Canada Health Act stipulates a set of principles that must be followed in order to receive federal transfer payments to support financing; this, and a series of investments in the uniform capture of data on health systems and hospital services, has facilitated pan-Canadian assessments of performance of both health systems and hospitals through outcome measures.

However, health system and hospital performance outcome measures have inherent limitations and deficiencies to accurately and adequately reflect their contribution towards the realization of health in populations and patients. Outcome measures, therefore, require ongoing evaluation to determine their continued fitness for use and relevance, especially as in recent years, their use and public reporting has increased to address transparency and accountability requirements[8].

Furthermore, it should be better understood to what degree outcome measures are interrelated, complementary, or even divergent (for example, given the competing interests in the goals of efficiency and effectiveness).

The research community occupies an important role in advancing the understanding and use of outcome measures to support health system and hospital performance measurement. This dissertation is composed of five research questions and resultant studies on outcomes-based measurement in the Canadian health system and hospital contexts. It explores the selection, prioritization, effectiveness, utility, validity, and strengths and limitations of outcome measures.

Background

The Building Blocks of the Field

The notion of modern outcomes measurement can be placed nearly 170 years ago through the efforts of Florence Nightingale and her ground-breaking use of data and visual statistics to justify the need for hygienic clinical care (to reduce mortality due to infection). Some decades later, at the start of the 20th century, an American surgeon, Ernest Codman, steadfastly championed a movement to follow-up with patients so as to be able to measure the eventual outcomes of the care they received[9]; this notion was dubbed the 'end-result'. Largely opposed by his colleagues, Codman was not dissuaded, and continued enumerating the concept of systematically tracking patients to determine the effectiveness of treatments provided. Perhaps beneficially, Codman was brash, and did not waiver when being criticized for his cause. He resigned from the Massachusetts General Hospital to establish his own hospital – the Codman Hospital.

In 1913, in the lead-up to establishing the American College of Surgeons, Codman served on a Committee of Standardization of Hospitals that deliberated[10]:

"By what standards can we compare hospitals? It is obvious that there are many. There may be a standard of architecture, of cleanliness, of kindness to patients, of nursing, of medical education, etc. To some persons the per capita cost, the number of patients annually treated, the success of private practice of their medical and surgical staff, the quality of the scientific papers produced, or the up-to-dateness of the laboratories may seem the important elements. Some hospitals seem satisfied with the famous contributions to medical science which some member of their staff made a hundred years ago.... We believe...that even cleanliness, marble operating rooms, famous physicians and surgeons, up-to-date laboratories, and time-honored reputation do not necessarily mean that the individual patient will to-day be freed from the symptoms for which he seeks relief.... The more time we have spent on this subject, the more obvious it has seemed to us that the only firm ground on which we can compare hospitals is by the actual results to the individual patient."

Codman held true to his credo that the patient must be followed long enough to deduce the effectiveness of treatment received. It was truly pioneering for Codman to voluntarily publish his book *A Study in Hospital Efficiency: As Demonstrated by the Case Report of the First Five Years of a Private Hospital* recounting detailed patient outcomes and the experiences of his small, private hospital in 1918. Codman said[10] (abridged, as pertaining to outcomes measurement),

"So I am called eccentric for saying in public:

That Hospitals, if they wish to be sure of improvement,

- *Must find out what their results are.*
- *Must analyze their results, to find their strong and weak points.*
- *Must compare their results with those of other hospitals.*
- *Must welcome publicity not only for their successes, but for their errors, so that the Public may give them their help when it is needed."*

And he concluded that "*Such opinions will not be eccentric a few years hence.*" 'A few years' turned into a few decades, while public and private health spending progressively chewed larger portions of individual and government budgets in the United States and other countries including Canada. Better health, too, increased (as measured via life expectancy). But towards the close of the 20th century, numerous independent factors arrived at a critical juncture to transform the paradigm of the day. It would take several more decades until Codman's vision would begin to be more-widely accepted and systematized in health care.

A large responsibility for advancing these paradigms lay at the hands of Avedis Donabedian, the modern-day champion of quality health care. Donabedian published and practiced widely, but his contributions are perhaps most-popularly summed up in three little words: structure, process, outcome[11]. 'The Donabedian Model' eloquently, succinctly, and intuitively categorized and explained a conceptual framework for assessing the quality of care through relevant dimensions, as he first described the concept in 1966[12] (see table 1). While still the dominant conceptual framework in the field, there have been adaptations over the years, such as the inclusion of an 'output' component. Donabedian would continue contributing towards the field of outcomes and quality measurement for the next four decades to round out the 20th century.

Table 1 – Examples of health system and hospital-level outcome measures

	HEALTH SYSTEM-LEVEL	HOSPITAL-LEVEL
STRUCTURE	• General Practitioners per 100,000 population. • MRI machines per 100,000 population.	• Number of beds, workforce, technology equipment, etc.
PROCESS	• Wait times for cataract surgery, oncology care, long-term care. • Hospital Admission rates for Ambulatory Care Sensitive Conditions.	• ED wait time for physician initial assessment. • Length of Stay. • Compliance to standards (antibiotics, therapy, etc.). • % of Low-risk caesarean sections.
OUTCOME	• Avoidable Deaths from Preventable / Treatable Causes. • Health-Adjusted Life Expectancy. • Health-related Quality of Life (HRQOL) Measures.	• In-hospital mortality. • Readmission to hospital. • Complications following major surgery.

The Canadian Context

Following the aftermath of the second world war, governments returned their attention home to building and improving access to basic social services, including government-funded health care[13]. With this came an increased interest in the performance of health systems and hospitals. In Canada, localized efforts in this light began with Saskatchewan Premier Tommy Douglas introducing hospital insurance. In 1960, he later argued for the implementation of a universal medical care plan, going beyond hospitals to also encompass primary care. Indeed, the efforts and vision of Tommy Douglas to ensure universal health coverage reins true decades on, with Canadians voting him as The Greatest Canadian in the country's history.

As other provinces followed suit in enacting similar policies, the federal government of Canada began negotiating cost-sharing programs with provincial and territorial governments. The passing of the *Canada Health Act* in 1984 consolidated preceding legislation to introduce universal principles for governance of health care provision throughout the country. The five tenets of the Act are: public administration, comprehensiveness, universality, portability, and accessibility.

Another notable milestone in Canada was the 1974 publication, *A New Perspective on the Health of Canadians* (affectionately known as "*The Lalonde Report*"[14], led by then Minister of National Health and Welfare, Marc Lalonde). The publication was ground-breaking in that it offered an updated lens on health; it argued that

four equally important quadrants constituted the determinants of health: lifestyle, biology, environmental factors, and health care organization. Indeed revolutionary, the Lalonde Report also triggered the field of health promotion, and paved the way for the first ever International Health Promotion Conference (resulting in the *Ottawa Charter for Health Promotion*). Indeed, Canada was regarded internationally as a "health promotion powerhouse" with its contributions conceptualizing the social determinants of health[15].

Beginning in the 1980s, the concept of New Public Management brought with it new paradigms of efficiency, customer service-orientation, value for money, fiscal control, target-setting and monitoring performance of public services and organizations. The health sector was no longer immune from this new scrutiny and control. Hence, somewhat unwillingly, health system and hospital administrators now needed to open their books and doors to accept greater government and regulatory oversight. Medicine has always been a trade in which there is a considerable imbalance between the provider and the recipient. Medical professionals are required to possess vast quantities of complex knowledge for their trade; their profession has propagated the notion that "doctors know best", inferring that patients are not in a position to question authority.

But a series of analyses released in the early 2000s began to shake the field. The WHO's *World Health Report 2000* showed that health systems once perceived as high-performing may not in fact be superior as once thought; Canada's overall health system performance ranking placed 30th out of 191 Member States. In the United States, the Institute of Medicine's (IOM) report, *To Err is Human*, estimated nearly 100,000 hospital deaths a year at the hand of medical errors[16]. Their subsequent publication, *Crossing the Quality Chasm*[17], prescribed a fundamental redesign of the health care system, including recommendations grounded in the basis of improving patient experience. In 2004, the *Canadian Adverse Events Study*[18] estimated 180,000 hospitalizations (an incidence rate of 7.5%) that resulted in harm to patients, with many potentially preventable.

In the 2000s, outcomes measurement had progressed to the state where more data were available, increasingly digital and granular, and, thus, more robustly quantifiable. This evolution did not occur by chance; it was the result of targeted initiatives proposed years prior.

In addition to the formulation of Statistics Canada in 1971 as a federal department mandated to oversee the centralized statistical system of the country, a series of complementary agencies and initiatives were launched in the late 1980s and 1990s to promote the use of health information for analytical and accountability

purposes[19]. In 1988, the Conference of Deputy Ministers formed the National Health Information Council (NHIC), a joint federal/provincial body to develop and coordinate a national health information system[20]. Shortly afterwards, the Wilk Report – *Health Information for Canada, 1991: A Report by the National Task Force on Health Information* – recommended the creation of an independent national institute for health information[21]. As a direct result, in 1994, the Canadian Institute for Health Information (CIHI) was formed with the mandate to coordinate the collection and analysis of health information from across the entire country; this was a notable achievement given the autonomy of provinces and territories in administering their respective health systems. Just prior, the Institute for Clinical Evaluative Sciences (ICES) was established to provide evidence on the performance of the Ontario health care system[22]; similarly, in 1991, the Manitoba Centre for Health Policy was also established. In 1997, the Ontario Hospital Association (OHA) committed to the public-reporting of hospital performance, with initial funding for the *Hospital Report* publication series spearheaded by investigators at the University of Toronto. The Hospital Report publication series eventually found a home at CIHI, and was expanded throughout the years; this, and other projects, such as the *Health Indicators* annual analytic reports, began to form the broader *Health System Performance* reporting activities of CIHI.

In 2012, CIHI launched the *Canadian Hospital Reporting Project (CHRP)*, a pan-Canadian online tool that published 27 performance indicators for the over 600 hospitals throughout the country. The tool was a first for Canada; pan-Canadian, comprehensive and publicly-available. With it came greater public and media scrutiny. The Canadian Broadcasting Corporation (CBC) used some of the underlying data to produce their own elementary version of a hospital scorecard. Hospital administrators found themselves on new ground: having to respond to media and public scrutiny on the performance of their hospitals. Building on CHRP to expand the number of performance indicators, and to incorporate region-level reporting (of the ~100 administrative regions in Canada), CIHI launched the *Your Health System (YHS)* online tool in 2014.[23, 24]

As a result of the aforementioned investments to strengthening health information infrastructure[25], Canada holds certain capacities in health system and hospital outcome measures. Both the Canadian public and health system stakeholders have access to an increasing quantity and complexity of outcome measures.

Outcome measures used in Canada to determine the performance of health systems and hospitals need to be periodically evaluated for their effectiveness, utility, and validity for continuous improvement.

As such, five distinct research topics (and resultant research questions) are investigated in this doctoral dissertation in order to critically assess the state of outcomes measurement in Canada:

1. State of use of Outcomes Measurement in Canada
2. Evaluation and Prioritization of Health System and Hospital Performance Indicators
3. Evaluating the Validity of the Hospital Standardised Mortality Ratio Indicator
4. Trends in Performance of Hospital Outcomes
5. The Interrelatedness of Hospital Outcomes

State of Use of Outcomes Measurement in Canada

Outcomes measurement gained greater prominence in the 1980s and 1990s as a result of the interest in the quality improvement movement[26]. Increasingly, instruments were becoming available to measure patient clinical status and experience[27]. These data collections became periodic and repeated to capture more than just a single time-point, but a progression of a patient's journey. There was also increasing importance in the patient's perspective, rather than solely relying on clinical results.

Interest in outcomes measurement also identified the need to capture more than just hospital-care data. Previously, there was a reliance on hospitalization data to infer more broadly the performance of health systems, which did not adequately reflect the outcomes, health status and experiences of patients. For this, the establishment of clinical registries were required to more comprehensively capture patients in the community and beyond hospital-services.

The notion of Patient Reported Outcome Measures (PROMs) seeks to capture a patients' perspective on their functional health status and quality of life. Similarly, Patient Reported Experience Measures (PREMs) gave voice to patients to describe how they experienced receiving health services (for example, if they were seen on time).

This paradigm shift towards capturing PROMs and PREMs made headway in the United States and Europe; clinical registries became more frequent, and patient/consumer perspectives came to the forefront of discussions on improving the quality and experience of care.

Given the emerging developments in outcomes measurement, to begin this dissertation, the research question *What is health outcomes measurement and its state of use in Canada?* will be addressed in chapter 1 through a review of the literature and synthesis of key examples from other nations and progress in Canada. A notable rubric (5Ds) is used to assess the five dimensions of outcomes measurement and Canada's level of maturity. Through this assessment of Canada's evolution and state of outcomes measurement, policy-level recommendations are provided on the expansion, institutionalization and strengthening of outcomes measurement in Canada.

Evaluation and Prioritization of Health System and Hospital Performance Indicators

As previously discussed, advancements in the depth and breadth of health system performance information should be welcomed (such as expansion to collect and report on PROMS and PREMS), but it is not without posing a series of capacity and resource challenges. Health information agencies mandated to produce health system performance analyses naturally have a finite capacity to collect data, calculate, and report on an increasing number of indicators. For example, in 2000, CIHI produced 13 health system performance indicators, but in 2014, this number had reached to more than 80 indicators; this expansion reflected the growing information needs of the healthcare system to examine additional domains of care (as they became of increased priority), and as an opportunity to utilize more granular and improved underlying data. Similarly, hospitals and health authorities that had to collect and analyze performance data were faced with choices of prioritizing their limited resources to the domains that were most important at any given time.

For these reasons, and others, it prompted a meeting in 2011 of senior health leaders in Canada to discuss 'Indicator Chaos'[28] (the rapid proliferation of health indicators). To address the valid concerns of too many health system performance indicators, CIHI endeavored to arrive at a more refined list of indicators, using a systematic approach to evaluating their utility, and seeking confirmation from the health system and hospital leadership community on identifying priority indicators for continued production.

While there are many examples in the scientific literature on how to select a set of indicators for a particular evaluation exercise (for example, via the use of Delphi-type exercises for clinical guideline development), there were little to no documented criteria or processes to inform how to evaluate health indicators for continued reporting and prioritization[29].

Of particular need for the Canadian context was a comprehensive process that informed and empowered the national health information agency to systematically evaluate a varying suite of health system performance indicators. Such guidance required the use of rigorous and acceptable evaluation criteria; a transparent, multi-phased and participatory process of diverse specialists; and ultimately receiving consensus from health authorities across the country and health system levels.

In chapter two, the research question *How are health system and hospital performance indicators evaluated and prioritized?* systematically evaluates a suite of 56 health system and hospital performance indicators produced by CIHI. Eighteen indicator evaluation criteria were chosen through a process of research and experimental development., Modified-Delphi (RAND/UCLA method) exercises were used to iteratively evaluate and synthesize the scores of CIHI technical and leadership groups. Subsequently, through an online survey, hospital and health system performance stakeholders throughout the country reviewed and scored recommendations. Lastly, at an in-person National Consensus Conference, recommendations on indicator dispositions were voted on through a ratification process[30, 31].

Evaluating the Validity of the Hospital Standardised Mortality Ratio Indicator

In addition to the periodic evaluation of a suite of health system performance indicators, individual outcome measures require comprehensive reviews to ensure continued validity for reporting. One of the earliest and crude outcome measures of hospital performance has been a patient's survival or death while in hospital. Such a binary outcome of hospital performance can be misleading if terminally ill patients are included in numerator counts. Furthermore, even valid denominator and numerator patient cases must to the fullest extent possible apply risk-adjustment methodologies (on patient characteristics and hospital service provision) to make as best-possible apple to apple comparisons of hospital performance and patient outcomes.

Following the release of the Hospital Standardised Mortality Ratio (HSMR) indicator in the United Kingdom[32], CIHI began a process of research and development, consultations, testing, and eventual calculation and reporting of HSMR results for Canadian hospitals[33]. A critical element of HSMR is whether a terminally ill patient (requiring palliative care) should be excluded in the indicator calculation methodology.

Prior to the introduction of the HSMR indicator, the palliative care code in hospital abstracts was not widely used in Canada. To address this deficit in practice and knowledge, CIHI introduced clinical coding trainings, and provided to hospitals and

health authorities their HSMR results with both palliative care patients both included and excluded in indicator calculations. Furthermore, an adjustment period was provided for the update of clinical coding guidelines.

It was not long until the validity of the indicator came into question. In the UK, reports emerged of hospitals gaming the palliative care code in order to artificially reduce in-hospital mortality rates. Eventually similar lines of questioning emerged in Canadian media that, here too, hospitals had gamed the palliative care code in order to lower in-hospital mortality rates. A 2012 study by Canadian researchers reported a substantial increase in the use of the palliative care code, and potential gaming of the HSMR indicator[34]. To further investigate these claims, and to better acquire a recent understanding of palliative care coding practices, a detailed analytical study was required to quantify the degree of impact on the HSMR indicator.

As such, chapter three will explore the research question *What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?*. The Discharge Abstract Database will be used to assess all hospitalizations in Canada, while Vital Statistics will inform the number of deaths occurring outside hospital-settings. In this longitudinal study covering 2006 to 2013, patient characteristics (including demographics and the Charlson Comorbidity Score) will be compared over time to understand changes to risk-adjustment values in HSMR model specifications. To measure any impact of palliative care coding on the HSMR indicator, a new HSMR-Palliative Care indicator will be calculated to include palliative care cases; these two indicator results (with and without palliative cases) will be used to determine the degree of influence palliative care cases can have at the hospital, provincial/territorial, and national levels. The quality of palliative care coding will be assessed against national coding guidelines and measured throughout the study period.

Trends in Performance of Hospital Outcomes

Hospital performance management schemes hold substantial consequence (as a result of their development and execution). Similarly, if systems-level hospital quality improvement initiatives are to be effective, they must be responsive to the changing needs and landscape of hospital performance.

But in Canada, a comprehensive assessment of systems-level trends of hospital performance had yet to be published. Hospital performance management schemes and systems-level quality improvement initiatives, therefore, may not accurately reflect the evolving landscape.

Detailed, diverse, and complementary breakdowns of performance data are required to understand how hospitals perform (both at the individual and systems-levels). However, outcomes on hospital performance are generally narrow in scope, capturing a specific clinical disease or procedure, a small group of participating hospitals or hospital types (or even specified units within a hospital), and often do not span a prolonged time-period.

Moreover, Canada's unique and vast geography, and in turn the distribution and organization of hospital services, warrants inquiry into performance outcomes across the four hospital types (Teaching, Community-Large, Community-Medium, and Community-Small hospitals) and 13 provincial/territorial regions. Yet, the limited number of Canadian studies reporting on hospital performance described either a narrow clinical focus or hospital type, and generally captured a short time-span.

Furthermore, rigorous research was lacking in Canada on how hospitals performed across multiple outcome indicators and domains of care; for example, there was an absence of summary-level findings that illustrated recent performance trends of hospitals throughout the country on outcome measures in the appropriateness, effectiveness and safety of care delivered by hospitals.

As such, the research question *What are the performance trends on hospital outcome indicators?* will be explored in chapter four through a longitudinal analysis of eight hospital performance indicators covering the domains of appropriateness, effectiveness and safety of care; hospital performance data spanning 2012 to 2017 will be used from the Your Health System (YHS) online public tool. Performance trend categorical results are available for a total of 489 Canadian hospitals. Performance trend outcomes for hospitals will be disaggregated by indicator, hospital peer group, provincial/territorial jurisdiction. Any significance of national trends over time will be determined through linear regression analyses.

Interrelatedness of Hospital Outcomes

As previously discussed, it is worthwhile to simultaneously analyse disparate hospital outcome measures in order to glean meaningful insights on overall hospital performance. This is evermore true when hospital outcome measures are tied to divergent performance priorities; thus, requiring particular attention in the implementation of hospital performance management schemes.

The tendency in practice has been to highlight a particular performance domain that requires attention and correction; frequent examples include the need to reduce

in-hospital mortality, to reduce the number of readmissions to hospital, or to become more efficient in resource use (i.e., optimize the length of an average hospital stay).

Despite their widespread use in performance management mechanisms, to what degree these three disparate performance domains are interrelated is still not well understood. Several studies have examined the level of association between in-hospital mortality, readmission, and the patient's length of stay (LOS) in hospital[35,36]; however, the area of work remains inconclusive, partly due to the wide heterogeneity in methods and data used in the analyses[37, 38, 39].

As previously noted, much of the scientific literature on Canadian examples of hospital outcomes measurement largely focused on a targeted group of hospitals (usually Teaching facilities), assessed a narrow clinical domain, and likely captured a short time-span. Due to this absence of conclusive evidence, performance management mechanisms could potentially cause unintended consequences in the prioritization of one outcome over others.

As such, in chapter five, three indicators (hospital death, readmission, and length of stay) and eight hospital characteristics measures will be used to address the research question *What is the degree of association between hospital performance outcome indicators?* A subset of 119 teaching and large-sized hospitals will form the longitudinal study covering 2013 to 2018; data will be obtained from the YHS public online tool. Repeated measures analyses will determine the significance of change in hospital-performance over time. Correlation analyses will determine the level, direction and significance of interrelatedness across outcome indicators and eight hospital characteristic measures. Lastly, hospital performance outcomes of improving or worsening trends will be categorized and quantified.

Research Aims and Outline of the Thesis

The main aim of this dissertation is to contribute to the field of outcomes measurement. The Canadian health system and hospital performance contexts will be used for the analysis. A series of outcome measures, data types and sources, and analytical methods will be applied (see Table 2). The results of the analyses are presented as discrete publications.

The specific research questions of this thesis are:

1. What is outcomes measurement and its state of use in Canada?
2. How are health system and hospital performance indicators evaluated and prioritized?

3. What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?
4. What are the performance trends on hospital outcome indicators?
5. What is the degree of association between hospital performance outcome indicators?

Outline of the Dissertation

This dissertation is structured into five chapters.

A general introduction describes the field of outcomes measurement in Canada and lists the research questions and analytical methods used in this dissertation.

- Chapter 1 introduces outcomes measurement, its state of use in Canada (and examples internationally), and provides recommendations on their expansion and improvement in the Canadian context.
- Chapter 2 describes the process and results of a national systematic evaluation of a suite of health system and hospital performance indicators.
- Chapter 3 evaluates the validity and impact of Palliative Care coding practices on the Hospital Standardised Mortality Ratio (HSMR) indicator.
- Chapter 4 explores hospital performance trends across multiple outcome indicators and domains of care.
- Chapter 5 investigates the degree of association between Hospital Deaths (HSMR), Readmission, LOS and hospital facility characteristics.

A general discussion synthesizes the overall findings of the thesis and the five research questions, provides a reflection on outcomes measurement and the research methods used in this dissertation, and proposes considerations for future research and policy-making.

Table 2 – Research questions, indicators investigated, study design and methods, data sources, and years covered in this dissertation

CHAPTER	RESEARCH QUESTION	INDICATORS INVESTIGATED	STUDY DESIGN & METHODS	DATA SOURCE(S)	YEARS COVERED
1	What is outcomes measurement and its state of use in Canada?	• Health Outcomes (along the 5Ds rubric, death, disease, disability, discomfort and dissatisfaction) • Patient Reported Outcome Measures (PROMs) • Patient Reported Experience Measures (PREMs) • Quality Adjusted Life Years (QALYs)	• Literature review/synthesis on outcomes measurement. • Stock-take on evolution and state of outcomes measurement in Canada. • Comparison of Canadian outcomes measurement with that of other nations and international trends.	• Scientific and grey literature.	Up to 2015
2	How are health system and hospital performance indicators evaluated and prioritized?	• 56 health system performance indicators at administrative region and hospital levels* (see Table 3 below)	• Literature review/synthesis on indicator evaluation. • Research & Experimental Development for the suggested 18 indicator evaluation criteria and the systematic process. • Two Modified-Delphi (RAND/UCLA method) exercises involving CIHI Technical and Leadership groups (providing initial scores/ rationales on evaluation of indicators) • An Online Survey of hospital and health system performance stakeholders on indicator disposition recommendations. • A two-day, in-person National Consensus Conference to ratify results of online survey and indicator evaluation recommendations.	• Scientific and grey literature. • Indicator calculation methodologies (CIHI). • Indicator utilization statistics (CIHI). • Hospital and health system performance results for ~630 hospitals and ~100 administrative regions.	2009 to 2014

CHAPTER	RESEARCH QUESTION	INDICATORS INVESTIGATED	STUDY DESIGN & METHODS	DATA SOURCE(S)	YEARS COVERED
3	What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?	• Hospital Deaths (HSMR) (with Palliative Care cases) • Hospital Deaths (HSMR) (without Palliative Care cases) • HSMR Patient characteristics • 30-day in-hospital mortality following AMI • 30-day in-hospital mortality following stroke • All Deaths (hospital and non-hospital) (Vital Statistics)	• Longitudinal analysis of patient characteristics and hospitalization descriptive statistics. • Modeling to calculate a 73rd HSMR diagnosis group (to include Palliative Care cases). • Longitudinal recalculation of national, provincial and hospital-level HSMR results (to compare results with and without palliative care cases). • Data quality analysis of national palliative care coding guidelines. • Trend analysis of Charlson Comorbidity Scores. • Linear regression analyses to determine level of association between reduction of crude mortality and HSMR results, and HSMR results with palliative care coding practices.	• Hospitalization abstracts through the Discharge Abstract Database (DAD). • HSMR, 30-day in-hospital mortality following stroke/ AMI hospital-level results through the Your Health System online tool. • Vital Statistics (mortality and population estimates) through Statistics Canada	2006 to 2013
4	What are the performance trends on hospital outcome indicators?	• Hospital deaths (HSMR) • Hospital deaths following major surgery • Medical readmission • Obstetric readmission • Readmission of patients aged 19 years and younger • Surgical readmission • In-hospital sepsis • Obstetric trauma (with instrument)	• Longitudinal analysis of 8 hospital outcome indicators for 489 Canadian hospitals, across three performance outcomes. • Linear regression analysis to determine significance of national trend over time. • Analysis of hospital performance stratified across four hospital peer-groups. • Trend analysis of hospital performance over five-year period. • Trend analysis of aggregate provincial/ territorial performance over time.	• Hospital-level results for 8 indicators through the Your Health System online tool.	2012 to 2017

CHAPTER	RESEARCH QUESTION	INDICATORS INVESTIGATED	STUDY DESIGN & METHODS	DATA SOURCE(S)	YEARS COVERED
5	What is the degree of association between hospital performance outcome indicators?	• Hospital Deaths (HSMR) • All Patients Readmitted to Hospital • Average Length of Stay (LOS) Eight hospital characteristic summary measures: • Number of Acute Care Hospital Stays • Number of Acute Care Beds • Number of Emergency Department Visits • Average Acute Care • Resource Intensity Weight • Total Acute Care Resource Intensity Weight • Hospital Occupancy Rate • Patients Admitted Through the Emergency Department (%) • Patient Days in Alternate Level of Care (%)	• Longitudinal analysis of three hospital outcome indicators and eight hospital characteristic measures over five-year period for 119 teaching and large-sized Canadian hospitals. • Repeated measures analysis to determine significance of change in hospital-level performance over time. • Correlation analysis between three hospital outcome indicators and eight hospital characteristics. • Quantification of categorical performance outcomes on Hospital Deaths (HSMR) and Readmission indicators.	• Hospital-level results for 3 indicators and eight hospital characteristics through the Your Health System online tool.	2013 to 2018

Table 3 – The suite of 56 Health System and Hospital Performance Indicators evaluated in Chapter 2

HEALTH SYSTEM-LEVEL (ADMINISTRATIVE REGION)	HOSPITAL-LEVEL
• 30-day AMI readmission • 30-day AMI in-hospital mortality • 30-day medical readmission • 30-day obstetric readmission • 30-day readmission for mental illness • 30-day readmission: patients age 19 and younger • 30-day stroke in-hospital mortality • 30-day surgical readmission • Ambulatory care sensitive conditions • Caesarean section rate • Cardiac revascularisation • Coronary artery bypass graft (CABG) • General/Family physicians per 100 000 population • Hip replacement • Hospital Deaths (HSMR) • Hospitalised AMI event • Hospitalised hip fracture event • Hospitalised strokes • Hysterectomy • Inflow/outflow ratio • Injury hospitalisation • Knee replacement • Mental illness hospitalisation • Mental illness patient days • Percutaneous coronary intervention (PCI) • Physician specialists per 100 000 population • Repeat hospital stays for mental illness • Self-injury hospitalization • Wait times for hip fracture repair	• 28-day readmission after AMI • 28-day readmission after hysterectomy • 28-day readmission after prostatectomy • 28-day readmission after stroke • 30-day AMI in-hospital mortality • 30-day in-hospital mortality following major surgery • 30-day medical readmission • 30-day obstetric readmission • 30-day overall readmission • 30-day readmission: patients age 19 and younger • 30-day stroke in-hospital mortality • 30-day surgical readmission • 90-day readmission after hip replacement • 90-day readmission after knee replacement • Birth trauma • Caesarean section rate • Hip fracture surgery within 48 hours • Hip fracture surgical procedures performed within one facility (48 hours) • In-hospital hip fracture in elderly (age 65+) patients • Low-risk caesarean section • Nursing sensitive adverse events for medical patients • Nursing sensitive adverse events for surgical patients • Obstetric trauma—vaginal delivery with instrument • Obstetric trauma—vaginal delivery without instrument • Primary caesarean section rate • Use of coronary angiography following AMI • Vaginal birth after caesarean section

References

1. Papanicolas I, Smith P. Health system performance comparison: an agenda for policy, information and research. London; McGraw-Hill Education (UK): 2013.
2. World Health Organization. (2000). The World Health Report2000 –Health Systems: Improving Performance. World Health Organization.
3. Nolte E, Wait S, McKee M. Investing in health. Benchmarking health systems. The Nuffield Trust. 2006.
4. Nolte E, McKee M, Wait S. (2005) Describing and evaluating health systems. In: Bowling, A. and Ebrahim, S. (eds.) Handbook of health research methods: Investigation, measurement and analysis. Maidenhead: McGraw-Hill/Open University Press.
5. Tomasich F, Oliveira AV, Oliveira AJ, Correia MITD. The history of quality and safety of the surgical patient: from the initial standards to the present day. Rev Col Bras Cir. 2020;47:e20202650.
6. Canadian Institute for Health Information. Health Outcomes of Care: An Idea Whose Time Has Come. Ottawa. 2012.
7. CIHI. National Health Expenditure Trends, 2020. Ottawa. 2021.
8. Campanella P, Vukovic V, Parente P, Sulejmani A, Ricciardi W, Specchia ML. The impact of Public Reporting on clinical outcomes: a systematic review and meta-analysis. BMC Health Serv Res. 2016;16:296.
9. Donabedian A. (1989). The End Results of Health Care: Ernest Codman's Contribution to Quality Assessment and Beyond. The Milbank Quarterly. 67(2), 233-256.
10. Brand RA. Biographical sketch: Ernest Amory Codman, MD (1869-1940). Clin Orthop Relat Res. 2013;471(6):1775-1777.
11. Donabedian A. The Quality of Care: How Can It Be Assessed? *JAMA*. 1988;260(12):1743–1748
12. Donabedian A. Evaluating the quality of medical care. 1966. Milbank Q. 2005;83(4):691-729.
13. MacDougall H. (2007). Reinventing public health: a new perspective on the health of Canadians and its international impact. *Journal of epidemiology and community health*, *61*(11), 955–959.
14. Lalonde M. A new perspective on the health of Canadians: a working document. Ottawa: Government of Canada, 1974.

15. Mikkonen J, Raphael D. (2010). Social Determinants of Health: The Canadian Facts. Toronto: York University School of Health Policy and Management.

16. Institute of Medicine Committee on Quality of Health Care in America; Kohn LT, Corrigan JM, Donaldson MS, editors. To Err is Human: Building a Safer Health System. Washington (DC): National Academies Press (US); 2000.

17. Institute of Medicine. 2001. Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, DC: The National Academies Press.

18. Baker GR, Norton PG, Flintoft V, Blais R, Brown A, Cox J, et al. (2004). The Canadian Adverse Events Study: the incidence of adverse events among hospital patients in Canada. *CMAJ: 170*(11), 1678–1686.

19. Wolfson M, Alvarez R. Towards integrated and coherent health information systems for performance monitoring: the Canadian experience. In: Smith PC, ed. Measuring up: improving health system performance in OECD countries. Paris, OECD, 2002:133–155.

20. Morris M. Standing on the Shoulders of Giants: History of Statistics Canada: 1970 to 2008; Ottawa, Statistics Canada; 2018.

21. CIHI. CIHI: A History. Ottawa, 2021; https://www.cihi.ca/en/cihi-a-history Accessed 10 May 2020.

22. Dolan D, Grainger J, MacCallum N, Creatura D, Forrester J, Shiller S. The Institute for Clinical Evaluative Sciences: 20 years and counting. Healthc Q. 2012; 15(4):19-21.

23. Lacroix J, Cooper K. Providing Meaningful and Actionable Health System Performance Information: CIHI's 'Your Health System' Tools. Proceedings of Statistics Canada Symposium-Growth in Statistical Information: Challenges and Benefits 2016; Ottawa: Statistics Canada.

24. Vogel L. Landmark tool assesses Canadian hospitals. CMAJ May 2012;184(8):866.

25. OECD. Strengthening Health Information Infrastructure for Health Care Quality Governance: Good Practices, New Opportunities and Data Privacy Protection Challenges. Paris. 2013.

26. Colton D. Quality improvement in health care. Conceptual and historical foundations. Eval Health Prof. 2000 Mar;23(1):7-42.

27. Licciardone JC. The evolving role of outcomes measurement and management in healthcare. J Am Osteopath Assoc. 1997 May;97(5):290-2.

28. Saskatchewan Health Quality Council. Think big, start small, act now: tackling indicator chaos: a report on a national summit. Saskatoon, 30–31 May 2011.

29. Mattke S. When should measures be updated? Development of a conceptual framework for maintenance of quality-of-care measures. Qual Saf Health Care 2008;17:182–6.

30. Fekri O, Leeb K, Gurevich Y. Systematic approach to evaluating and confirming the utility of a suite of national health system performance (HSP) indicators in Canada: a modified Delphi study. BMJ Open 2017;7:e014772.

31. CIHI. Rethink, Renew, Retire: Report from the Fourth Consensus Conference on Evaluating Priorities for Canada's Health Indicators. Ottawa. 2015.

32. Jarman B, Gault S, Alves B, Hider A, Dolan S, Cook A, et al. Explaining differences in English hospital death rates using routinely collected data BMJ 1999; 318:1515

33. CIHI. HSMR: A New Approach for Measuring Hospital Mortality Trends in Canada; Ottawa. 2007.

34. Chong CA, Nguyen GC, Wilcox ME. Trends in Canadian hospital standardised mortality ratios and palliative care coding 2004-2010: a retrospective database analysis. BMJ Open. 2012;2(6):e001729.

35. Kaboli PJ, Go JT, Hockenberry J, Glasgow JM, Johnson SR, Rosenthal GE, Jones MP, Vaughan-Sarrazin M. Associations between reduced hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. Ann Intern Med. 2012 Dec 18;157(12):837-45.

36. Kutz A, Gut L, Ebrahimi F, Wagner U, Schuetz P, Mueller B. Association of the Swiss Diagnosis-Related Group Reimbursement System With Length of Stay, Mortality, and Readmission Rates in Hospitalized Adult Patients. JAMA Netw Open. 2019 Feb 1;2(2):e188332.

37. Finney JW, Humphreys K, Kivlahan DR, Harris AH. Why health care process performance measures can have different relationships to outcomes for patients and hospitals: understanding the ecological fallacy. Am J Public Health. 2011 Sep;101(9):1635-42.

38. Hofstede SN, van Bodegom-Vos L, Kringos DS, et al. Mortality, readmission and length of stay have different relationships using hospital-level versus patient-level data: an example of the ecological fallacy affecting Hospital performance indicators. BMJ Qual Saf 2018;27:474–83.

39. Finney JW, Humphreys K, Kivlahan DR. et al. Excellent Patient Care Processes in Poor Hospitals? Why Hospital-Level and Patient-Level Care Quality-Outcome Relationships Can Differ. J GEN INTERN MED 31, 74–77 (2016).

CHAPTER 1
WHAT IS OUTCOMES MEASUREMENT AND ITS STATE OF USE IN CANADA?

Jeremy Veillard, Omid Fekri, Irfan Dhalla, Niek Klazinga

This chapter was published as:

Measuring Outcomes in the Canadian Health Sector: Driving Better Value from Healthcare Better

CD Howe. Policy Commentary, No.438, November 2015, Healthcare Policy

ABSTRACT

While Canada has a well-established tradition of transparency and accountability for health-system performance comparisons, few measures of outcomes are reported. In this Commentary, we examine what outcomes measurement is; the state of outcomes measurement in Canada; and offer recommendations so that the generation of better information on health system outcomes can help achieve greater value in the health sector.

Outcome measures help to better understand how effectively the health system achieves its goals, support better decision-making by relating investment decisions to outcomes, and better match the delivery of health and social services to the evolving needs of populations and patients. From a research perspective, outcome measures help better understand how policy interventions and healthcare services can contribute to achieving targeted outcomes and their role in the broader social determinants of health. And from a democratic perspective, publicizing outcome measures can empower patients, families and communities to engage in the policy debate about which outcomes matter most and at what cost – and in the ways healthcare should be delivered.

Among our key recommendations:

- The federal and provincial governments should complement current data with outcome measures of relevance to patients, clinicians, system managers and policy practitioners. In particular, patient-reported outcome measures and patient reported experience measures should augment datasets currently available in pan- Canadian clinical registries.
- Organizations with a mandate to report publicly on health-system performance, such as the Canadian Institute for Health information and provincial health quality councils, should collect outcomes data and report publicly on outcomes, filling current gaps in outcomes measurement and public reporting.

The ultimate yardstick of success, however, will not be the quantity and accuracy of Canadian healthcare outcomes data, but rather how this information is put to use by clinicians, system managers and policy-makers to advance health system goals. Better measurement can only take us so far. More critical is how the data will be aggregated, analyzed, risk-adjusted and, most importantly, how public policy and other interventions will incent professionals to improve outcomes and patients to demand better outcomes and value from the healthcare sector.

Measuring health outcomes more effectively holds great potential to improve the quality and effectiveness of healthcare in Canada, and ensure the system is delivering value for money

According to the World Health Organization (WHO), a healthcare system's goals are to improve health; be responsive to the needs of patients and the public; protect patients from financial hardship when they are sick; and to achieve these objectives in an efficient manner (WHO 2008). For their part, Canadians also expect to have access to quality healthcare services when and where they need them, to be treated with respect and be involved in decisions about their treatment. Canada devotes considerable resources toward achieving these goals. Total healthcare expenditures were projected to reach $219.1 billion in 2015, or $6,105 per person (CIHI 2015). Canadians want their health system to be the best it can be while providing value for money, so a basic and important question is whether this investment is meeting their primary goals.

Yet, there are important areas of the Canadian health system that are not subject to adequate measurement. Where indicators of health- system performance are abundant and allow for comparisons and learning, they most commonly focus on inputs, resource utilization and access to care, or more recently, quality of care. While these indicators are important, they do not provide a complete picture of how the Canadian healthcare system is performing in relation to its primary goals.

In contrast, other public services have made substantial progress in measuring outcomes. The education sector, for example, reports pan-Canadian indicators of educational performance, focused mainly on student achievement in core areas. These initiatives are not without their critics, particularly for being too narrow in scope. Nevertheless, the use of education outcome indicators has been very effective at stimulating policy debates among, and within, provinces about how to improve outcomes. These indicators have also promoted best practices across the country related to teaching and learning strategies.

In the health sector, there are advanced approaches to the measurement and reporting of outcomes that show more can be done to better measure outcomes in Canada. The UK National Health Service (NHS) Outcomes Framework, for one, provides an overview of key expectations for the healthcare systems and results for these indicators are regularly reported publicly (Table 1). Interestingly, a number of these indicators are already reported by the Canadian Institute for Health Information

(CIHI), but with notable gaps around the measurement of patient experience and harm to patients.

From an accountability and transparency perspective, one can use outcome measures to better understand how effectively the health system achieves its goals – and delivers value to citizens. From a policy perspective, outcome measures support better decision-making by relating investment decisions to outcomes pursued as exemplified through health technology assessment and its expansion to other types of investment decisions. From a managerial perspective, outcome measures help better match the delivery of health and social services to the evolving needs of populations and patients. They also focus on the accountability of regional health authorities, care providers and front-line care staff on key results. From a research perspective, outcome measures help better understand how policy interventions and healthcare services can contribute to achieving targeted outcomes and their role in the broader social determinants of health. And, finally, from a democratic perspective, publicizing outcome measures can empower patients, families and communities to engage in the policy debate about which outcomes matter most and at what cost – and in the ways healthcare should be delivered.

Most countries are still in the early stages of developing better outcomes measurement, with few quantifiable examples of such measures producing better performance (CIHI 2012, Raleigh and Foot 2010). That said, we see performance measurement as a necessary step to steer policy and efforts to improve healthcare delivery. Recently, the Harvard Business School's Michael Porter and Dr. Thomas Lee (2013) argued similarly about the necessity to better understand health outcomes and costs to patients in order to achieve value-based healthcare, which they define as "outcomes that matter to patients relative to the cost of achieving those outcomes."

The ultimate yardstick of success, however, will not be the quantity and accuracy of Canadian healthcare outcomes data, but rather how this information advances health-system goals. Better measurement can only take us so far. More critical is how the data will be aggregated, analyzed, risk-adjusted and, most importantly, how this data will incent or inform better performance among professionals and patients.

While Canada has a well-established tradition of transparency and accountability for health system performance comparisons, few measures of outcomes are reported. In this Commentary, we examine what outcomes measurement is; the state of outcomes measurement in Canada; and offer recommendations so that the generation of better information on health system outcomes can help achieve greater value in the health sector.

Table 1 – UK NHS Outcomes Framework (2015-2016)

DOMAIN	KEY OUTCOME INDICATORS
PREVENTING PEOPLE FROM DYING PREMATURELY	• Potential years of life lost (from causes amenable to healthcare interventions) • Life expectancy at age 75 • Neonatal mortality and stillbirths
ENHANCING QUALITY OF LIFE FOR PEOPLE WITH LONG-TERM CONDITIONS	• Health-related quality of life for people with long-term conditions
HELPING PEOPLE RECOVER FROM ILL HEALTH OR FOLLOWING INJURY	• Emergency admissions for acute conditions that should not usually require hospital admission • Emergency readmissions within 30 days of discharge from hospital
ENSURING PEOPLE HAVE A POSITIVE CARE EXPERIENCE	• Patient experience of primary care • Patient experience of hospital care • Friends and family test • Patient experience categorized as poor or worse (primary and hospital care)
TREATING AND CARING FOR PEOPLE IN A SAFE ENVIRONMENT AND PROTECTING THEM FROM AVOIDABLE HARM	• Deaths attributable to problems in healthcare • Severe harm attributable to problems in healthcare

Source: UK NHS.

Part 1.
Outcomes Measurement: What Is It?

Outcomes Measurement in Healthcare

The Oxford English Dictionary defines "outcome" as "the way a thing turns out; a consequence." In healthcare, we are concerned with how things turn out after interventions to prevent, treat or cure health problems. This requires, in simple terms, that we are able to measure health states before interventions and at various points thereafter. These could include, for example, measures of vision for cataract surgery patients, or pain and mobility measures for joint replacement surgery. We might be able to say that the wait time for a hip replacement fell within acceptable limits and that the procedure was carried out according to current best practices, but unless we can measure health before and after the intervention, we cannot judge whether or not it had a beneficial impact.

In other words, we need to be able to identify the desired consequences of care (the ones that matter to patients) before measuring interventions and results. Capturing this flow will inform us about whether we are doing the appropriate things and how well we are doing them. As Michael Wolfson, a Canada Research Chair in Population Health Modelling/Populomics at the University of Ottawa, observes: "The most critical requirement is routine and repeated measures of patients' health status. There is no way to tell whether or not an intervention had a beneficial impact without knowing whether the individual's health status after the intervention was better than before (Wolfson 2011, p.271)."

This apparently simple idea is not new. One hundred years ago, E.A. Codman, a US surgeon influenced by scientific management principles, advocated for his "end-result idea," the notion that "every hospital should follow every patient it treats long enough to determine whether or not the treatment has been successful, with a view to preventing a similar failure in the future (quoted in Donabedian 1989, p.238)." More recently, a renewed interest in outcomes measurement has been fuelled by the quality improvement movement that took hold in healthcare in the 1990s, drawing heavily from examples initiated by William Deming and others in the industrial sector (Colton 2000).

Measuring outcomes in healthcare, however, is different from other areas. In most economic sectors, profit, growth, market share and other measures are key performance indicators. In some ways, healthcare reverses this relationship. As Don Berwick, past president and chief executive officer of the Institute for Healthcare Improvement in Cambridge, Mass., observes, "You want hospitals that seek to be empty, doctors that seek to be idle, machines that are few (Boseley 2012)." A perfectly healthy

population would not need to visit hospitals, see doctors or use medical equipment. Although healthcare leaders and policymakers increasingly view the measurement of healthcare outcomes as essential to improving overall care, outcomes measurement is proving to be a complex endeavour.

The connection between care provided and subsequent health status is not always clear or easily ascertained, particularly over longer timeframes and when multiple care providers, settings and interventions are involved. To further complicate matters, health is not exclusively produced by healthcare. It is also shaped significantly by other important determinants such as education, housing, environment, employment and social integration.

Types of Outcome Measures: the 5Ds

Outcome measures have been captured under the rubric known as the "5Ds" (Lohr 1988): death, disease, disability, discomfort and dissatisfaction (Table 2).

It has long been recognized that death rates alone are not sufficient for evaluating the quality of healthcare. There are several reasons for this. First, although many deaths can be prevented by high-quality healthcare, some cannot, at least not with the current state of medical knowledge. For example, effective treatment is still not possible for most patients with pancreatic cancer.

Second, the death rate from many preventable diseases, such as coronary artery disease, is related not only to the quality of healthcare but also to other factors such as smoking rates. If smoking rates were to decrease over the next decade, the number of deaths due to coronary artery disease might decrease, even if the quality of healthcare worsened. Income, education, housing and many other social determinants of health similarly influence health, but the levers available to influence them often lie outside of the span of control of health ministries.

Third, death occurs too rarely (fortunately) for it to be used as a quality indicator for many health conditions. For example, patients are very unlikely to die from osteoarthritis, but their quality of life may be significantly affected.

Meanwhile, a number of morbidity measures developed in the mid-1960s have made population- level information about disease (such as incidence, prevalence and severity) more accessible (Bergner 1985), providing an additional dimension to the study of health status. By the mid-1970s, indices examining function and disability (related to aging or disease) had been developed, adding a third dimension (Bergner 1985, Tennant and McKenna 1995).

In the 1970s, a new genre of health-related, quality-of-life measures were developed that moved beyond death, disease and functional impairment to include physical

and mental well-being (Greenfield and Nelson 1992). At the same time, the concept of patient satisfaction (Mpinga and Chastonay 2011) began to be used to measure patient perceptions of their care.[1]

The more focused the aim of measurement, the more detailed data sources and measures are required (Table 2). Disease-specific outcome measures, such as how far a patient with a chronic lung disease can walk within six minutes, may be more useful than death rates alone and have a better, but still limited, actionability when it comes to health-system improvement. Similarly, reducing the prevalence of measles, hypertension and diabetes, increasing five-year survival rates for cancer and reducing impairment caused by problems of vision, mobility or hearing are all useful measures for assessing system performance.

The disease-based measures also align well with medical reasoning and the logic with which most medical services are organized (e.g., vaccination services, primary care, cancer services) while disability measures come closer to capturing the experience of health problems, albeit on a functional level. Meanwhile, patient satisfaction assessments provide useful information about the perceptions patients have of their healthcare experiences.

An increasingly widely used measure of health improvement that is also used to guide resource allocation in some jurisdictions is the quality- adjusted life year (QALY) (Weinstein, Torrence and McGuire 2009). Unlike most of the measures discussed above, which focus on particular treatments, QALYs enable comparisons across different diseases, which is why they are so useful for resource allocation.

QALYs take into account the increase in life expectancy that is expected from an intervention, but because living longer alone may not be a sufficient measure of success, QALYs also take into consideration changes in quality of life. In a comparative cost utility analysis, the benefits of a new intervention in terms of cost per QALY are compared to the costs of existing interventions. Disability measures, patient satisfaction and health- system responsiveness measures can all improve the accuracy in which QALYs are expressed, which together help to inform healthcare decisions that are made with limited public resources.

1 Notable examples include the EuroQol EQ-5DTM, the 36-item Short Form Health Survey (SF-36) and the Health Utilities Index.

Table 2 – The 5Ds Rubric

DOMAIN	MEASUREMENT GOAL	EXAMPLES OF INDICATORS
DEATH	Quantification of life and death	• Potential years of life lost, avoidable mortality, life expectancy
DISEASE	Understand prevalence and incidence, disease severity, responsiveness to treatment	• Symptoms, physical signs, laboratory abnormalities, prognosis • Generic and disease-specific measures
DISABILITY	Level of functioning/ impairment	• Disability adjusted life expectancy • Days of disability, activity restrictions • Activities of daily living • Generic and specific disability measures
DISCOMFORT	Level of discomfort	• Pain, nausea, dyspnea, emotional responses (e.g., distress, anger, sadness) • Generic and disease-specific measures • Quality adjusted life years
DISSATISFACTION	Patient perceptions of the quality and other aspects of care	• Quality, access, availability, cost of care • Patient experience

Source: Lohr, 1988.

Patient Perspectives

Until recently, outcomes were determined from a clinical perspective. Was the operation a success? Has the wound healed? Increasingly, though, the paradigm is shifting toward outcomes determined from a patient perspective. Was the operation a success for me? Can I walk better? Do I feel better? Can I function optimally, at work and in my personal life?

Formally, this shift is reflected in what are called patient-reported outcome measures (PROMs), which reflect patients' views of their symptoms, their functional status and their quality of life, along with patient-reported experience measures (PREMs). PREMs focus on actual, more easily measurable care experiences such as whether the patient was seen on time, whereas PROMs focus on outcomes experienced and reported directly by patients.

PROMs were initially used as research instruments to supplement information gathered through clinical trials but, as the patient voice becomes predominant in the context of outcome measurement, their use is expanding into healthcare performance assessment, providing a much needed extension of the existing suite of outcome measures.

There are two broad categories of PROMs: disease specific and generic (Black 2013). The former focus on the symptoms and impact of specific health conditions, while the latter collect information on pain, function, mental health and, more generally, the ability to perform activities of daily life. In this way, PROMs go beyond function and health status to measure quality of life, a dimension that reflects the ways in which patients perceive and react to their health status and situate it in the broader context of their lives. As a result, patient-reported outcomes provide a much needed patient-centred perspective on the health status measures of disease, disability and well-being.

Part 2. The State of Outcomes Measurement in Canada

Canada has made progress on outcomes measurement in recent years. Since the early 1990s, several provincial exemplars have emerged, while the two leading national health information agencies, the Canadian Institute for Health Information (CIHI) and Statistics Canada have brought about significant improvements in the country's health information infrastructure. Population health outcomes can be assessed to some extent at the national, provincial and regional level through instruments such as the Canadian Community Health Survey (CCHS) and the Commonwealth Fund Survey, which incorporate validated and widespread measurement tools such as a health-utilities index and a short-form suite of questionnaires.

Standardized databases enabling provincial comparisons were also developed in the areas of home and long-term care, rehabilitation and mental health, all of which derive their information from longitudinal client assessments, which involve repeated observations over multiple years. In addition, provinces have invested in the development of a small number of specialized longitudinal clinical databases (clinical registries). CIHI is also involved at the international level, working with the Organisation for Economic Co-operation and Development (OECD) on the development of internationally comparable PROMs and data collection of health indicators for primary care, mental health, patient safety and experience.

How does Canada Compare Internationally?

Despite notable progress in Canada, much remains to be done if we are to better use outcomes measurement to improve population health, patient experience and deliver better value for money. Table 3 below describes the state of outcomes measurement

for each of the five domains of outcomes measurement identified previously and compares where Canada stands with other developed countries.

Table 3 – Canada's Comparative Progress on Outcomes Measurement

5Ds DOMAIN	CANADA'S STATE OF OUTCOMES MEASUREMENT	INTERNATIONAL TRENDS
DEATH	• Ability to analyze in-depth all deaths that occur in hospital. • Greater ability to link death records to health records or to disease registries. • Analysis of deaths is limited to the principal cause.	Leading countries moving beyond estimates of life expectancy or simple mortality measurement to quantification of excess mortality for sub-categories of the population (e.g. people with mental health issues), linking vital statistics to disease-based registries. Example: excess mortality for people with mental health conditions (South Korea, Slovenia, Denmark, New Zealand, Finland, Israel, Sweden) based on linkage of death data and disease-based registries.
DISEASE	• Limited number of pan-Canadian clinical registries (cancer, hip/knee replacement, organ replacement, and multiple sclerosis). • Canadian Community Health Survey. • Canada considering collecting PROMs as part of targeted clinical registries. • Eight provinces and territories have adopted common standards (interRAI) for home and continuing care, mental health, including information on outcomes. • Limited ability to systematically track stages of development/ severity of chronic conditions.	Extensive and advanced use of clinical registries in Sweden, Denmark, UK, US. Established use of PROMs in the UK and increasingly in Sweden and the US. Over 40 countries are now using the InterRAI assessment tools for an increasing number of domains, care settings and disabilities.

5Ds DOMAIN	CANADA'S STATE OF OUTCOMES MEASUREMENT	INTERNATIONAL TRENDS
DISABILITY	• Outcomes measures related to disability are partially available through the InterRAI assessment systems in eight provinces through the CCHS Health Utilities Index and on a small scale through pilot-data collection of patient-reported outcomes measures.	Established use of PROMs in the UK and, increasingly, in Sweden and the US. 40 countries are using the InterRAI assessment tools for an increasing number of domains, care settings and disabilities.
DISCOMFORT	• Canadian provinces are at the preliminary stages of introducing patient-reported outcome measures.	Established use of PROMs in the UK and, increasingly, in Sweden and the US.
DISSATISFACTION	• A standardized pan-Canadian Patient Experience Reporting Survey for acute care services currently is being implemented in five provinces: British Columbia, Alberta, Manitoba, Ontario and New Brunswick. • The redesigned CCHS survey administered by Statistics Canada (2015) includes internationally comparable questions adapted by the OECD from Commonwealth Fund surveys and related to patient experience with ambulatory care services. • The Commonwealth Fund Survey collects information about patient experience for Canada.	The UK, US, the Netherlands and Norway have made substantial progress in the measurement of patient experience (US Consumer Assessment of Healthcare Providers and Systems, UK NHS Patient Experience Framework and the Dutch Centre for Consumer Experience in Healthcare).

Source: Author's compilation.

Outcomes Measurement: A Priority for Policymakers and Managers

Every five years, CIHI and Statistics Canada convene a national conference of health-sector stakeholders to consider priorities for health- information reporting and analysis. The fourth such pan-Canadian Consensus Conference on Health Indicators was held in October 2014 and received clear directions from national stakeholders (i.e., policymakers, systems managers, clinicians, researchers and patients asking for greater collection and use of outcomes measures at the patient and system levels in order to make better decisions, manage more effectively and provide better care (CIHI 2015a).

Enhancing the capacity to measure outcomes will require better and more extensive data collection, data linkage and greater use of electronic health records (EHRs). Currently, assessments of health-system performance in Canada are largely unable to track the care trajectories of patients and related outcomes such as the succession and interactions of encounters with the healthcare system and longer-term outcomes of patients once they leave care settings.

Despite significant advances in health information infrastructure over the last two decades, in most cases we lack the data or ability to link data that makes these trajectories visible. Data linkage and EHRs can provide the means for enhancing such visibility. At root, development of capacity in these areas is less about overcoming technical challenges than about creating the regulatory environment in which this can be done in ways that ensure balancing the need to protect privacy while meeting information needs (Protti 2015).

Using QALYs for Decision-making

Although Canadian researchers have been at the forefront in the development of QALY methodologies, their use in Canada remains limited. Independent agencies such as the Canadian Agency for Drugs and Technology in Health (CADTH), Health Quality Ontario and l'Institut National d'Excellence en Santé et en Services Sociaux in Quebec all use QALYs when conducting evaluations of new drugs, diagnostic tests and procedures in order to provide healthcare decision-makers with guidance in the face of rapid technological and pharmacological change. QALYs also have applications beyond the evaluation of drugs and devices and could be used more broadly when new areas of use increase (Husereau 2011).

How PROMs and PREMs Can help

While Canada is in the early stages of PROM data collection and reporting, PROMs have become a centrepiece of outcomes measurement in Sweden, the UK and parts of the United States (Black 2013). In the UK, PROMs were first implemented in 2008, and their use has been expanded and made mandatory in certain areas such as elective surgeries. They are now included in the National Health Service (NHS) Outcomes Framework (NHS Group, Department of Health 2014), specifically within the domains of enhancing quality of life for people with long-term conditions and ensuring people have a positive experience of care (see Table 1).

In February 2015, CIHI hosted a pan-Canadian PROMs forum aimed at highlighting the importance of collecting outcome measures, sharing best practices and experience, and holding discussions on a framework to guide future initiatives. Participants identified a range of useful PROMs for policymakers and patients (Table 4) (CIHI 2015b).

Patient perceptions of their care can also guide service improvement and inform the redesign of the healthcare experience (health-system responsiveness). Meanwhile, PREMs go well beyond the limited focus of satisfaction surveys to hone in on the experience of care itself, such as whether it was perceived as respectful and whether the patient was involved in treatment decisions. PREMs can prove particularly valuable in improving interactions with healthcare personnel and addressing challenges with access, navigability of facilities and gaps in services.

The publication of patient experience results has also been advanced as supporting patient choice. However, there is yet little evidence supporting the argument that greater access to information by patients leads to different care-consumption patterns, particularly in contexts where access challenges limit patient options.

Though interest is increasing across Canada, the collection of patient-reported experience measures is still in very preliminary stages, and we lag behind other countries that have established initiatives such as the US Consumer Assessment of Healthcare Providers and Systems, the UK NHS Patient Experience Framework and the Dutch Centre for Consumer Experience in Healthcare.

Table 4 – Value of PROMs Identified by Canadian Stakeholders

STAKEHOLDER	USES
HEALTH-SYSTEM POLICYMAKERS/ SYSTEM MANAGERS	• Compare outcomes locally, regionally and provincially over time, as well as with similar regions and jurisdictions. • Compare different care models and clinical pathways for outcomes analysis. • Support health-service allocation decisions informed by information about the relative cost of achieving desired outcome states ("value-based care"). • Identify clinical organizations and/or regions that would benefit from further support in building better capacities to improve outcomes.
HEALTH CARE ORGANIZATIONS	• Monitor organization and provider performance, compare with peer organizations and identify organizations with high outcomes scores for engagement and improvement. • Identify areas and providers that would benefit from further education and support.
HEALTH CARE PROVIDERS	• Direct feedback that can be used to modify patient care pathways and provide evidence toward improving or maintaining a high level of care and expected outcomes. • Support improved clinician-patient communication and raise awareness of problems that would otherwise be unidentified. • Facilitate performance comparisons with expected standards.
PATIENTS	• Opportunity to provide input from their perspective and to be more aware of expected outcomes and how they compare. • Opportunity to provide feedback independent of their provider's view and also potentially identify providers with poor outcomes results. • Enhance communication with care providers and patient involvement in care planning and decision-making.

Source: CIHI 2015b.

Part 3. Strengthening Outcomes Measurement in Healthcare in Canada

The collection, reporting and use of outcome measures in decision-making are critical to creating better value for health systems. The investments made to develop health-outcomes measurement should aim to strengthen information infrastructure and improve quality of care and policy development. In addition, improved health-system management recommendations speak specifically to governance and incentives that ensure appropriate alignment with health-system goals.

There are several initiatives that would strengthen the collection and dissemination of outcomes measurement in the Canadian healthcare sector.

(1) Canada already benefits from a strong data infrastructure with high-quality administrative, survey, census and vital statistics. Further investments should be made by the federal and provincial governments to complement this infrastructure with outcome measures of relevance to patients, clinicians, system managers and policy practitioners. In particular, patient- reported outcome measures and patient reported experience measures should augment datasets currently available in pan-Canadian clinical registries. In addition, cost information should be expanded to cover the continuum of care and inform better policymakers on the value of specific interventions benefiting patients.

(2) Additional efforts to strengthen underlying information systems should focus on developing a national, standardized approach to the systematic measurement of patient experiences across the continuum of care, improving the coding of secondary causes of death and continuing the adoption across Canada of outcome measurement tools developed by the interRai international collaborative network.

High-quality surveys administered by Statistics Canada such as the CCHS should be augmented by a common instrument measuring population- level health outcomes like the EQ5D or Veterans RAND (VR) 12 instruments currently being explored in Alberta and British Columbia. As well, longitudinal surveys such as the Canadian study on ageing should be exploited to deliver better information on health outcomes over time.

(3) The expansion of electronic health and medical records should include the collection of minimum data sets (content standards), allowing for pan-Canadian comparisons. The data should include measures of patient experience and patient-reported outcomes for use by clinicians, system managers and policy practitioners. In the near future, we should be routinely capturing data about relevant symptoms and quality of life before and after every significant intervention (e.g., joint replacement, use of a new drug, etc.).

(4) Further efforts should be made by national health information agencies and research organizations to link datasets across the care continuum and more broadly with other types of datasets influencing health outcomes such as education, housing and employment datasets. Such linkage should be done in a way that, while respecting privacy, maximizes the use of information for policymaking, system management and clinical care.

(5) Opportunities to augment linked national datasets with data from the private sector (for example, from insurance companies or from workers' safety compensation agencies) should be explored with a view to maximizing the use of this information while respecting patient and workers privacy safeguards.

(6) Organizations with a mandate to report publicly on health-system performance, such as CIHI and provincial health quality councils, should expand their data collection efforts to report publicly on outcomes, filling current gaps in outcomes measurement and public reporting.

(7) With appropriate data risk-adjustments in place, measurement and public reporting of clinician- level outcomes (e.g., mortality rates for patients of individual cardiac care surgeons) should be considered. The development of clinician- level outcome indicators should ideally be led by societies of specialists. Reporting should be done privately to individual clinicians until there is enough confidence that methods are robust enough to support public disclosure. The UK NHS, for example, reports outcomes for individual specialists and family practices. In the US, the Physician Quality Reporting System encourages "eligible professionals" – those paid through Medicare – to report information on the quality of their care. While the information is not made public, the system enables peer comparisons. Beginning in 2015, negative payment incentives will be implemented to encourage further participation in this benchmarking mechanism.

How to Use Health-System Outcome Measures

Porter and Lee propose five components in their patient value agenda (2013), in addition to building an enabling technology platform. They consist of:

(i) organizing care into integrated practice units;

(ii) measuring outcomes and costs for every patient;

(iii) moving to bundled payments for care cycles;

(iv) integrating care delivery across separate facilities; and

(v) expanding excellent services across geography.

These recommendations are aligned and supportive of current policy in a number of provinces that are attempting to introduce alternative care delivery models, integrating services for high-needs, high-cost patients. As well, these alternatives are characterized by payment schemes that incent providers to deliver services meeting minimum clinical requirements, pay for bundles of care across cycles organized around the patient experience rather than by provider silo and, more broadly, integrate care across different facilities. To be successful, these policy experiments are highly dependent on the generation of timely, accessible information on care outcomes and costs.

Accordingly, we recommend that:

(1) Provincial governments:

I. define health-sector targets to be reached with available resources;

II. ensure that PROMS and other clinical outcome measures are embedded in future funding models, together with costing data integrated across the continuum of care;

III. provide agencies responsible for evaluating new drugs and technologies with the regulatory power to enforce their recommendations;

IV. strengthen their ability to benchmark and learn from innovations to improve health outcomes and compare their approach to the impact of outcomes measurement and reporting in other sectors such as education; and

V. communicate desirable goals and targets to health professionals, with their engagement throughout the development and use of outcomes data.

(2) Regional health authorities and healthcare delivery organizations shift their accountability approaches from volume and quality of care only to include outcomes measurement in their sets of key performance indicators and report publicly on their plans to improve outcomes and related results.

(3) CIHI, Statistics Canada and provincial health- quality councils accelerate their efforts to regularly report better measures of health-system outcomes and healthcare costs with the objective of informing the general public about the value created by the Canadian health system for Canadians.

(4) The federal Canadian Institutes for Health Research and other health research funders provide incentives to the health-services research community to deliver a more ambitious research program on outcomes measurement and improvement.

Conclusion

The use of health-outcome indicators can inform policy debates among, and within, provinces about how to improve outcomes while enabling knowledge-sharing about the effectiveness of different policies, procedures and strategies. We see the growth in measuring health outcomes and disseminating the results as important aspects in improving the value of health services and enabling broader change. Certainly, in other public services like public education better outcomes measurement over time has led to more structured, evidence- based debates on policy and quality.

There are some international examples of successes that have arisen due to the collection of better health data, but widespread use and measured improvements have not been fully accomplished yet in any advanced nation. Producing quality outcomes data is not sufficient – such data must lead to advancement of health-system goals. Achieving this will require not only the appropriate analysis of the data but also integration with elements of health-system design, such as financing and accountability rules.

A recent study by the King's Fund in England concluded that population-based health systems tend to deliver better outcomes and share the common characteristics of: (i) wrapping care integration around patients' and people's needs with proper planning for health and equity; (ii) pooling data from various population and equity perspectives and analyzing data with a view to improving outcomes; (iii) designing proper incentives that align with better population health objectives (in particular, health promotion and disease prevention); (iv) supporting action on social determinants of health; and (v) better engaging and empowering patients and society at large, including the private sector and not-for-profit sector (Alderwick et al. 2015).

These characteristics give a sense of the coordinated policy interventions required to achieve substantially better health outcomes. Better measurement of health sector outcomes will give policymakers and the public a concrete sense of where we are, where we want to go and how well we are doing in getting there. It is an important step towards building a healthcare system delivering value to Canadians.

References

Alderwick, Hugh, Chris Ham, and David Buck. 2015. "Population Health Systems: Going Beyond Integrated Care." London: The King's Fund.

Bergner, Marilyn. 1985. "Measurement of Health Status." Medical Care 23(5): 696-704.

Berwick, Donald, Thomas Nolan, and John Whittington. 2008. "The Triple Aim: Care, Health, and Cost." Health Affairs 27(3): 759-769.

Black, Nick. 2013. "Patient Reported Outcome Measures could Help Transform Healthcare." BMJ 346: f167.

Boseley, Sarah. 2012. "US Healthcare Reform Cannot Be Undone, says former Medicare boss." The Guardian. June 15. http://www.theguardian.com/ world/2012/jun/15/us-healthcare-reform-undone (Date of Access: April 1, 2015).

Canadian Institute for Health Information (CIHI). 2012. "Health Outcomes of Care: An Idea Whose Time Has Come." Ottawa: CIHI. https://secure. cihi.ca/free_products/HealthOutcomes2012_ EN.pdf (Date of Access: September 16, 2015).

CIHI. 2014. "National Health Expenditure Trends, 1975 to 2014." Ottawa: CIHI. http://www.cihi.ca/ web/resource/en/nhex_2014_report_en.pdf (Date of Access: April 1, 2015).

–––––. 2015a. "Rethink, Renew, Retire: Evaluating Priorities for Canada's Health Indicators Consensus Conference 2014." Ottawa: CIHI. https://www.cihi. ca/en/health-system-performance/performance- reporting/indicators/rethink-renew-retire-evaluating (Date of Access: October 27, 2015)

–––––. 2015b. "PROMs Background Document." Ottawa. CIHI. https://www.cihi.ca/sites/ default/ files/document/proms_background_may21_en-web. pdf.

Colton, David. 2000. "Quality Improvement in Health Care; Conceptual and Historical Foundations." Evaluation & The Health Professions 23(1): 7-42.

Donabedian, Avis. 1989. “The End Results of Health Care: Ernest Codman’s Contribution to Quality Assessment and Beyond.” Milbank Quarterly 17 (2): 233-256.

Greenfield, Sheldon, and Eugene Nelson. 1992. “Recent Developments and Future Issues in the Use of Health Status Assessment Measures in Clinical Settings.” Medical Care 30(5) Supplement: MS23- MS41.

Husereau, Don. 2011. “Value-based Pricing of Pharmaceuticals in Canada: Opportunities to Expand the Role of Health Technology Assessment.” Canadian Health Services Research Foundation. Ottawa: CHSRF. December.

Lohr, Kathleen. 1988. “Outcome Measurement: Concepts and Questions.” Inquiry 25: 37-50.

Mpinga, Emmanuel Kabengele, and Philippe Chastonay. 2011. “Satisfaction of Patients: A Right to Health Indicator?” Health Policy, 100: 144-150.

NHS Group, UK Department of Health. 2014. NHS Outcomes Framework 2015/16. https://www.gov.uk/ government/uploads/system/uploads/attachment_ data/ file/385749/NHS_Outcomes_Framework.pdf (Date of Access: April 1, 2015).

Porter, Michael, and Dr. Thomas Lee. 2013. “The Strategy that will Fix Health Care.” Harvard Business Review 91(10): 50-70.

Protti, Denis. 2015. Missed Connections: The Adoption of Information Technology in Canadian Healthcare. Commentary 422. Toronto: C.D. Howe Institute. March.

Raleigh, Veena, and Catherine Foot. “Getting the Measure of Quality: Opportunities and Challenges.” London: The King’s Fund. https://www.kingsfund. org.uk/sites/ files/kf/Getting-the-measure-of- quality-Veena-Raleigh-Catherine-Foot-The-Kings- Fund-January-2010.pdf (Date of Access: September 16, 2015).

Tennant, Alan, and S.P. McKenna.1995. “Conceptualizing and Defining Outcome.” Rheumatology 34(10): 899-900.

Weinstein, Milton, George Torrence, and Alistair McGuire. 2009. “QALYs: the basics.” Value in Health 12(supplement 1): S5-S9.

Wolfson, Michael. 2011. “Health care is a knowledge industry, and should be more so.” In New Directions for Intelligent Government in Canada: Papers in Honour of Ian Stewart. Ottawa, ON: Centre for the Study of Living Standards, 249-282.

World Health Organization. 2008. The World Health Report 2008 – Primary Health Care (Now More Than Ever). Geneva. http://www.who.int/whr/2008/en/ (Date of Access: July 31, 2015).

CHAPTER 2
HOW ARE HEALTH SYSTEM AND HOSPITAL PERFORMANCE INDICATORS EVALUATED AND PRIORITIZED?

Omid Fekri, Kira Leeb, Yana Gurevich

This chapter was published as:

Systematic approach to evaluating and confirming the utility of a suite of national health system performance (HSP) indicators in Canada: a modified Delphi study

BMJ Open 2017

ABSTRACT

Objectives Evaluating an existing suite of health system performance (HSP) indicators for continued reporting using a systematic criteria-based assessment and national consensus conference.

Design Modified Delphi approach with technical and leadership groups, an online survey of stakeholders and convening a national consensus conference.

Setting A national health information steward, the Canadian Institute for Health Information (CIHI).

Participants A total of 73 participants, comprised 61 conference attendants/ stakeholders from across Canada and 12 national health information steward staff.

Primary and secondary outcome measures Indicator dispositions of retention, additional stakeholder consultation, further redevelopment or retirement.

Results 4 dimensions (usability, importance, scientific soundness and feasibility) typically used to select measures for reporting were expanded to 18 criteria grouped under the 4 dimensions through a process of research and testing. Definitions for each criterion were developed and piloted. Once the definitions were established, 56 of CIHI›s publicly reported HSP indicators were evaluated against the criteria using modified Delphi approaches. Of the 56 HSP indicators evaluated, 9 measures were ratified for retirement, 7 were identified for additional consultation and 3 for further research and development. A pre-Consensus Conference survey soliciting feedback from stakeholders on indicator recommendations received 48 responses (response rate of 79%).

Conclusions A systematic evaluation of HSP indicators informed the development of objective recommendations for continued reporting. The evaluation was a fruitful exercise to identify technical considerations for calculating indicators, furthering our understanding of how measures are used by stakeholders, as well as harmonising actions that could be taken to ensure relevancy, reduce indicator chaos and build consensus with stakeholders.

Introduction

Health indicators offer valuable insight into the performance of health systems and the health of populations. As the discipline of health system performance (HSP) measurement has grown over the decades, so too have the number of available health measures. In Europe alone, journal publications related to performance indicators increased at a rate of 20% annually between 2000 and 2009.[1] However,

continuing to increase the number of indicators reported runs contrary to, and inhibits, the provision of concise findings on the performance of health systems.[2] Health measure producers and users are constrained with finite resources, and must make important decisions on which indicators they deem important, have high utility, are valid and are feasible. Periodic reviews of indicators and conceptual frameworks can ensure their continued relevance and efficacy.[3]

Two national agencies, the Canadian Institute for Health Information (CIHI) and Statistics Canada, have collaborated for more than 15 years on developing and publicly reporting health measures for health regions, provinces and territories as part of the Health Information Roadmap.[4] Over the years, the number of indicators has increased from 13 in 2000 to more than 80 in 2014. This in part reflects the growing information needs of healthcare systems in general. For example, new indicators measuring outcomes, wait times and patient safety were the areas of focus for development in recent years. CIHI also expanded its indicator reporting over the years by refining the granularity of public reporting, and in 2007 began public reporting of health indicators for acute care hospitals in Canada. The indicators were developed and reported on according to the CIHI–Statistics Canada Health Indicator Framework.[5] In 2012, the suite of publicly available indicators at the hospital level was expanded substantially and in 2015, was expanded again to include indicators for long-term care homes.

After a period of rapid growth in public reporting of indicators likely due to the rising demand for accountability and quality improvement data as well as increases in capacity-building activities across the country, health system managers identified that having too many indicators to monitor and respond to was not achieving the goal of helping understand how well the healthcare system was performing. In 2010, this phenomenon was coined 'indicator chaos',[6] and initiated a new focus on streamlining indicator reporting and development activities. Partly in response to this notion of indicator chaos, but also in efforts to ensure relevancy and efficiency, CIHI initiated a programme of work aimed at streamlining health system reporting in Canada. As part of this work, CIHI developed a new HSP framework to better reflect the relationship between indicator measurement and health system goals.[5] CIHI also recognised the need to ensure that the indicators being produced and reported reflected these goals and contributed to a broader understanding of HSP rather than continuing to add to the reporting and monitoring burden across the country. This required a systematic indicator evaluation process that could be repeated periodically to inform indicator reporting initiatives across the organisation and possibly beyond.

Coincidentally, every 5 years (1999, 2004, 2009, 2014), CIHI and Statistics Canada invite stakeholders from across the country to a national Consensus Conference on Health Indicators to discuss priority setting of indicator development and reporting

for the next half decade.[7–10] The latest such conference (held in 2014) provided an opportunity to present the results of the internal evaluation of publicly reported indicators and to validate the results with stakeholders.

This paper describes CIHI's approach to evaluating a set of HSP indicators using a systematic criteria-based assessment tool and process. The results of the pilot—including achieving reconfirmation through a national consensus process—and possible next steps for broader implementation of the strategy are also presented in the paper.

Methods

This project had four distinct components:

1. Process and criteria development for systematic evaluation of HSP indicators.
2. Internal CIHI modified Delphi sessions.
3. Preconference survey of stakeholders on indicator recommendations.
4. Presentation and ratification of results at the national Consensus Conference.

Systematic evaluation of HSP indicators

The Institute of Medicine's (IOM's) *Recommendations for Measure Selection Criteria*[11]—usability, importance, scientific soundness and feasibility—are consistently used in the evaluation and selection of health measures.[12] While many examples in the literature employ these four domains of criteria, we saw the need to expand the dimensions to include other criteria within three of the four domains. Through a process of research and testing, we arrived at a total of 18 criteria points organised around the 4 IOM domains (see table 1) that were feasible to apply and that held meaning to our project objective regarding continued reporting of indicators. There is congruence between these criteria and CIHI's Data Quality Framework[13] dimensions of accuracy, timeliness, comparability, usability and relevance. Over a period of 2 months, 56 of CIHI›s suite of HSP indicators were assessed against these 18 criteria. To aid evaluators in their subsequent reviews, we created a one-page summary for each indicator denoting results for each evaluation criterion.[14]

Table 1 – Evaluation criteria

DOMAIN/CRITERION	DEFINITION
USABILITY	
Granularity of reporting	Reporting at national, provincial/territorial, regional and facility levels
Pan-Canadian coverage	Extent of participation from all provinces and territories
Comprehensiveness	Proportion of providers submitting data for the indicator
Usage	Level and extent of usage
Dimensionality	Ability to break down results by age, sex, socioeconomic status and other dimensions
Timeliness	Latest year of available results
Reporting frequency	Whether indicator is reported quarterly, annually or other
Accessibility	Whether the indicator is publicly and/or privately reported
Trendability	Number of years of available results for trending
IMPORTANCE	
Relevance	Environmental scan identified uses of indicator by stakeholders
Actionability	Extent to which providers can meaningfully influence the indicator
Stakeholder follow-up	Number of data and methodological requests within last fiscal year
Sufficient volumes	Percentage of results suppressed (due to low counts)
Significance of variation	Degree of variation across reported values
SCIENTIFIC SOUNDNESS	
Data quality	Strength of data quality, ability to validate results, based on standards
Validity review	Extent and frequency of reviewing indicator's validity/methodology
Participation bias	Mandatory or voluntary participation by providers
FEASIBILITY	
Production cost	Extent of staff/resources to produce indicator

Internal CIHI modified Delphi sessions

Two groups within CIHI participated in the evaluation. First, a technical group of experts (n=6) (comprised epidemiologists, methodologists and statisticians) independently reviewed each indicator and criterion point, and provided a Likert Scale score between 1 and 9. Likert scores were assessed as follows: 7–9 was considered as robust strength for the indicator and agreement for continued reporting; 4–6 denoted

equivocal evidence and further discussion at inperson Delphi session is required and 1–3 was considered as weak support for the indicator suggesting it should be retired. Respondents were instructed to produce a Likert score and disposition recommendation based on their assessment of all 18 evaluation criteria as a whole. We therefore forewent weighting evaluation criteria. This allowed for flexibility and context in instances where some criteria proved more informative than others.

Likert scores were averaged and presented at an internal inperson Delphi session as a basis for discussions, but were not automatically tied to a final result of continued indicator reporting. The mean was used to average scores as there were no outlier values across responses. Furthermore, all individual respondent ratings were shown alongside the mean score, thereby illustrating the level of concordance. Beginning with the lowest average scores, each indicator was discussed, pertinent commentary synthesised and a final consensus reached on a disposition recommendation. Disposition options for indicators were retain, recommend further research and development (R&D) or consultation, or retire.

Recommendations of the technical group's Delphi sessions were then presented to the CIHI HSP leadership group (n=6) (comprised senior managers and researchers) who repeated the preceding exercise. First, they were asked to independently review all results to date (including indicator assessments and Likert scores, commentary and disposition recommendations). Results of their individual assessments were collated and presented at an inperson session. Disposition recommendations for each of the 56 indicators were consolidated and finalised based on group consensus. The RAND/UCLA Appropriateness Method[15] guided our internal iterative modified Delphi sessions.

Preconference survey of stakeholders on indicator recommendations

A pre-Consensus Conference survey solicited initial feedback on recommendations. The online survey was available for a period of 6 weeks prior to the conference. Consensus Conference participants were chosen from an existing list of CIHI partners, stakeholders and clients; participants were largely hospital/health region CEOs, academics and researchers, representatives from ministries of health, clinicians and national collaboration partners involved in measuring and monitoring the performance of the healthcare system. An electronic survey was emailed to conference participants along with background documentation on the evaluation process, methodology and recommendations. The survey asked respondents whether they Agreed, Disagreed or had No opinion on the recommendation to retire select HSP indicators as per recommendations from CIHI's internal review.

National consensus conference presentation

There were 61 participants at the invitational inperson Consensus Conference held in Toronto on 16 and 17 October 2014. Results of the preconference survey were presented. A threshold of 70% agreement by respondents was used to automatically pass recommendations or to otherwise hold further group discussion at the conference. An external moderator facilitated discussion and voting on final indicator dispositions.

Results

Systematic evaluation of HSP indicators

The systematic evaluation of HSP indicators was a summative process considering 18 criteria points. Some criteria differentiated indicators more than others. For example, a small number of criteria resulted in mostly uniform findings for the suite of HSP indicators. However, when assessed alongside remaining criteria, important contextual considerations can be gleaned. Notable findings are summarised below by criterion.

Usability

The *granularity of reporting* criterion identified nuances inherent within public reporting purposes. There are ~100 administrative health regions in Canada, and ~600 acute care hospitals. Twenty-nine indicators are reported at the regional level, and 27 are reported at the hospital/facility level. All indicators are reported at an aggregate provincial/territorial and national level.

With respect to *pan-Canadian coverage*, 44 of 56 indicators provided complete pan-Canadian coverage (all provinces and territories). The province of Quebec does not have available or comparable data for a dozen indicators. Similar to the criterion of pan-Canadian coverage, the *comprehensiveness* criterion assessed the inclusiveness of health services providers that submit data towards the indicator. For example, the mental illness hospitalisation indicator includes data on mental health patients treated in general hospitals only, while hospitalisations at free-standing psychiatric institutions are not included due to the differences in data collection.

For the *usage* criterion, we polled CIHI HSP staff responsible for interacting with clients on indicators and data requests. This provided a proxy for the level and extent of the indicator›s usage by clients. The 56 indicators under evaluation were rated as high (n=33), medium (n=15) or low usage (n=8).

With regard to *dimensionality*, breakdowns of indicator results by dimensions of sex and socioeconomic status (SES) are available where applicable. Thus, 15 indicators are reportable by SES and 14 are reportable by sex.

In terms of *Timeliness, Reporting frequency and Accessibility,* all 56 indicators were publicly reported annually within 10 months of the relevant data being available for analysis. At the time of the evaluation, all HSP indicators were accessible publicly through online publications such as the Health Indicators e-Publication. Additionally, a majority of facility-level indicators are available to providers through private online tools to allow for more granular breakdowns of results and peer comparative reports.

For the *trendability* criterion, it was found that time trends vary by indicator. For example, the set of facility-level indicators was largely first reported beginning with 2007 data. Results for select regional indicators dated back to 1997. Overall, regional indicators possessed almost twice as many available years of results compared with facility indicators, a nature of the timing of reporting programmes.

Importance

As a proxy measure for *relevance*, an environmental scan was conducted to understand stakeholder utilisation of indicators. A total of 232 instances online were recorded. The top five indicators were hospital standardised mortality ratio (HSMR) (n=23), 30-day overall readmission (n=18), wait times for hip fracture repair (n=17), ambulatory care sensitive conditions (n=14) and caesarean section rate (n=13).

Detailed statements on the *actionability* of each indicator were provided to evaluation participants. Specifically, summations on the purpose of indicator, strengths, caveats and scientific evidence in support were considered.

To measure the degree of *stakeholder follow-up*, we reviewed all instances of patient-level data requests from providers. In 2013–2014, there were 298 requests, with 11 facility-level readmission indicators accounting for 58% of all requests (n=173).

The criterion *sufficient volumes* quantifies the proportion of indicator results that are suppressed per CIHI›s data privacy protocols. In general, indicator results with cell counts <5 are suppressed, and results based on <50 denominator cases per hospital are flagged as low volume and unstable rates. Facility-level indicators are particularly affected by low volumes and suppressed results: 23 of 27 facility-level indicators had at least one-fifth of all results flagged as low volume. A further seven of these indicators had at least one-fifth of all results suppressed due to small cell counts. At the extreme, we note the 28-day readmission after stroke and acute myocardial infarction (AMI) indicators with ~75% low-volume rates and one-third of all results suppressed.

We performed *significance of variation* analysis to determine the variability within indicator results. For example, the hip fracture surgical procedures performed within 48 hours indicators (both within one and across facilities) had the lowest relative

SD values of 16% and 17%, respectively, indicating minimal differences across indicator results.

Scientific soundness

The criterion *data quality* garnered the greatest discussion during Delphi reviews. Limitations of using administrative data were considered. Examples of concern include the inability to assess indications for angiography for AMI patients for the indicator use of coronary angiography following AMI, and the ability to properly identify denominator cases for the hysterectomy indicator.

The evaluation revealed that *validity reviews* were performed for each indicator on an annual basis. These included significance testing of risk factors, monitoring of diagnosis and procedure coding updates, and outlier and significant change analyses. Indicators recommended for further consultation and R&D were identified as such mainly for the purpose of seeking feedback from stakeholders on the validity and clinical relevance of current calculation methodologies.

The criterion *participation bias* assessed whether data submission and participation in the calculation of indicator results were a nature of voluntary participation. All but two indicators—physician specialists and general/family physicians per 100 000 population—required mandatory participation. In other instances, such as indicators produced for long-term care facilities, participation is not yet mandatory across the country, and therefore, results published may contain a participation bias.

Feasibility

Production cost was considered based on the extent of staff resources required to produce each indicator. Indicators with complex linkages across multiple databases and those requiring building of episodes of care necessitate a larger degree of resources.

Modified Delphi sessions of CIHI technical and leadership groups

The mean Likert scores, recommendations and rationale are noted in tables 2–4. Nine indicators were recommended as candidates for retirement (table 3), seven were identified as requiring additional consultation and three were recommended to undergo further redevelopment (table 2). Thirty-five indicators were recommended for retention (table 4). The rationale to retain these HSP indicators was based on the assessment of all 18 evaluation criteria as a whole. Although retained indicators correlate strongly with high mean Likert scores, this was only one contributor to the recommendation. Ultimately, the discussion during the inperson Delphi sessions allowed for the most pertinent and informative of the 18 evaluation criteria to be considered above others.

Table 2 – Indicators identified for additional consultation and further redevelopment

TYPE	INDICATOR	MEAN LIKERT SCORE	RATIONALE
	ADDITIONAL CONSULTATION		
Region	Hip replacement	5	There are concerns of utility and actionability for these indicators as they represent procedure counts per population.
	Knee replacement	4.8	
	Coronary artery bypass graft (CABG)	6.6	
	Percutaneous coronary intervention (PCI)	6.6	
	Cardiac revascularisation	6.6	
Facility	Vaginal birth after caesarean section	4.4	There are concerns of validity and utility for these indicators.
	Birth trauma	5.4	
	FURTHER REDEVELOPMENT		
Region	Hysterectomy	4.4	R&D is required to improve identification of appropriate denominator cases.
Facility	Nursing sensitive adverse events for medical patients	6.8	There is an opportunity for incorporation within newly developed hospital harm indicator.
	Nursing sensitive adverse events for surgical patients	6.8	

Mean Likert Scale Score: 7–9, robust indicator, recommending continued reporting; 4–6, equivocal indicator, further discussion at inperson Delphi session required; 1–3, weak indicator, recommending indicator retirement.

Table 3 – Indicators recommended for retirement

TYPE	INDICATOR	MEAN LIKERT SCORE	RATIONALE	PRE-CONSENSUS CONFERENCE SURVEY AGREEMENT FOR RETIREMENT (AS A % OF RESPONSES)
Facility	28-day readmission after prostatectomy	5.2	These indicators have low volumes of cases leading to unstable rates as well as to the suppression of a large number of results for public reporting. Furthermore, these cases are included in the surgical/medical readmission indicators, and can still be derived through private reporting tools.	82%*
	28-day readmission after hysterectomy	5.6		80%*
	90-day readmission after knee replacement	6.4		73%*
	90-day readmission after hip replacement	6.4		72%*
	28-day readmission after stroke	6.2		58%
	Use of coronary angiography following AMI	6.4	Angiography may not be indicated for every AMI patient, depending on his or her clinical history, and the clinical appropriateness of angiography is difficult to ascertain from the administrative hospitalisation data. Therefore, it is challenging to interpret and compare the results for this indicator.	78%*
	Hip fracture surgical procedures performed within one facility (48 hours)	6.4	This indicator does not measure the true proportion of surgeries performed within 48 hours of admission to an acute care hospital, since it does not account for transfers across hospitals. Many patients are transferred from their initial admitting acute care facility to another facility for surgery. The indicator hip fracture surgical procedures performed within 48 hours, which measures total time across all acute care facilities, will continue to be produced and reported on.	72%*

TYPE	INDICATOR	MEAN LIKERT SCORE	RATIONALE	PRE-CONSENSUS CONFERENCE SURVEY AGREEMENT FOR RETIREMENT (AS A % OF RESPONSES)
Facility	28-day readmission after AMI	6.4	Concerns have been raised regarding hospitals' ability to take action on this indicator. It is felt that with the regionalisation of cardiac care, it is more appropriate to measure readmission after AMI at the regional level (by patient residence) than at the hospital level. In addition, having a low volume of cases leads to unstable rates and to the suppression of a large number of results for public reporting. Therefore, it was proposed to keep the Readmission after AMI indicator at the regional level and to retire the facility-level indicator. Furthermore, readmissions after AMI are included in the 30-day overall readmission indicator at the facility level.	59%
	Primary caesarean section rate	4.6	A new indicator (low-risk caesarean section) measures the rate of deliveries via caesarean section among singleton term cephalic pregnancies for women without placenta previa or previous C-section. Since this new indicator is limited to women who have not had a previous C-section, it can take the place of primary caesarean section rate and be a better indicator of appropriateness.	57%

Mean Likert Scale Score: 7–9, robust indicator, recommending continued reporting; 4–6, equivocal indicator, further discussion at inperson Delphi session required; 1–3, weak indicator, recommending indicator retirement. *Passing the threshold (of 70% agreement among responses) for automatic ratification.

Table 4 – Indicators retained

TYPE	INDICATOR	MEAN LIKERT SCORE
REGION	30-day AMI inhospital mortality	8.8
	30-day stroke inhospital mortality	8.8
	Hospital standardised mortality ratio (HSMR)	8.8
	Ambulatory care sensitive conditions	8.6
	Wait times for hip fracture repair	8.4
	30-day readmission for mental illness	7.8
	Repeat hospital stays for mental illness	7.8
	Self-injury hospitalisation	7.6
	30-day AMI readmission	7.4
	Hospitalised hip fracture event	7.2
	Hospitalised strokes	7.2
	Hospitalised AMI event	7
	Inflow/outflow ratio	7
	30-day readmission: patients age 19 and younger	6.8
	30-day obstetric readmission	6.8
	30-day medical readmission	6.8
	30-day surgical readmission	6.4
	Mental illness patient days	6.2
	Mental illness hospitalisation	6
	Injury hospitalisation	5.4
	Caesarean section rate	4.8

TYPE	INDICATOR	MEAN LIKERT SCORE
FACILITY	30-day AMI inhospital mortality	8.8
	30-day stroke inhospital mortality	8.6
	Hip fracture surgery within 48 hours	8.4
	30-day overall readmission	8
	30-day inhospital mortality following major surgery	8
	30-day readmission: patients age 19 and younger	7.8
	30-day obstetric readmission	7.8
	30-day medical readmission	7.6
	30-day surgical readmission	7.4
	Inhospital hip fracture in elderly (age 65+) patients	7.4
	Obstetric trauma—vaginal delivery with instrument	7.4
	Obstetric trauma—vaginal delivery without instrument	7.4
	Caesarean section rate	6.8
	Low-risk caesarean section	6.8

Mean Likert Scale Score: 7–9, robust indicator, recommending continued reporting; 4–6, equivocal indicator, further discussion at inperson Delphi session required; 1–3, weak indicator, recommending indicator retirement.

CIHI leadership and technical groups identified indicators for additional consultation and redevelopment. These indicator recommendations were not forwarded to Consensus Conference participants, but were instead identified for internal R&D efforts in the interim.

Pre-Consensus Conference survey

Forty-eight Consensus Conference participants completed the online survey (response rate of 79%). Eighty-five per cent of conference participants had more than 10 years of healthcare experience. Geographic distribution of respondents correlated well with Canada's population across provinces/territories. Stakeholders from federal and provincial government agencies accounted for three-quarters of survey respondents, followed by regional health authority executives, hospital administrators and academic/research funding organisations. The mean survey agreement score (as a percentage of responses) for all nine indicators proposed for retirement was 70%, and was used as a benchmark for automatic ratification. The option to select No opinion for each indicator under survey accounted for an average of 20% of responses (ranging

between 12% and 30% across indicators); such an option was made available in the event that respondents held insufficient knowledge on the indicator or did not utilise the indicator within their setting; a response of Agreed, Disagreed or No opinion was mandatory in the survey.

National Consensus Conference

Of the nine indicators recommended for retirement, six received more than 70% agreement as a proportion of responses in the preconference survey, and therefore were automatically accepted for retirement (table 3). The remaining three indicators were discussed as a group, and subsequently also ratified for retirement by conference participants. The majority of indicators recommended for retirement were condition-specific readmission indicators. Ultimately, the decision to retire these indicators was based on appropriateness for continued public reporting. While these indicators were ratified for retirement over concerns of rate stability and small numbers, facilities can continue to calculate and monitor these indicators through CIHI private reporting tools. Consensus on retiring these indicators was achieved with greater ease, given that a provider's capacity to continue to privately monitor performance would be maintained.

Two contextual health human resources indicators at the regional level—physician specialists and general/family physicians per 100 000 population—were also included in the modified Delphi review process, and rated low in Likert Scale scoring (both received a mean score of 3.2). While these indicators provide some context on HSP characteristics, they are already reported elsewhere within CIHI. It was agreed to continue reporting on these indicators but outside of the HSP framework.

Table 4 lists 35 HSP indicators retained for continued public reporting. Although retained indicators correlate strongly with high mean Likert scores, this was only one contributor to the recommendation. For example, the regional level caesarean section rate indicator received a mean Likert score of 4.8 from the technical group, but was retained for public reporting after discussion by the leadership group due to continued concerns over high rates in Canada and therefore, a need for continued monitoring.

Discussion

This exercise proved to be an informative, objective, systematic, transparent, inclusive and likely repeatable process for evaluating and reconfirming a national set of HSP indicators. Overall, the approach of using 18 subcriteria was manageable and informative, with feedback from participants that the added information and context made it easier to make a final disposition recommendation for each indicator. The overall timeline of the evaluation process from inception to completion was 18 months. Three distinct phases stand out, each requiring ~6 months to complete: initial R&D of the evaluation plan, executing the evaluation internally at CIHI and achieving consensus across stakeholders.

An initial Likert score of indicators provides a baseline to proceed with group Delphi reviews. We found it beneficial to begin with the lowest scores and work our way to the highest rated indicators. We also found it operational to have our technical group first review indicators and to pass on recommendations to a leadership group that would consider these in addition to their knowledge and understanding of the use of HSP information in the field. The iterative process of having participants first review indicators independent of other Delphi members and to then convene as a group to discuss findings allowed for a balanced and participatory discussion among participants. These iterative methods ensured a summative process whereby findings were transparent and confirmed at each stage.

The national Consensus Conference provided an opportunity to pilot-test the results of a rigorous, mostly internal methodology for evaluating indicators produced by CIHI. Most recently, CIHI has been incorporating the learnings from this exercise into a broader 'lifecycle' approach to indicator development, evaluation and retirement recognising that all too often there is a tendency to add new indicators to the suite of those reported paying little attention to the utility of those reported in some instances for years. The internally developed evaluation process including the 18 criteria used for assessing previously reported indicators will also lend itself to midcycle reviews of suites of indicators that could be modified for such a process. The ability to affirm our internal process with external stakeholders at a national conference provided further confidence in the process. And, while stakeholders appreciated the opportunity to review and ratify our findings, going forward, they expressed comfort with CIHI implementing a systematic evaluation of the indicators and making decisions about reporting. There was congruence in opinion on the suitability of HSP indicators for public reporting throughout the evaluation process, beginning with Likert scores and assessments from CIHI technical staff, to CIHI leadership, and finally with stakeholders.

Strengths and weaknesses of the study

We recognise that the overall evaluation process required considerable time and resources, there are important benefits to such a comprehensive approach. For example, we ensured a transparent and sequential evaluation, whereby discourse and findings were accumulated and presented in a summarised manner at each phase. We solicited feedback from a wide array of expertise including those responsible for monitoring the results of these indicators on a regular basis. An external moderator facilitating the discussion ensured independence during the consensus process. These processes have been described as favourable conceptual approaches to aid exercises of indicator development, maintenance and evaluation.[14]

One main weakness of this process was the lack of involvement of the 'patient/public' voice in evaluating the utility of CIHI's current suite of publicly reported HSP indicators. Traditionally, the approach to HSP reporting has largely been targeted to system decision makers. With the growing recognition that HSP includes measuring things that are important and relevant to the patient/public, it is clear that the patient/public perspective needs to be embedded in future aspects of this work. In 2013, CIHI solicited input from 3000 Canadians (randomised, representative sample) through small group dialogues and online questionnaires about which types of indicators and domains of HSP they would like to see publicly reported. In an attempt to obtain broader input to the evaluation process discussed in this paper, the same survey sent to Consensus Conference participants was made available on CIHI's website for public participation. The survey responses from the general public were highlighted and considered at the Consensus Conference. However, a more systematic approach to including the patient/public perspective within the 'lifecycle' approach to development, evaluation and retirement is needed to going forward.

Shekelle[16] notes that there is little agreement on methodologies for developing performance indicators, and this can also be said regarding their evaluation. Nonetheless, Stelfox and Straus[14] emphasise the importance of clearly establishing the chosen evaluation criteria in advance of launching a consensus process. In the majority of the studies we reviewed and cite, a smaller number of evaluation criteria were applied: most often, usability, importance, scientific soundness and feasibility (or a variation thereof that drew on similar domains). Conversely, we found it helpful to apply multiple subcriteria to comprehensively reflect the evaluation of indicators for their suitability of ongoing public reporting. Furthermore, providing a more granular evaluation schema for participants ensured more consistent definitions of domains and structured evidence/results for evaluators' consideration. Nonetheless, while these evaluation criteria were informative and applicable to this precise context, not all would apply for other evaluation purposes. Further efforts are necessary to

determine the level of customisation required to ensure that the process and criteria are applicable to other sectors of care and types of indicators.

In addition to convening an inperson consensus conference (or expert panel) to evaluate indicators, Santana *et al*[17] forwarded their evaluation survey to 101 trauma centres across 4 countries involved in the use and assessment of injury care indicators. Moreover, a novel subsequent process has been described by Bobrovitz *et al*[18] whereby the discussion occurring throughout the consensus conference is transcribed and undergoes qualitative content analysis to identify key themes raised throughout the deliberations. These additional activities can provide complementary evidence to the evaluation process, such as qualitative findings to an otherwise objective and quantitative exercise, and reaching a broader group of stakeholders and users of health measures.

There are certain characteristics of the Canadian healthcare system that are favourable for such an evaluation exercise. As the national healthcare system information steward, CIHI receives data for virtually all hospitalisations across the country in a standardised manner. All but 2 of the 56 HSP indicators are calculated using this standardised data source. Therefore, the application of 18 evaluation criteria to these indicators can be performed so in a systematic process, so that objectivity is maintained. A centralised healthcare information system is more conducive for cross-country analysis and reporting.[19] This also extends to the convening strength of CIHI to bring together stakeholders from all provinces and territories to agree on a national agenda.

To balance the limiting aspects of a Delphi exercise on a set of existing indicators, the Consensus Conference also included working group sessions on identifying priority areas for future indicator development (organised by health system quadrants of Inputs and Characteristics, Outputs, Outcomes and Social Determinants of Health). From these discussions, along with a cross-country consultation process, CIHI has embarked on a path to develop new indicators for the domains of safety (eg, infections), mental health and addictions (alcohol attributable hospitalisations), and others relating to recently identified priority populations such as seniors and ageing (eg, palliative care), and children and youth.

Conclusion

The proliferation of health measures required to fulfil reporting gaps occurred with minimal consideration to alignment and utility with pre-existing indicators. Not surprisingly, then, stakeholders were overwhelmingly in favour of implementing a process that would result in a leaner, more applicable suite of HSP indicators.

CIHI will gradually expand this evaluation methodology to applicable sectors of care. We will also continue to work with external partners to reduce indicator chaos and increase alignment with reporting requirements across the country.[6]

This exercise generated identified analytical alignment actions that can be taken at CIHI throughout indicator production and maintenance with a view to reduce indicator chaos. Furthermore, we gained new knowledge about how the HSP indicators we produce are used by stakeholders through an internet-based environmental scan and via discussions held at the Consensus Conference.[10]

In line with established practices of convening a Consensus Conference every 5 years, we feel that it is highly beneficial to inform those discussions with a wholesale and systematic criteria-based review of indicators just prior. A broad consultation process encompassing diverse public health stakeholders from across the country helps ensure the development and use of indicators most appropriately reflecting the health of populations and the performance of health systems.[20] Similarly, a retrospective exercise on national HSP practices can identify important lessons, of which the selection of indicators suitable for public reporting is an integral component.[21]

References

1. Klazinga N, Fischer C, ten Asbroek A. Health services research related to performance indicators and benchmarking in Europe. J Health Serv Res Policy 2011:16:38–47. http://hsr.sagepub.com/content/16/suppl_2/38.long (accessed 16 Oct 2016).

2. Kelley E, Arispe I, Homes J. Beyond the initial indicators: lessons from the OECD Health Care Quality Indicators Project and the US National Healthcare Quality Report. Int J Qual Health Care 2006;18(Suppl 1):45–51. http://intqhc.oxfordjournals.org/content/18/suppl_1/45.long (accessed 16 Oct 2016).

3. Carinci F, Van Gool K, Mainz J, et al. Towards actionable international comparisons of health system performance: expert revision of the OECD framework and quality indicators. Int J Qual Health Care 2015;27:137–46. http://intqhc.oxfordjournals.org/content/27/2/137 (accessed 16 Oct 2016).

4. Canadian Institute for Health Information. Roadmap initiative … launching the process. Ottawa. 2000. https://www.cihi.ca/en/profile_roadmap_launch_pdf_en.pdf (accessed 16 Oct 2016).

5. Canadian Institute for Health Information. A performance measurement framework for the Canadian health system. Ottawa. 2013. https://secure.cihi.ca/free_products/HSP-Framework-ENweb.pdf (accessed 16 Oct 2016).

6. Saskatchewan Health Quality Council. Think big, start small, act now: tackling indicator chaos: a report on a national summit. Saskatoon, 30–31 May 2011. http://hqc.sk.ca/Portals/0/documents/tracking-indicator-choas.pdf (accessed 16 Oct 2016).

7. Canadian Institute for Health Information. National consensus conference on population health indicators. Ottawa. 1999. https://secure.cihi.ca/free_products/phi.pdf (accessed 16 Oct 2016).

8. Canadian Institute for Health Information. The health indicators project: the next 5 years. Report from the Second Consensus Conference on Population Health Indicators. Ottawa. 2005. https://secure.cihi.ca/free_products/Consensus_Conference_e.pdf (accessed 16 Oct 2016).

9. Canadian Institute for Health Information. The Health Indicators Project: Report from the Third Consensus Conference on Health Indicators. Ottawa. 2009. https://secure.cihi.ca/free_products/82-230-XWE_e.PDF (accessed 16 Oct 2016).

10. Canadian Institute for Health Information. Rethink, Renew, Retire: Report from the Fourth Consensus Conference on Evaluating Priorities for Canada's Health Indicators. Ottawa. 2015. https://secure.cihi.ca/free_products/Rethink_Renew_Retire.pdf (accessed 16 Oct 2016).

11. Hurtado M, Swift E, Corrigan J, eds. Committee on the National Quality Report on Health Care Delivery, Board on Health Care Services. Envisioning the National Health Care Quality Report. Washington, DC: National Academy Press, 2001. http://www.ncbi.nlm.nih.gov/books/NBK223318/pdf/Bookshelf_NBK223318.pdf (accessed 16 Oct 2016).

12. Mattke S. When should measures be updated? Development of a conceptual framework for maintenance of quality-of-care measures. Qual Saf Health Care 2008;17:182–6. doi:10.1136/qshc.2006.021170http://qualitysafety.bmj.com/content/17/3/182.abstract (accessed 16 Oct 2016).

13. Canadian Institute for Health Information. The CIHI Data Quality Framework, 2009. Ottawa. 2009. https://www.cihi.ca/en/data_quality_framework_2009_en.pdf (accessed 16 Oct 2016).

14. Stelfox H, Straus S. Measuring quality of care: considering conceptual approaches to quality indicator development and evaluation. J Clin Epidemiol 2013;66:1328–37.

15. Fitch K, Bernstein S, Aguilar M, et al. The RAND/UCLA appropriateness method user's manual. Santa Monica, CA: RAND Corporation, 2001. http://www.rand.org/pubs/monograph_reports/MR1269 (accessed 16 Oct 2016).

16. Shekelle P. Quality indicators and performance measures: methods for development need more standardization. J Clin Epidemiol 2013;66:1338–9.

17. Santana MJ, Stelfox HT, Asbridge M, et al. Development and evaluation of evidence-informed quality indicators for adult injury care. Ann Surg 2014;259:186–92.

18. Bobrovitz N, Parrilla JS, Santana M, et al. A qualitative analysis of a consensus process to develop quality indicators of injury care. Implement Sci 2013;8:45.

19. OECD. Strengthening Health Information Infrastructure for Health Care Quality Governance: Good Practices, New Opportunities and Data Privacy Protection Challenges. Paris. 2013.

20. Klazinga N, Stronks K, Delnoij D, et al. Indicators without a cause. Reflections on the development and use of indicators in health care from a public health perspective. Int J Qual Health Care 2001;13:433–8. http://intqhc.oxfordjournals.org/content/intqhc/13/6/433.full.pdf (accessed 16 Oct 2016).

21. van den Berg MJ, Kringos DS, Marks LK, et al. The Dutch health care performance report: seven years of health care performance assessment in the Netherlands. Health Res Policy Syst 2014;12:1.

CHAPTER 3
WHAT IS THE VALIDITY AND IMPACT OF THE PALLIATIVE CARE CODE ON THE HOSPITAL STANDARDISED MORTALITY RATIO (HSMR) INDICATOR?

Omid Fekri, Joseph Emmanuel Amuah, Viachaslau Herasimovich, Zeerak Chaudhary, Kira Leeb, Yana Gurevich

This chapter was published as:

Palliative care coding practices in Canada since the introduction of guidelines and the HSMR indicator

BMJ Open 2015

ABSTRACT

Objectives This study examines palliative care (PC) coding practices since the introduction of a national coding standard and assesses a potential association with hospital standardised mortality ratio (HSMR) results.

Setting Acute-care hospitals in Canada.

Participants ~16 million hospital discharges recorded in Canadian Institute for Health Information (CIHI)'s Discharge Abstract Database from April 2006 to March 2013.

Primary and secondary outcome measures In-hospital mortality, patient characteristics and service utilisation among all hospitalisations, HSMR cases and palliative patients.

Methods We assessed all separations in the Discharge Abstract Database between fiscal years 2006–2007 and 2012–2013 for PC cases at national, provincial and facility levels. In-hospital mortality was measured among all hospitalisations (including HSMR cases) and palliative patients. We calculated a variant HSMR-PC that included PC cases.

Results There was an increase in the frequency of PC coding over the study period (from 0.78% to 1.12% of all separations), and year-over-year improvement in adherence to PC coding guidelines. Characteristics and resource utilisation of PC patients remained stable within provinces. Crude mortality among HSMR cases declined from 8.7% to 7.3%. National HSMR declined by 22% during the study period, compared with a 17% decline in HSMR-PC. Provincial results for HSMR-PC are not significantly different from regular HSMR calculation.

Conclusions The introduction of a national coding standard resulted in increased identification of palliative patients and services. Aside from PC coding practices, we note numerous independent drivers of improving HSMR results, notably, a significant reduction of in-hospital mortality, and increase in admissions accompanied by a greater number of coded comorbidities. While PC impacts the HSMR indicator, its influence remains modest.

Introduction

In 2005, the Canadian Institute for Health Information (CIHI) began examining palliative care (PC) coding practices associated with discharge abstract data received from hospitals across Canada. At the time, there were wide variations in local coding practices for PC patients, largely due to the absence of a formal coding standard for palliative services. Little corrective action had been taken, mainly because the data were not used to produce performance indicators. Shortly after, when CIHI was in the exploratory phase of introducing its hospital standardised mortality ratio (HSMR) indicator, which is clearly affected by the inclusion of PC patients, PC coding came under greater scrutiny.

PC is a branch of medicine whose main goal is to reduce patient discomfort. It is also referred to as *end-of-life care*, *comfort care*, *supportive care and compassionate care*.[1] While PC is predominantly associated with incurable conditions, it can also apply to reversible ailments. The need for palliation can be identified any time during a hospital stay. Furthermore, palliation can be delivered regardless of whether there are designated PC beds, units or delivery teams. Pain control unaccompanied by other palliative services is not considered palliation.

Accurate measurement and record-keeping is fundamental to improving hospital care and to reporting indicators of health system performance. To fully understand the extent of PC delivery in Canada, we require precise and detailed notations of patient characteristics and clinical interventions. In Canada, the *Canadian Coding Standards for ICD-10-CA and Canadian Classification of Health Interventions (CCI)* prescribes standard definitions to identify and capture PC patients in clinical administrative databases.

During development of the HSMR, CIHI conducted stakeholder consultations, methodological investigations, pilot-testing and literature reviews regarding whether or not to include PC patients in HSMR calculations. CIHI was not the only producer of an HSMR grappling with this issue. British counterparts first introduced an HSMR without risk-adjustment for PC patients but, in 2004, reversed their decision in response to the concerns of hospitals with palliative units.[2] Two of four entities producing hospital mortality rates in the USA exclude PC encounters from their calculations.[3] In the end, CIHI excluded PC patients from HSMR calculations but recognised the need to implement a national coding standard on PC. To address this need, the National Coding Advisory Committee released an interim PC coding bulletin on 1 October 2007, followed by a national coding standard effective 1 April 2008.

Traditionally, it takes time for changes in coding standards to be reflected in abstracted clinical administrative data. During development of the HSMR, hospitals were sent results of their PC coding to aid education efforts. Likewise, discharge abstract coders

received targeted professional education so they could conform to the new national coding standard.

Additionally, with the introduction of the HSMR, many facilities and regions instituted programmes to improve overall clinical documentation. Historically, in-hospital patient care documentation focused on the delivery of care, and less so on the use of abstracted data for performance indicators. Given the transparency that public reporting of the HSMR generates, a greater focus was placed on the completeness as well as the accuracy of the data being submitted. One initiative to address this divide was the introduction of the concept of Clinical Documentation Improvement (CDI) and the training of CDI specialists to guide physicians regarding the impact of patient charting on the capture of significant comorbidities.

Two data quality assurance protocols were also introduced as a result of the new PC coding standard. The first ensures that abstracts with PC as the most responsible diagnosis (MRDx) also include a secondary diagnosis. The second states that the ICD-10-CA code Z51.5 *Palliative care* must not be assigned as a post-admission comorbidity.[1]

In this paper, we explore the following research questions:

- the extent of PC coding in Canada and adherence to the coding standard,
- patient case-mix changes and resource utilisation across all hospitalisations, PC and HSMR cases,
- rates of mortality in and out of hospital,
- changes in HSMR results over time, and
- variation in HSMR results when including PC cases.

Methods

Using the Discharge Abstract Database (DAD), we analysed all inpatient acute care hospitalisations (n~2.4 million/year) in Canada between fiscal years 2006–2007 and 2012–2013. Owing to differences in coding standards, our study excluded PC cases from Quebec, however, inpatient hospitalisations from the province are included in HSMR risk-adjustment and baseline calculations. Prince Edward Island, Yukon, the Northwest Territories and Nunavut were excluded from provincial/territorial analysis due to small counts, however, their cases were included in national and facility-level analyses.

ICD-10-CA code Z51.5 *Palliative care* on a patient discharge abstract was used to identify patients who fulfilled the standardised criteria for PC diagnoses. We analysed all records, as well as a subset of those containing Z51.5.

We calculated crude percentage of discharges that had PC diagnosis code Z51.5 coded as the MRDx, preadmit comorbidity (type 1) and service transfers (types W, X and Y). To examine potential changes in the characteristics of PC patients over time, we assessed age, disease burden (using the Charlson Comorbidity Index) and resource utilisation (resource intensity weight (RIW), alternate level of care (ALC) days and length of stay (LOS)). We also assessed adherence to the coding standard following the introduction of new coding guidelines.

We used vital statistics from Statistics Canada CANSIM tables[4, 5] to report mortality trends in and out of hospital. Additionally, we reviewed complementary in-hospital mortality indicators (following acute myocardial infarction and stroke) to examine changes over time.

HSMR methodology

The HSMR is the ratio of *observed* deaths to *expected* deaths, multiplied by 100. We used CIHI HSMR methodology V.4.0 and the reference year 2009–2010 for this study. Seventy-two diagnosis groups, accounting for about 80% of all inpatient mortality in Canada, are included in HSMR calculations. Records coded with one of the 72 diagnosis groups as the MRDx qualify as HSMR cases. To ensure meaningful comparison of stable results, facility-level analysis was restricted to hospitals with a minimum of 1000 HSMR cases in each data year between 2006–2007 and 2012–2013.

To determine the impact of PC cases on HSMR, we created a 73rd diagnosis group within HSMR calculation methodology to account for PC cases coded as MRDx. All other HSMR calculation methods remained constant in order to control for only the inclusion of PC cases. The results of this sensitivity analysis are reported as HSMR-PC. We performed a linear regression test to assess similarities in provincial trends of HSMR and HSMR-PC.

The Charlson Index is one of six HSMR risk-adjustment variables; it takes into account preadmission diagnoses. The Charlson Index is an overall comorbidity score that has been shown to be highly and positively associated with mortality, and has been widely used in clinical research.[6] Detailed methodology on HSMR calculation is available elsewhere.[7]

Canadian Coding Standards define comorbidity as a condition that is present at the time of admission or that subsequently develops and meets at least one of the following conditions: requiring treatment beyond maintenance of the pre-existing

condition, increases the LOS by at least 24 h, or significantly affects the treatment received. In all instances, assignment of a comorbid diagnosis type must be supported by physician documentation.[1]

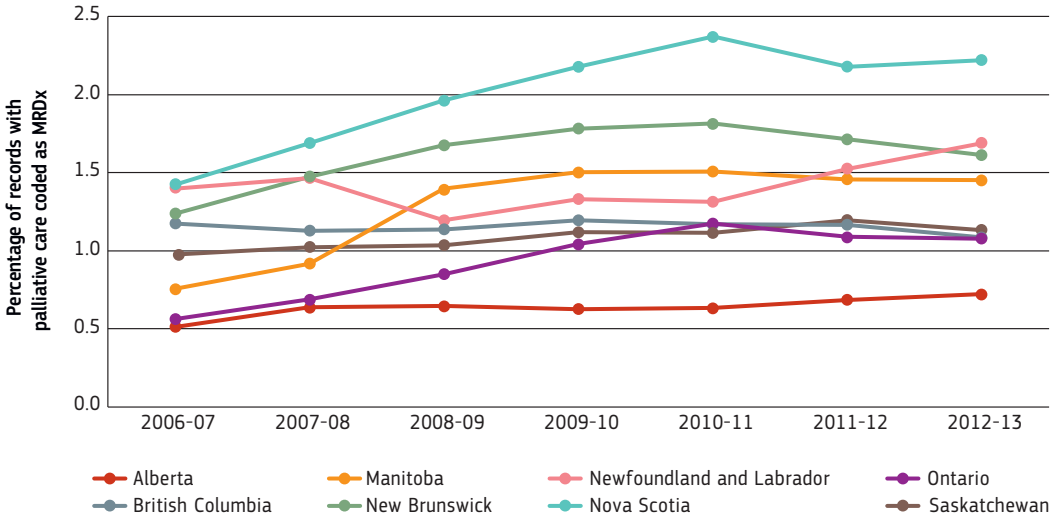
Statistical analyses were run on SAS V9.2 (SAS Institute Inc, Cary, North Carolina, USA) and R V.3.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

Results

PC coding changes from 2006–2007 to 2012–2013

Beginning in 2006–2007, the percentage of all hospitalisations coded with an MRDx of PC varied across provinces from 0.5% to 1.4% (figure 1). After years of fluctuation in provincial PC coding rates, the introduction of coding standards in 2008–2009 led to mostly stabilised rates, beginning in 2009–2010. The Atlantic provinces of Newfoundland and Labrador and Nova Scotia, which have small populations and few facilities, accounted for the largest increase and the greatest volatility in PC coding. Between 2010–2011 and 2012–2013, provincial rates of PC coding in the MRDx field mostly declined or remained stable (except in Newfoundland and Labrador). The percentage of PC cases as a proportion of in-hospital deaths mirrors the trend of overall PC coding. We observe an increase during the guideline uptake period, and a subsequent plateau beginning 2009–2010 (see online supplementary table S1 and figure A).

Figure 1 – Provincial palliative care coding trends. Percentage of records with palliative care coded as most responsible diagnosis (MRDx)



The percentage of abstracts with a PC code appearing as a comorbidity diagnosis (type 1, W, X or Y) more than doubled (138%, $p<0.001$) between 2006–2007 and 2009–2010, with an insignificant increase (22%, $p=0.368$) from 2009–2010 to 2012–2013.

To assess adherence to PC coding standards, we examined a subset of records where the MRDx of PC was assigned without any secondary diagnosis code (table 1). Comparing 2006–2007 and 2012–2013, instances of these records dropped sharply, from 201 to 29/10 000 records. Instances where PC was assigned as a postadmission comorbidity also dropped from 52 to 6/10 000 PC records.

Table 1 – Descriptive statistics of all DAD, HSMR and palliative care records/cases

FISCAL YEAR	DAD RECORDS			HSMR CASES			PALLIATIVE CARE RECORDS		
	2006–2007	2009–2010	2012–2013	2006–2007	2009–2010	2012–2013	2006–2007	2009–2010	2012–2013
Cases, N	2 388 258	2 403 517	2 480 749	649 150	667 216	715 088	18 603	26 797	27 870
Mean age, years	46	46.1	47.5	67.2	67.2	68.3	70.4	72	73.4
Mean LOS, days	6.5	6.7	6.7	10.1	10.1	9.8	15.5	15.6	14.7
Crude mortality, %	3.52	3.52	3.45	8.7	7.8	7.3	67.1	68.5	69.9
Crude PC coding as MRDx, %	0.78	1.11	1.12	n/a	n/a	n/a	100	100	100
PC cases among in-hospital deaths, %	14.7	21.7	22.8	n/a	n/a	n/a	n/a	n/a	n/a
Mean RIW	1.4	1.4	1.4	2	2	2.1	2.3	2.5	2.3
ALC, total days	–	–	–	–	–	–	31 376	54 751	57 749
PC code as a comorbidity (type 1, W, X, Y), %	0.8	1.9	2.31	–	–	–	–	–	–
PC as the only diagnosis (per 10 000 records)	201	46	29	NA	NA	NA	201	46	29
PC as post-admission comorbidity (per 10 000 records)	52	36	6	NA	NA	NA	52	36	6

ALC, alternate level of care; DAD, Discharge Abstract Database; HSMR, hospital standardised mortality ratio; LOS, length of stay; MRDx, most responsible diagnosis; NA, not applicable; PC, palliative care; RIW, resource intensity weight.

Analysis of the PC cohort revealed consistent patient-level characteristics of LOS and RIW (table 1). With similar trends in DAD records and HSMR cases, the mean age of PC patients also increased (from 70.4 to 73.4 between 2006–2007 and 2012–2013). Total ALC days of PC patients rose sharply during the new coding adoption phase between 2006–2007 and 2009–2010, but plateaued thereafter. Provincial breakdowns of variables are contained in online supplementary table S1. These findings indicate a relatively homogenous PC patient cohort throughout Canada and provincial consistency during the study period.

Mortality in Canada

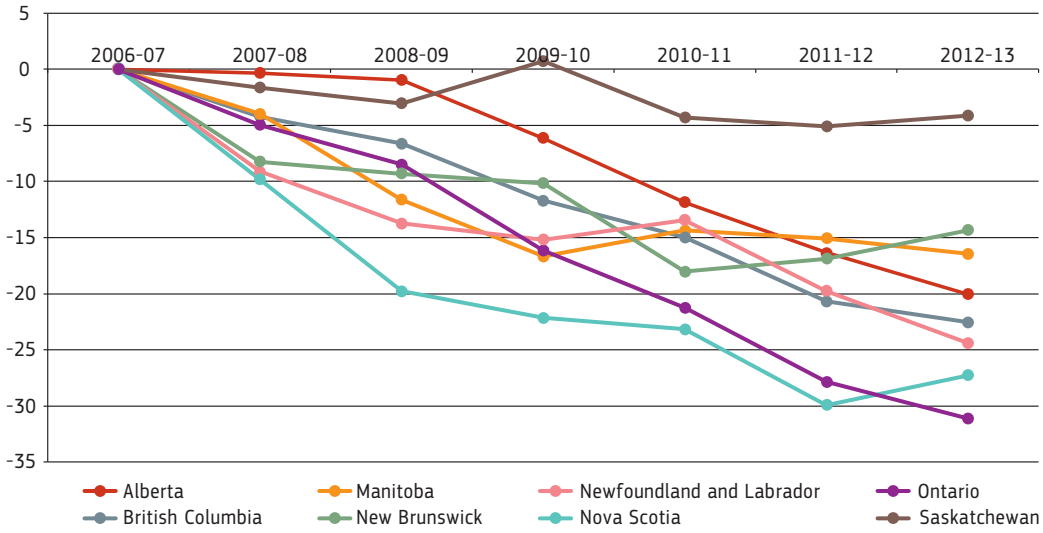
Vital statistics were analysed for mortality trends in and out of hospital. Comparing 2000 with 2011, total deaths in Canada increased from 218 062 to 242 074 (see online supplementary table A).[4] While crude mortality rates in Canada remained stable (711/100 000 population in 2000; 705/100 000 population in 2011) (see online supplementary figure B), we observed an 11% decrease (from 512 to 456/100 000 population) of in-hospital mortality. This illustrates the increasing trend of Canadians dying out of hospital, with a concurrent decline in the proportion of in-hospital deaths between 2000 and 2011.

Crude mortality among all hospitalisations declined between 2006–2007 and 2012–2013 from 3.52% to 3.45%. Among all HSMR cases, crude mortality declined from 8.7% in 2006–2007 to 7.3% in 2012–2013. There is an inverse trend of increased crude mortality in the PC cohort from 67.1% to 69.9%.

HSMR

Nationally, the HSMR declined by 22% between 2006–2007 and 2012–2013. HSMR results improved for all provinces, with the largest improvements seen in Ontario (31 points, from 120 (95% CI 118 to 121) to 89 (95% CI 88 to 90)), Nova Scotia (27 points, from 133 (95% CI 128 to 138) to 106 (95% CI 102 to 110)), Newfoundland and Labrador (24 points, from 134 (95% CI 127 to 141) to 110 (95% CI 104 to 116)) and British Columbia (23 points, from 108 (95% CI 106 to 110) to 85 (95% CI 84 to 87)) (figure 2). Provincial reductions in crude mortality among HSMR cases for the same time period were highest in Ontario (−20.3%) Nova Scotia (−17.7%) and Manitoba (−14.8%).

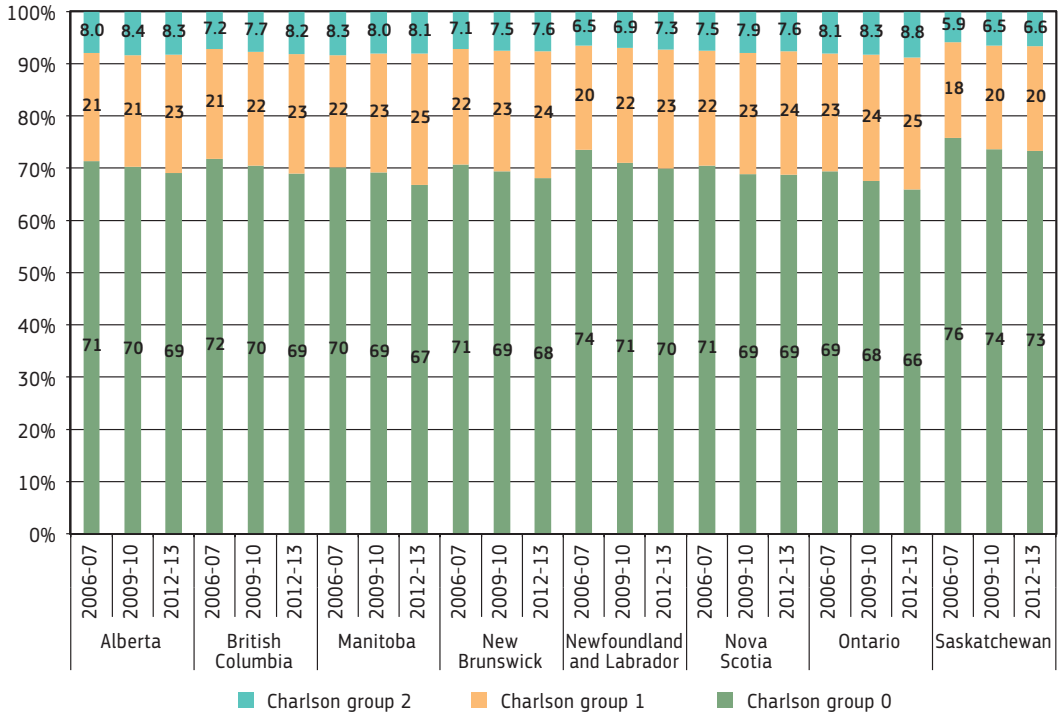
Figure 2 – Change in provincial HSMR relative to 2006–2007 (set at 0).



From 2009–2010 to 2012–2013, there was a positive correlation between reduction in crude mortality among DAD records and improvement in HSMR rates among all provinces except Newfoundland and Labrador (correlation coefficients: Newfoundland and Labrador, −0.80; Nova Scotia, 0.87; New Brunswick, 0.77; Ontario, 0.79; Manitoba, 0.82; Saskatchewan, 0.79; Alberta, 0.66; British Columbia, 0.92).

In addition to a reduction in crude mortality, we observe changes in risk-adjustment variables included in the HSMR model. Increases in patient population groups with more pre-admission conditions led to a higher likelihood of expected in-hospital mortality. There are pronounced trends when comparing Charlson Index groups over time (figure 3). Provincial results show consistent declines in HSMR cases without comorbidities (Charlson group 0). Increases in Charlson groups 1 and 2 indicate a greater proportion of patients with significant comorbidities.

Figure 3 – Percentage of HSMR cases within each Charlson group by province.



Another risk-adjustment variable that contributed to a decrease in the HSMR is patient age at admission, which has increased over time (table 1). With constant model coefficients, increases in patient age led to higher values of expected death, resulting in HSMR improvement.

Although all provinces have improved HSMRs, not all have shown increases in PC coding (figure 1). British Columbia had a lower PC coding percentage in 2012–2013 (1.08%) than in 2006–2007 (1.18%). Between 2009–2010 and 2012–2013, British Columbia, Manitoba and New Brunswick all had lower rates of PC coding than in previous years. Ontario and Saskatchewan are the only provinces that showed a slight increase between 2009–2010 and 2012–2013 compared with the period 2006–2007 and 2008–2009.

To explore the association between change in HSMR and PC coding at the facility level, we observed a weak correlation year-over-year (between −0.05 and −0.21) between 2006–2007 and 2012–2013 for (n=142) facilities that met the criterion of 1000 HSMR cases in each data year.

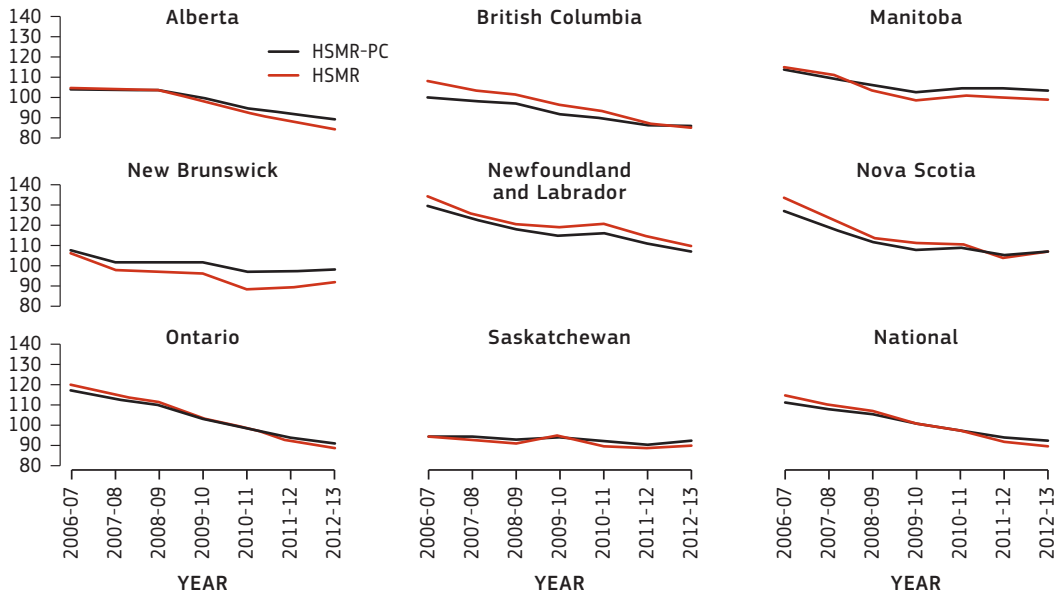
To further examine in-hospital mortality, and to determine whether HSMR trends are similar to those for other health system performance indicators, we examined two other in-hospital mortality indicators that have shown considerable declines over a similar study period. Between 2006–2007 and 2011–2012, 30 day in-hospital mortality following acute myocardial infarction[8] declined by 25.5% (from 9.4% to 7%), while 30 day in-hospital mortality following stroke[8] declined by 18.3% (from 18% to 14.7%) (see online supplementary figure C).

Sensitivity analysis when including PC cases into HSMR calculation

We performed sensitivity analysis to determine the extent PC coding may influence HSMR results if included in the calculation methodology, and denote it by HSMR-PC.

At the national level, HSMR-PC declined by 17.2% (from 111 in 2006–2007 to 92 in 2012–2013), compared to a 22% decline in regular HSMR (from 114 in 2006–2007 to 89 in 2012–2013). Adjustment for PC cases resulted in an increase of 2.6 points in national HSMR for 2012–2013. We observe no significant differences when comparing provincial results of HSMR and HSMR-PC (see figure 4). Analysing eight provinces over seven data years, we note four instances (7%) of non-overlapping CIs between HSMR and HSMR-PC results. A linear regression test shows that regular HSMR and HSMR-PC provincial trends are not significantly different for all provinces.

Figure 4 – Provincial and National HSMR results with and without inclusion of palliative care cases.



Furthermore, positioning of provinces remained relatively constant when comparing HSMR and HSMR-PC. For example, in 2012–2013, in either calculation scenario, British Columbia, Alberta and Ontario remain as the top three provinces with the lowest HSMR. Similarly, both calculation methods produce highest HSMR results for Manitoba, Nova Scotia and Newfoundland. This illustrates an insignificant impact on relative positioning at the provincial level when including PC cases in HSMR calculation methodologies.

Discussion

Our analysis sheds light on the extent and quality of PC coding in Canada. PC coding increased in Canada after the introduction of the national coding standard (interim in October 2007 and permanent in April 2008), which reflects an expected outcome of the uptake of the new coding standard and intensive coder education. Traditionally, it takes time for changes in coding standards to be fully reflected in abstracted clinical administrative data. The percentage of PC cases coded has plateaued in recent years. Our study showed that adherence to the PC coding standard has improved since it was introduced in 2008. The proportion of records where an MRDx of PC was coded without any secondary diagnosis has dropped sharply over the years. Instances where PC was assigned as a post-admission comorbidity have also dropped. Moreover, a reabstraction study of the 2007–2008 DAD data showed that 92.8% (95% CI 91% to 95%) of hospitalisations in which PC was recorded were confirmed by the second independent coder; this increased to 96.4% (95% CI 95% to 98%) for a similar study on the 2009–2010 DAD data.[9, 10]

Clinical administrative databases such as the DAD have several uses, with health system reporting being only one. Prior to 2007, the PC code was not routinely part of the methodology used to produce health system performance indicators in Canada. Therefore, it was not a priority (nor a mandatory requirement) for hospitals to ensure standardisation of coding for such cases. For this and other reasons, it is likely that there was under-coding of PC patients prior to the introduction of the HSMR.

The decision to include or exclude PC patients from the HSMR indicator is a contested subject with some studies concluding that excluding PC patients from HSMR calculations will artificially improve results,[11] ,[12] even though sensitivity analyses have found minimal overall differences in HSMR results when comparing those that include and exclude these cases.[2]

A recent Canadian study by Chong *et al*[13] suggests that PC coding may have been manipulated since the introduction of public reporting of HSMR. Our analysis confirms that rates of HSMR improvement are slower when PC cases are included

into the model. However, adjustment for PC cases explains no more than a quarter of the overall HSMR improvement. We found no evidence to suggest measurable manipulation of PC coding on the HSMR.

We report on numerous independent factors that also contributed to improving HSMR. Our alternative conclusion on the importance of PC coding on HSMR is supported by more granular and comprehensive analyses. By examining beyond 2009–2010 up until 2012–2013, we show a clear and consistent plateau of PC coding. The trajectory of increased PC coding clearly occurs during the PC guideline adoption phase, and stabilises beginning 2009–2010 up until 2012–2013.

While Chong *et al* suggest that hospitals have dramatically increased PC coding since public reporting of HSMR, our study arrives at a different conclusion. Our analyses demonstrate that throughout the study period, there was no consistent increase of PC coding across all provinces. Analysis at the provincial level illustrates that select provinces maintained a low rate of PC coding or even lowered their rate throughout the study period. It is possible that Chong *et al*'s use of a 2004–2005 baseline year, when stable coding of PC cases had not yet been achieved, overestimated the influence of PC on improving HSMR results in Canada.

Complementary health system performance indicators and vital statistics confirm that substantially fewer Canadians are dying in hospital. Furthermore, we noted an increase in the database capture of comorbidities, which could be partly explained by improved coder and physician education via CDI initiatives. Such pronounced trends towards recording and managing more complex cases of patients with multiple chronic conditions ultimately lead to a higher calculated probability of death. These, in conjunction with lower observed rates of in-hospital mortality, are significant drivers of improving HSMR results. Nonetheless, we continue to recognise and acknowledge that for some hospitals, PC coding may play a larger role in HSMR improvements. Owing to the limitations of administrative abstract data in definitively determining the appropriateness of a patient's PC diagnosis in terms of his or her clinical severity and the services and interventions received, we are unable to clearly identify the manipulation of PC coding. However, our current analyses and previous reabstraction studies[9, 10] indicate that any potential manipulation of data may occur in only an inconsequential number of facilities. Further research is required to precisely quantify the changes and effects of risk-adjustment variables included within the HSMR model.

There is no question that coding precision is a continuous refinement process. As particular health topics become more significant, attention and effort are directed toward providing the most accurate and authoritative reflection of these in the context of Canadian health services. There are rigorous standards and legal agreements for hospitals to report accurate records on the patients they treat. Analyses such

as this study are one way to monitor the uptake and impact of changes in coding standards and the impact on the resulting data abstracted by hospitals. The impetus behind developing the HSMR indicator was to provide facilities and health system decision-makers with the ability to track their hospital's mortality over time. This big-dot indicator is designed to be unpacked to hone in on certain patient groups, disease categories and diagnosis groups to understand which patient populations are driving their HSMR results, with a view to assessing the quality of care these patients are receiving. With the understanding that no single indicator is perfect, the HSMR framework still allows for a starting point in the quality assessment journey, provided that patient groups are accurately identified and reflected in the measure.

Results of our analysis can be summarised into five main findings:

1. Quality of PC coding has improved year-over-year.
2. PC patient characteristic trends are consistent within provinces.
3. In-hospital mortality has declined substantially.
4. HSMR results show consistent improvement across provinces for factors beyond PC coding.
5. Inclusion of PC cases into the model results in minimal HSMR differences at the provincial level.

Strengths and limitations

CIHI has inherent advantages and strengths in conducting this type of study; these include the ability to analyse all Canadian hospitalisations (n~16 million records) over seven fiscal years, not just those considered HSMR cases, which allows us to compare patient characteristics and resource utilisation against a non-palliative population. Our study additionally examined adherence to the national PC coding standard.

PC cases from Quebec were excluded from this analysis due to differences in coding standards. Quebec is currently discussing the introduction of coding standards that would align it with other jurisdictions in Canada. Prince Edward Island, Yukon, the Northwest Territories and Nunavut were excluded from provincial/territorial analyses due to low counts and unstable results; however, their cases were included in national and facility-level analyses. There are inherent limitations in the use of administrative abstraction data, particularly for the calculation of mortality indicators. Application of algorithms are limited to available variables within administrative databases, and therefore cannot entirely account for patient severity or comorbidities.[14]

References

1. Canadian Institute for Health Information. Canadian coding standards for version 2012 ICD-10-CA and CCI, revised September 2012. Ottawa: CIHI, 2012. https://secure.cihi.ca/free_products/canadian_coding_standards_2012_e.pdf (accessed 9 Sep 2015).

2. Bottle A, Jarman B, Aylin P. Hospital standardized mortality ratios: sensitivity analyses on the impact of coding. Health Serv Res 2011;46:(6Part I):1741–61.

3. Cassel JB, Jones AB, Meier DE, et al. Hospital mortality rates: how is palliative care taken into account? J Pain Symptom Manage 2010;40:914–25.

4. Statistics Canada. Table 102–0509—Deaths in hospital and elsewhere, Canada, provinces and territories, annual. CANSIM (database). Ottawa: Statistics Canada, 2013. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1020509&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=(accessed 9 Sep 2015).

5. Statistics Canada. Table 051–00011—estimates of population, by age group and sex for July 1, Canada, provinces and territories. CANSIM (database). Ottawa: Statistics Canada, 2014. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0510001&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid=(accessed 9 Sep 2015).

6. Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. Am J Epidemiol 2011;173:676–82.

7. Canadian Institute for Health Information. Learn about the hospital standardized mortality ratio. Ottawa: CIHI. http://www.cihi.ca/cihi-ext-portal/internet/en/tabbedcontent/health+system+performance/quality+of+care+and+outcomes/hsmr/cihi022025 (accessed 9 Sep 2015).

8. Canadian Institute for Health Information. Health indicators e-publication. Ottawa: CIHI, 2014. http://www.cihiconferences.ca/indicators/2013/tables13_e.html (accessed 9 Sep 2015).

9. Canadian Institute for Health Information. CIHI data quality study of the 2007–2008 discharge abstract database. Ottawa: CIHI, 2010.

10. Canadian Institute for Health Information. CIHI data quality study of the 2009–2010 discharge abstract database. Ottawa: CIHI, 2012.

11. Hawkes N. Patient coding and the ratings game. BMJ 2010;340:c2153. doi:10.1136/bmj.c2153

12. Penfold RB, Dean S, Flemons W, et al. Do hospital standardized mortality ratios measure patient safety? HSMRs in the Winnipeg Regional Health Authority. Healthc Pap 2008;8:8–24.

13. Chong CA, Nguyen GC, Wilcox ME. Trends in Canadian hospital standardised mortality ratios and palliative care coding 2004–2010: a retrospective database analysis. BMJ Open 2012;2:pii:e001729.

14. Shahian DM, Iezzoni LI, Meyer GS, et al. Hospital-wide mortality as a quality metric: conceptual and methodological challenges. Am J Med Qual 2012;27:112–23.

CHAPTER 4
WHAT ARE THE PERFORMANCE TRENDS ON HOSPITAL OUTCOME INDICATORS?

Omid Fekri, Edgar Manukyan, Niek Klazinga

This chapter was published as:

Appropriateness, effectiveness and safety of care delivered in Canadian hospitals: a longitudinal assessment on the utility of publicly reported performance trend data between 2012–2013 and 2016–2017

BMJ Open 2020

ABSTRACT

Objectives To assess the utility of publicly reported performance trend results of Canadian hospitals (by hospital size/type and jurisdiction).

Design Longitudinal observational study.

Setting 489 hospitals in Canada between fiscal years 2012–2013 and 2016–2017.

Participants Analysis focused on indicator results of individual Canadian hospitals.

Primary and secondary outcomes Eight outcome indicators of hospital performance: in-hospital mortality (2), readmissions (4) and adverse events (2). Performance trend outcomes of improving, weakening or no change over time. Comparators in performance by hospital size/type of above, below or same as average.

Results At the national level, between 2012–2013 and 2016–2017, Canadian hospitals largely reduced in-hospital mortality: hospital deaths (hospital standardised mortality ratio) −9%; hospital deaths following major surgery −11.1%. Conversely, readmission to hospital increased nationwide: medical 1.5%; obstetric 5%; patients aged 19 years and younger 4.6% and surgical 3%. In-hospital sepsis declined −7.1%. Approximately 10% of the 489 hospitals in this study had a trend of improving performance over time (n=49) in one or more indicators, and a similar number showed a weakening performance over time (n=52). Roughly half of the hospitals in this study (n=224) had no change in performance over time for at least four out of the eight indicators. No single hospital had an improving or weakening trend in more than two indicators. Teaching and larger-sized hospitals showed a higher ratio of improving performance compared with smaller-sized hospitals.

Conclusions Analysis of Canadian hospital performance through eight indicators shows improvement of in-hospital mortality and in-hospital sepsis, but rising rates of readmissions. Subdividing the analysis by hospital size/type shows greater instances of improvement in teaching and larger-sized hospitals. There is no clear pattern of a particular province/territory with a significant number of hospitals with improving or weakening trends. The overall assessment of trends of improving and weakening as presented in this study can be used more systematically in monitoring progress.

Introduction

Performance information can aid a range of policy and organisational change levers to facilitate healthcare performance management (such as accountability) and contribute towards quality improvement initiatives.[1] The design of coherent and integrated health information systems has ensured the collection, calculation and access to data necessary for performance monitoring.[2] The use of these data and evidence in quality improvement science, and for full transparency of performance, is essential as we enter a new generational era in medicine and healthcare.[3] But as novel performance data and methods are introduced, their assessment for utility is warranted to ensure they are fit for purpose and actionable.[4]

Mortality rates,[5] readmission rates[6] and adverse events[7] are frequent publicly reported indicators used to illustrate hospital performance with respect to appropriateness, effectiveness and safety of care. Public-reporting of these performance results aims to, among numerous goals, spur quality improvement initiatives at the hospital and health jurisdiction level.[8–10]

However, much of the existing scientific literature on hospital performance focuses on a small number of indicators at a time, generally in a narrow care setting (such as teaching hospitals or specific hospital units), and captures a short time span. In the Canadian context, few, if any studies have been published that quantify hospital performance across all Canadian hospitals, across numerous hospital performance domains or cover sizeable time-spans.

This type and level of evidence would inform meso-level and macro-level system initiatives that may hold greater promise of impact. Backed by this evidence, pan-national and provincial/territorial agencies charged with performance improvement mandates would be able to gather (otherwise isolated) best-practices, and target (potentially pooled) resources to address areas of care and services that are most pressing to the performance of Canadian hospitals. It also helps to assess the overall long-term changes in performance of Canadian hospitals.

The Canadian Institute for Health Information (CIHI) holds the mandate to collect hospital admissions data, to perform statistical calculations and to report on the performance of all hospitals in Canada. CIHI has disseminated hospital performance results in a variety of mediums over its 25-year history. In recent years, this has included establishing a consolidated online webtool titled Your Health System (YHS). CIHI's YHS tool provides detailed results for approximately 45 health system performance (HSP) indicators.[11] CIHI's mandate, similar to other health information agencies, is to report on hospital and HSP, but to refrain from overt ranking of hospitals or health jurisdictions, as there are unintended consequences associated with public release of

performance data.[12] Nonetheless, the data are often publicly available for others to perform secondary analyses.

In recent years, CIHI has added a dimension to its reporting by delineating hospital results by whether they are improving, weakening or having no significant change in performance over time. Eight hospital-level indicators within CIHI's YHS tool (covering in-hospital mortality, readmission and safety-related adverse events) show performance results with this dimension of performance trends over time. These eight indicators fall under CIHI's HSP framework[13] quadrant of health system outputs, and cover the themes of (1) appropriateness and effectiveness and (2) safety (see https://www.cihi.ca/en/indicator-library).

In this paper, we explore the utility of CIHI's publicly reported hospital results data to determine trends and any meaningful findings of performance by different care domains, by hospital type and size and at the national and provincial/territorial levels. Specifically, we explore the following four research questions:

1. What are the trends in hospital performance at the national level?
2. How many hospitals are improving or weakening in performance?
3. Is there a relationship in performance trends by hospital size/type?
4. What are the trends in hospital performance by province/territory?

Methods

We used the all data export report file from CIHI's YHS tool[14] to perform the analyses. The data file contains results for all indicators published on the YHS website as well as contextual measures and additional variables to assist with analysis and interpretation. The following eight indicators were assessed:

CIHI HSP framework theme: appropriateness and effectiveness

1. Hospital deaths (HSMR (hospital standardised mortality ratio)).
2. Hospital deaths following major surgery.
3. Medical patients readmitted to hospital.
4. Obstetric patients readmitted to hospital.
5. Patients aged 19 years and younger readmitted to hospital.
6. Surgical patients readmitted to hospital.

CIHI HSP framework theme: safety

1. In-hospital sepsis.
2. Obstetric trauma (with instrument).

All eight indicators are risk-adjusted by CIHI; all indicator-specific hospitalisations in the country were used to create a reference population in the risk model methodologies for respective indicators (model specifications and coefficients are publicly released by CIHI[15]). Five singleton fiscal year (1 April–31 March) hospital performance values were available covering 2012–2013 and 2016–2017. CIHI calculates national indicator rates by using the indicator values of all hospitals in the country. The last 3 years (2014–2015, 2015–2016, 2016–2017) of a hospital's results were used to calculate a performance trend outcome.

National-level performance rates were compared by calculating the percent change difference from 2012–2013 and 2016–2017 data years (national rates aggregate the result of all Canadian hospitals). A linear regression model was used to determine national trend analysis; p values were calculated in a model in which the indicator national rate was the dependent variable and time was the independent variable.

CIHI reports hospital performance trends in three categories: (1) improving; (2) weakening and (3) no change. To determine this trend over time, CIHI's methodology includes a series of two z-tests to compare the log-odds of a hospital's results over the most recent 3 years of data (2014–2015, 2015–2016, 2016–2017).[16] Additionally, there are three comparator categories for each hospital's indicator results: (1) same as average; (2) below average and (3) above average; and is calculated by determining whether the hospital's result was statistically significantly different from its peer group average.

To quantify trends in performance by hospital size/type, we stratified all results across the four hospital peer groups by the three performance categories. To quantify hospital performance trends subdivided by provincial/territorial jurisdictions, we identified each hospital that had either an 'improving' or 'weakening' indicator result.

Criteria for inclusion/exclusion of hospitals from this study

Not all indicators are applicable to every Canadian hospital; for example, clinical services may simply not be offered at certain facilities. Furthermore, hospitals that underwent a recent reorganisation (ie, a merger) experience a break in time-series, and are thus exempt from trending calculations in the short-term period. Moreover, indicator results may be suppressed due to privacy concerns (ie, small counts, generally when numerator and/or denominator values are between 1 and 4), or due to unstable results (a denominator between 1 and 49, or an expected event less than 1 if the

observed numerator count was greater than 0).[17] Nonetheless, the reported national indicator values incorporate all patient admissions throughout the country (regardless of small counts or mergers of individual hospitals). The province of Quebec merged many community-large and community-medium hospitals in 2015; as such, CIHI omitted these Quebec hospitals from trending value calculations for the 2016–2017 reporting year. As a result of the above criteria for hospital participation in the CIHI YHS tool and having performance trending values available, 489 hospitals were included in this analysis.

Hospital types

CIHI classifies Canadian hospitals into four distinct types (also referred to as 'peer groups'): teaching (T) hospitals; community-large (H1) hospitals; community-medium (H2) hospitals and community-small (H3) hospitals. This classification facilitates meaningful comparisons across hospitals of similar structural characteristics, patient volume and clinical complexity.[18] The four hospital types are described below:

Teaching hospitals (T)

A hospital is designated as 'teaching' by provincial/territorial ministries of health, or were identified as such in the provincial/territorial ministry's submission to CIHI's Management Information System database.

Community-large hospitals (H1)

A hospital is classified as 'community-large' if it met two of the following three criteria:

- More than 8000 inpatient cases.
- More than 10 000 weighted cases.
- More than 50 000 inpatient days.

Community-medium hospitals (H2)

A hospital is classified as 'community-medium' if having 2000 or more weighted cases.

Community-small hospitals (H3)

A hospital is classified as 'community-small' if having fewer than 2000 weighted cases.

Analyses were performed on R V.3.5.0 (R Foundation for Statistical Computing, Vienna, Austria).

Patient and public involvement

Patients or public involvement were not included in the design of this study.

Results

Trends in hospital performance indicators at the national level

There are clear trends in hospital performance across the domains of mortality, readmission and safety when comparing the first and last available years (2012–2013 and 2016–2017) (table 1). In-hospital mortality (hospital deaths (HSMR) and hospital deaths following major surgery) have decreased (−9% and −11.1%, respectively). All four hospital readmission indicators show slight increases at the national level. As for hospital safety, in-hospital sepsis has decreased (−7.1%), while obstetric trauma (with instrument) saw initial improvement followed by a recent uptick of the same degree over the study period. Of the eight indicators, only three showed statistically significant trends over time; an improving trend for hospital deaths (HSMR) and hospital deaths following major surgery, and a worsening trend for surgical patients readmitted to hospital.

Table 1 – National trends in hospital performance

INDICATOR	UNIT OF MEASUREMENT	NUMBER OF HOSPITALS WITH VALUES	NATIONAL RATE 2012–2013	NATIONAL RATE 2016–2017	CHANGE (2012–2013 TO 2016–2017) (%)	P VALUE FOR TREND
Hospital deaths (HSMR)	Baseline 100	92	100	91	–9	0.00245*
Hospital deaths following major surgery	%	180	1.80%	1.60%	–11.1	0.0154*
Medical patients readmitted to hospital	%	474	13.50%	13.70%	1.5	0.0577
Obstetric patients readmitted to hospital	%	225	2%	2.10%	5	0.0577
Patients aged 19 years and younger readmitted to hospital	%	185	6.50%	6.80%	4.6	0.0805
Surgical patients readmitted to hospital	%	246	6.70%	6.90%	3	0.0154*
In-hospital sepsis	Per 1000	431	4.2	3.9	–7.1	0.194
Obstetric trauma (with instrument)	%	100	18.90%	18.90%	0	0.88

*Statistically significant.

Quantifying hospitals that have an improving or weakening performance trend

Table 2 further illustrates the contrast in hospital performance across the domains of hospital mortality, readmissions and safety. The largest ratio of hospitals improving versus weakening occurred for the indicators in-hospital sepsis (17 vs 8), hospital deaths (HSMR) (10 vs 6) and hospital deaths following major surgery (8 vs 1). The four readmission indicators largely saw a weakening of hospital performance; in aggregate, there were 37 instances of hospitals with weakening readmission rates, compared with only 17 instances of improving rates. Readmission of patients aged 19 years and younger was the only indicator to have no hospitals improving.

Table 2 – Number of hospitals improving or weakening

INDICATOR	NUMBER OF HOSPITALS (PROPORTION OF REPORTED HOSPITALS, %)	
	IMPROVING	WEAKENING
Hospital deaths following major surgery	8 (4%)	1 (1%)
Hospital deaths (HSMR)	10 (11%)	6 (7%)
In-hospital sepsis	17 (4%)	8 (2%)
Medical patients readmitted to hospital	7 (1%)	12 (3%)
Obstetric patients readmitted to hospital	6 (3%)	9 (4%)
Patients aged 19 years and younger readmitted to hospital	0 (0%)	6 (3%)
Surgical patients readmitted to hospital	4 (2%)	10 (4%)
Obstetric trauma (with instrument)	2 (2%)	5 (5%)

The third performance trend category ‘no change’ can be slightly misleading on its own because it does not elaborate on whether the hospital’s performance was consistently poor or good. It is important to take into consideration whether hospitals with a trend of no change over time were performing above average, below average or same as average as compared with its hospital type (or peer group). Of all instances of ‘no change’ in indicator performance, 112 unique hospitals were performing above average, compared with 96 hospitals that were performing below average. A query of how many hospitals had no change in performance for at least four out of eight indicators produced a list of 224 hospitals (teaching (n=44), community-large (n=54), community-medium (n=85) and community-small (n=41)).

Quantifying performance trends by hospital type

Table 3 shows performance of the four hospital types across the eight indicators. One lens to view these data for any possible trends is to differentiate between instances of a greater number of hospitals improving versus weakening (shown with ✓), instances of a larger number of hospitals weakening versus improving (shown with **x**) and instances where the number of hospitals improving and weakening were the same (shown with **=**). Teaching hospitals had the most instances of improvement (five out of eight indicators), followed by community-large (two indicators) and community-medium (one indicator). Only community-small hospitals did not have an instance of an indicator showing a higher ratio of improvement to weakening performance. The only hospital type with more improving hospitals than weakening in any readmission indicator was teaching hospitals for medical readmission. The surgical and medical readmission indicators had the largest ratio of hospital types (three out of four) with overall weakening hospital performance.

Table 3 – Number of hospitals within each performance trend (by hospital size/type)

INDICATOR	TEACHING (T) HOSPITALS		COMMUNITY-LARGE HOSPITALS (H1)		COMMUNITY-MEDIUM HOSPITALS (H2)		COMMUNITY-SMALL HOSPITALS (H3)*		NATIONAL TOTAL—ALL HOSPITALS
Hospital Deaths (HSMR)	I: 6 (16%)	✓	I: 4 (8%)	✓	I: 0 (0%)	=	I: N/A	N/A	I: 10 (11%)
	W: 3 (8%)		W: 3 (6%)		W: 0 (0%)		W: N/A		W: 6 (7%)
	NC: 28 (76%)		NC: 41 (85%)		NC: 7 (100%)		NC: N/A		NC: 76 (83%)
Hospital Deaths Following Major Surgery	I: 3 (7%)	✓	I: 1 (2%)	=	I: 4 (6%)	✓	I: 0 (0%)	=	I: 8 (4%)
	W: 0 (0%)		W: 1 (2%)		W: 0 (0%)		W: 0 (0%)		W: 1 (1%)
	NC: 40 (93%)		NC: 53 (96%)		NC: 68 (94%)		NC: 10 (100%)		NC: 171 (95%)
Medical Patients Readmitted to Hospital	I: 3 (7%)	✓	I: 0 (0%)	x	I: 1 (1%)	x	I: 3 (1%)	x	I: 7 (1%)
	W: 2 (5%)		W: 2 (4%)		W: 4 (4%)		W: 4 (1%)		W: 12 (3%)
	NC: 38 (88%)		NC: 53 (96%)		NC: 85 (94%)		NC: 279 (98%)		NC: 455 (96%)
Obstetric Patients Readmitted to Hospital	I: 1 (3%)	x	I: 2 (4%)	=	I: 3 (4%)	=	I: 0 (0%)	x	I: 6 (3%)
	W: 3 (8%)		W: 2 (4%)		W: 3 (4%)		W: 1 (2%)		W: 9 (4%)
	NC: 32 (89%)		NC: 47 (92%)		NC: 74 (92%)		NC: 57 (98%)		NC: 210 (93%)
Patients 19 and Younger Readmitted to Hospital	I: 0 (0%)	x	I: 0 (0%)	=	I: 0 (0%)	x	I: 0 (0%)	=	I: 0 (0%)
	W: 2 (4%)		W: 0 (0%)		W: 4 (7%)		W: 0 (0%)		W: 6 (3%)
	NC: 43 (96%)		NC: 51 (100%)		NC: 57 (93%)		NC: 28 (100%)		NC: 179 (97%)
Surgical Patients Readmitted to Hospital	I: 0 (0%)	x	I: 1 (2%)	x	I: 3 (3%)	=	I: 0 (0%)	x	I: 4 (2%)
	W: 2 (5%)		W: 4 (7%)		W: 3 (3%)		W: 1 (2%)		W: 10 (4%)
	NC: 42 (95%)		NC: 50 (91%)		NC: 84 (93%)		NC: 56 (98%)		NC: 232 (94%)
In-Hospital Sepsis	I: 7 (15%)	✓	I: 7 (13%)	✓	I: 3 (3%)	=	I: 0 (0%)	=	I: 17 (4%)
	W: 0 (0%)		W: 5 (9%)		W: 3 (3%)		W: 0 (0%)		W: 8 (2%)
	NC: 41 (85%)		NC: 43 (78%)		NC: 84 (93%)		NC: 238 (100%)		NC: 406 (94%)
Obstetric Trauma (With Instrument)	I: 2 (6%)	✓	I: 0 (0%)	x	I: 0 (0%)	x	I: 0 (0%)	=	I: 2 (2%)
	W: 1 (3%)		W: 2 (4%)		W: 2 (11%)		W: 0 (0%)		W: 5 (5%)
	NC: 31 (91%)		NC: 43 (96%)		NC: 17 (89%)		NC: 2 (100%)		NC: 93 (93%)

Number (%) of hospitals improving, weakening or with no change (by hospital size/type and national total). I, improving; N/A, not applicable; NC, no change; W, weakening.

✓ indicates more hospitals improving (than weakening). x indicates more hospitals weakening (than improving). = indicates equal number of improving and weakening hospitals. *Community-small hospital quantifications should be interpreted with caution as these hospitals largely do not meet the minimum number of admitted patients and/or patients requiring high-complexity treatment to qualify for calculation and reporting of performance indicators.

Quantifying hospital performance trends by provincial/ territorial jurisdiction

Table 4 shows unique counts of hospitals (by province/territory) with a result of improving or weakening performance in at least one indicator. There is generally an equal distribution of trends across provinces and territories. Five regions had more hospitals weakening than improving; another five regions had more hospitals improving than weakening and the remaining three regions with an equal balance. At the hospital level, there were only five hospitals across the country that had a weakening trend for two indicators: two in each of teaching and community-large hospital types and one in community-medium. Of these five hospitals, three appeared in Ontario. Furthermore, there were five hospitals across the country that had an improving trend for two indicators; of these, four were teaching hospitals.

Table 4 – Number of unique hospitals improving or weakening and total number of hospitals within province/territory

PROVINCIAL/ TERRITORIAL REGION	NUMBER OF HOSPITALS WITH IMPROVING TRENDS	IMPROVEMENT TREND PROBABILITY, % (95% CI)	NUMBER OF HOSPITALS WITH WEAKENING TRENDS	WEAKENING TREND PROBABILITY, % (95% CI)	TOTAL NUMBER OF HOSPITALS WITHIN PROVINCE/ TERRITORY (AS REPORTED WITH PERFORMANCE TRENDING RESULTS IN THE YHS TOOL)
Alberta	5	5 (2 to 12)	10	11 (5 to 19)	92
British Columbia	7	10 (4 to 19)	7	10 (4 to 19)	71
Manitoba	2	4 (0 to 13)	4	7 (2 to 18)	55
New Brunswick	2	11 (1 to 33)	1	5 (0 to 26)	19
Newfoundland and Labrador	3	12 (3 to 32)	4	17 (5 to 37)	24
Northwest Territories	1	25 (1 to 81)	0	0 (0 to 60)	4
Nova Scotia	1	4 (0 to 18)	2	7 (1 to 24)	28
Nunavut	–	–	–	–	0
Ontario	22	18 (12 to 26)	19	16 (10 to 23)	122
Prince Edward Island	0	0 (0 to 46)	1	17 (0 to 64)	6
Quebec*	2	18 (2 to 52)	1	9 (0 to 41)	11*
Saskatchewan	3	5 (1 to 15)	3	5 (1 to 15)	56
Yukon	1	1 (2 to 100)	0	0 (0 to 97)	1
National totals	49		52		489

*Community-large and community-medium hospitals in Quebec underwent mergers in 2015, thus inhibiting calculation of trending data for indicators.

Discussion

Reporting of Canadian hospital performance has increased in its complexity and utility over the last decade.[11 19] Publicly available tools now provide multiple user interfaces (from decision-makers to the general public) to view and understand how hospitals perform within their jurisdiction and across Canada. While mindful not to 'name and shame', health information agencies still endeavour to provide reporting of hospital performance and HSP of increased actionability. In recent years, CIHI has added new dimensions to hospital performance reporting, including performance trends over time, top results, comparisons to the national average and outlier analysis using funnel plots.

To date, few, if any, scientific studies summarise hospital performance across disparate domains for all hospitals in Canada, including any quantification of improving versus weakening trends. This study, therefore, provides an initial overview on the landscape of hospital performance on appropriateness, effectiveness and safety of care.

This secondary analysis of CIHI's hospital performance reporting shows that in-hospital mortality—indicators of hospital deaths (HSMR) and hospital deaths following major surgery—has significantly declined in Canada, which has been shown elsewhere.[20] Conversely, national rates of hospital readmission showed slight increases over time (but mostly non-statistically significant in trend analysis). Moreover, hospital readmission accounted for the majority of instances of weakening hospital performance. With respect to the CIHI HSP framework domain of Safety, in-hospital sepsis is declining; however, obstetric trauma (with instrument) has risen modestly (after a short period of decline). Roughly half of the hospitals in this study, which account for approximately one-third of all Canadian hospitals, did not improve or weaken in performance across at least four out of the eight indicators.

Strengths and limitations of this study

The chief strength of this study is the standardised calculation methods for all eight indicators (applied to all Canadian hospitals) by CIHI. All data used for calculations, from hospital admission abstracts, to statistical methods to perform risk-adjustment, are uniformly applied to all indicators and hospitals. Therefore, results for all eight indicators and the 489 hospitals included in this analysis, are confidently valid having been vetted and assured for data quality by CIHI. Furthermore, the statistical methods used by CIHI to determine performance trends (improving, weakening or no change) employs robust statistical tests to determine directionality of performance.

This study assessed 5 years of data for eight indicators, with a pool of 489 hospitals. Additionally, this study reported results from multiple performance domains, and by the four Canadian hospital peer groups (teaching, community-large, community-medium and community-small hospitals), which is scarce in the scientific literature.

Due to mergers of community-large and community-medium hospitals in the province of Quebec in 2015, these hospitals were excluded from performance trending calculations by CIHI. In subsequent years, when additional years of data are calculated for these hospitals, it will be feasible to include all Quebec hospitals into a similar analysis. Performance of hospitals is largely limited to categorical outcomes, and did not include absolute quantitative performance.

Nearly half of all Canadian hospitals are classified as community-small. Compared with the other three hospital peer groups, community-small facilities treat fewer and less-complex patients. Therefore, it is common for indicator results for these hospitals to be suppressed (or at times not calculated) due to small counts of cases. Similarly, CIHI's model to calculate trending performance may not render statistically significant indicator results for smaller-sized hospitals due to small counts of patient cases. As such, smaller-sized hospitals overwhelmingly show performance trend outcomes of 'no change' over time.

Overall, the generalisability of the results in this study are largely restricted to Canada; this is due to the unique Canadian context of provision of hospital services, geographic distribution of hospitals and populations, risk-adjustment modelling to produce risk-adjusted indicator rates, indicator definitions, hospital size/type definitions and the quality and depth of the underlying clinical administrative data. Nonetheless, the methodology described by CIHI to produce performance trend outcomes can be applied to other national/subnational settings, hospital size/types and indicators.

Reflections on the study's findings

Mortality, readmissions and adverse events are unfavourable and costly hospital outcomes. A 2015 systematic evaluation and reconfirmation exercise of all HSP indicators reported by CIHI found the eight indicators in this study as having high-utility by health decision-makers across Canada.[4] In recent years, hospital mortality and adverse events were at the forefront of the performance management agenda, with programmes of pay-for-performance tying remuneration and hospital funding to results.[21] This study shows that in-hospital mortality and adverse events have been in decline. Conversely, there are observed increases in readmission rates, and a greater number of hospitals with declining performance compared with those improving. In addition to the complexities of behavioural, socioeconomic and health factors of patients, readmission to hospital is also indicative of the quality, organisation and delivery of an integrated healthcare system (ie, primary care, home care, mental healthcare).[22] Attention at national and provincial levels may now need to focus on addressing the system-level factors that contribute to hospital readmission.

Numerous national and provincial stakeholders occupy key roles in hospital performance improvement. Public reporting of hospital performance trending results provides valuable insight into current and future care domains that require concerted attention to address. National agencies charged with aiding hospital quality improvement (ie, the Canadian Foundation for Healthcare Improvement) would be able to use the findings of system-wide analyses such as this to identify best practices from across the country, and to accelerate their spread and scale. Performance information, such as the type used in this study, can facilitate numerous levers of change in the pursuit of quality improvement in health care.[1]

Provincial quality councils, hospital associations and ministries of health would be able to address more granular performance issues, such as particularly weakening performance within a select group of hospitals or type/sizes of hospitals. Accordingly, any provincial pay-for-performance schemes would benefit from periodic reviews to determine which hospital care domains have reached a performance plateau (ie, mortality and adverse events), and which should be newly incorporated (such as readmissions).

Community-small hospitals account for roughly half of all Canadian hospitals, yet these facilities generally do not meet the minimum number of patient cases in order to qualify for publicly reported performance results. Understandably, these rates, due to small counts, can fluctuate substantially from year to year, often show wide CIs and generally do not show significant trends over time. Nonetheless, for this sizeable group of Canadian hospitals to have meaningful inclusion in public and privately reported performance indicators, novel performance measurement techniques are required from health information agencies that account for these characteristics of smaller-sized hospitals.

The causality between public reporting of performance results leading to improved quality hospital care has been examined for over two decades; on balance, there is evidence that public reporting has spurred quality improvement activity at the hospital level,[9, 10] and measurable improvement on process and outcome indicators. However, such inquiries (including systematic reviews) have also concluded an insufficient sample-size, a lacking evidence-base and rigorous evaluation methods to be able to make a conclusive finding on the efficacy and impact of public performance reporting.[23, 24]

This study has shown that there are clear trends in Canadian hospital performance, and that meaningful findings can be gleaned from secondary analysis of publicly reported performance data. Various stakeholders and administrators of hospital performance may find this type of summary analysis of benefit in their planning of quality performance improvement initiatives, and assignment of resources towards prioritised hospital care domains.

Conclusion

This study shows that meaningful findings on hospital performance can be gleaned when assessing publicly reported performance results. Analysis of Canadian hospital performance through multiple indicators shows a reduction of in-hospital mortality and in-hospital sepsis, but slight increases in rates of hospital readmissions. Subdividing the analysis by hospital size/type shows greater instances of improvement in teaching and larger-sized hospitals. The overall assessment of trends of improving and weakening as presented in this study can be used more systematically in monitoring progress. Further research is required on the complementarity of the indicators studied, especially the relationship between in-hospital mortality and hospital readmission trends.[25]

References

1. Levesque J-F, Sutherland K. What role does performance information play in securing improvement in healthcare? A conceptual framework for levers of change. BMJ Open 2017;7:e014825.
2. Wolfson M, Alvarez R. Towards integrated and coherent health information systems for performance monitoring: the Canadian experience. In: Smith PC, ed. Measuring up: improving health system performance in OECD countries. Paris: Organisation for Economic Cooperation and Development, 2002: 133–55.
3. Berwick DM. Era 3 for medicine and health care. JAMA 2016;315:1329–30.
4. Fekri O, Leeb K, Gurevich Y. Systematic approach to evaluating and confirming the utility of a suite of national health system performance (Hsp) indicators in Canada: a modified Delphi study. BMJ Open 2017;7:e014772.
5. Klazinga NS, Li L. Comparing health services outcomes. In: Papanicolas I, Smith P, eds. Health system performance comparison: an agenda for policy, information and research. Maidenhead, UK: Open University Press, 2013: 157–81.
6. Fischer C, Anema HA, Klazinga NS. The validity of indicators for assessing quality of care: a review of the European literature on hospital readmission rate. Eur J Public Health 2012;22:484–91.
7. Slawomirski L, Auraaen A, Klazinga NS. The economics of patient safety: strengthening a value-based approach to reducing patient harm at national level. Paris: OECD Publishing, 2017.
8. Canadian Health Services Research Foundation. Performance reporting to help organizations promote quality improvement. Healthc Policy 2008;4:70–4.

9. Hafner JM, Williams SC, Koss RG, et al. The perceived impact of public reporting Hospital performance data. Int J Qual Health Care 2011;23:697–704.

10. Fung CH, Lim Y-W, Mattke S, et al. Systematic review: the evidence that publishing patient care performance data improves quality of care. Ann Intern Med 2008;148:111–23.

11. Lacroix J, Cooper K. Providing Meaningful and Actionable Health System Performance Information: CIHI's 'Your Health System' Tools. Proceedings of Statistics Canada Symposium-Growth in Statistical Information: Challenges and Benefits, 2016.

12. Marshall M, Davies H. Public release of information on quality of care: how are health services and the public expected to respond? J Health Serv Res Policy 2001;6:158–62.

13. Canadian Institute for Health Information. A performance measurement framework for the Canadian health system. Ottawa: CIHI, 2012.

14. Canadian Institute for Health Information. Your health system – in depth. Ottawa: CIHI, 2018. https://yourhealthsystem.ca

15. Canadian Institute for Health Information. Model specifications — clinical indicators. 2019. Ottawa: CIHI, 2019.

16. Canadian Institute for Health Information. Identifying indicator top results and trends for Regions/Facilities — methodology notes. Ottawa: CIHI, 2017.

17. Canadian Institute for Health Information. Information on data quality, suppression and other interpretation notes for the Your Health System web tool — methodology notes. 2019. Ottawa: CIHI, 2019.

18. Canadian Institute for Health Information. Indicator library: peer group methodology. Ottawa: CIHI, 2016.

19. Vogel L. Landmark tool assesses Canadian hospitals. CMAJ 2012;184:866.

20. Fekri O, Amuah JE, Herasimovich V, et al. Palliative care coding practices in Canada since the introduction of guidelines and the HSMR indicator. BMJ Open 2015;5:e008753.

21. Chan Y-CL, Hsu SH. Target-Setting, Pay for Performance, and Quality Improvement: A Case Study of Ontario Hospitals' Quality-Improvement Plans. Can J Adm Sci 2019;36:128–44.

22. Jiang HJ, Boutwell AE, Maxwell J, et al. Understanding patient, provider, and system factors related to Medicaid readmissions. Jt Comm J Qual Patient Saf 2016;42:115–21.

23. Ketelaar NABM, Faber MJ, Flottorp S, et al. Public release of performance data in changing the behaviour of healthcare consumers, professionals or organisations. Cochrane Database Syst Rev 2011:CD004538.

24. Metcalfe D, Rios Diaz AJ, Olufajo OA, et al. Impact of public release of performance data on the behaviour of healthcare consumers and providers. Cochrane Database Syst Rev 2018;9:CD004538.

25. Lingsma HF, Bottle A, Middleton S, et al. Evaluation of hospital outcomes: the relation between length-of-stay, readmission, and mortality in a large international administrative database. BMC Health Serv Res 2018;18:116.

CHAPTER 5
WHAT IS THE DEGREE OF ASSOCIATION BETWEEN HOSPITAL PERFORMANCE OUTCOME INDICATORS?

Omid Fekri, Edgar Manukyan, Niek Klazinga

This chapter was published as:

Associations between hospital deaths (HSMR), readmission and length of stay (LOS): a longitudinal assessment of performance results and facility characteristics of teaching and large-sized hospitals in Canada between 2013–2014 and 2017–2018

BMJ Open 2021

ABSTRACT

Objectives To examine the association between hospital deaths (hospital standardised mortality ratio, HSMR), readmission, length of stay (LOS) and eight hospital characteristics.

Design Longitudinal observational study.

Setting A total of 119 teaching and large-sized hospitals in Canada between fiscal years 2013–2014 and 2017–2018.

Participants Analysis focused on indicator results and characteristics of individual Canadian hospitals.

Primary and secondary outcomes Hospital deaths (HSMR); all patients readmitted to hospital; average LOS and a series of eight hospital characteristic summary measures: number of acute care hospital stays; number of acute care beds; number of emergency department visits; average acute care resource intensity weight; total acute care resource intensity weight; hospital occupancy rate; patients admitted through the emergency department (%); patient days in alternate level of care (%).

Results Comparing 2013–2014 to 2017–2018, hospital deaths (HSMR) largely declined, while readmissions increased; 69% of hospitals decreased their hospital deaths (HSMR), while 65% of hospitals increased their readmissions rates. A greater proportion of community-large hospitals (31%, n=14) improved on both hospital deaths (HSMR) and readmission compared to Teaching hospitals (13.9%, n=5). Hospital deaths (HSMR), readmission and LOS largely showed very weak and non-significant correlations. LOS was largely positively and statistically significantly correlated with the suite of eight hospital characteristics. Hospital deaths (HSMR) was largely negatively (not statistically significantly) correlated with the hospital characteristics. Readmission was largely not statistically significantly correlated and showed no clear pattern of correlation (direction) with hospital characteristics.

Conclusions Examining publicly reported hospital performance results can reveal meaningful insights into the association among outcome indicators and hospital characteristics. Good or bad hospital performance in one care domain does not necessarily reflect similar performance in other care domains. Thus, caution is warranted in a narrow use of outcome indicators in the design and operationalisation of hospital performance measurement and governance models (namely pay-for-performance schemes). Analysis such as this can also inform quality improvement strategies and targeted efforts to address domains of care experiencing declining performance over time; further granular subdivision of the analyses, for example, by hospital peer-groups, can reveal notable differences in performance.

Introduction

Over the last two decades, there has been substantial interest in hospital performance,[1] and with financing of hospitals increasingly tied to improving the quality of care delivered.[2] Along with improving the quality of care, a tandem goal of hospital reforms has been to improve efficiency[3] (ie, reducing waste, streamlining care pathways, increasing patient throughput, optimising the use of technology, etc). Hospital deaths[4] and readmission to hospital[5] are among the most commonly used indicators to measure quality of hospital care, while average length of stay (LOS) is often used as a measure of efficiency.[6] The three measures together (hospital deaths, readmission and LOS) have been the subject of increased interest in recent years to assist with more reliable interpretations of hospital performance.[7]

However, the goals of achieving quality and efficiency can at times be opposing. For example, it seems warranted to investigate whether a hastened hospital stay (shorter LOS) would lead to an increased chance of readmission to hospital.[8] Similarly, do efforts to reduce hospital readmissions have the unintended consequence of increasing the likelihood of mortality after hospitalisation?[9] While hospital deaths and readmission are both desired to be reduced, it is not definite (and varying across diseases and clinical procedures) whether a patient's LOS should be lower or higher in order to minimise readmission or in-hospital mortality. However, what can be deduced is that the relationships between LOS, in-hospital mortality and readmission are intertwined and interdependent. Hence, governance of hospitals based on these publicly reported indicators should be based on acknowledgement and consideration of these interdependencies.

Yet, despite a sizeable research community investigating the interrelationship between these indicators, the evidence base on the patterns of these interdependencies remains inconclusive due to wide heterogeneity in methods and findings across studies (which speaks to the complexity of the topic). For example, a switch between the unit of analysis (from patient level to hospital level), on the same underlying admissions data, will yield inconsistent, and even inverse, results.[10] In recent years, researchers have also examined hospital characteristics, such as hospital volumes[11] or hospital teaching status[12] to better understand any associations between LOS, readmission and in-hospital mortality.

Much of the afore cited literature originates from the USA and Europe. With a scarcity of local examples, this study used a large, nationally representative dataset of hospital performance measures (produced by the Canadian Institute for Health Information (CIHI)) to expand interest and add evidence for the Canadian context. Specifically, we investigate the relationship between hospital deaths, readmission and

LOS, and explore any associations with hospital characteristics. Our specific research questions are:

1. How have hospitals performed in both the hospital deaths (hospital standardised mortality ratio, HSMR) and readmission indicators over time?
2. What is the correlation between hospital deaths (HSMR), readmissions and LOS?
3. How do a series of eight hospital characteristics correlate with hospital deaths (HSMR), readmissions and LOS?
4. Do the results of the aforementioned research questions show differences between peer groups of teaching hospitals and community-large hospitals?

Methods

Data

We used the all data export report file from CIHI's Your Health System In Depth online tool[13] to perform the analyses. The data file contains results per hospital for all indicators published on the online tool as well as contextual measures and additional variables to assist with analysis and interpretation. Five singleton fiscal year (1 April to 31 March) data points were available covering 2013–2014 to 2017–2018 for the indicators capturing hospital deaths (HSMR) and all patients readmitted to hospital (henceforth referred to 'readmission'), while LOS and eight hospital characteristics measures were only available for the most recent year (2017–2018).

Definition of variables

The following indicators were used for the analysis: hospital deaths (HSMR), readmission (%) and LOS (days); and eight contextual measures of hospital facility characteristics: number of acute care hospital stays; number of acute care beds; number of emergency department visits; average acute care resource intensity weight (RIW); total acute care RIW; hospital occupancy rate; patients admitted through the emergency department; patient days in alternate level of care (%).

HSMR and other variations of summary hospital mortality measures are commonly used indicators to assess hospital performance. The hospital deaths (HSMR) indicator is a ratio of observed to expected in-hospital mortality, capturing the 72 leading causes of hospital death (representing ~80% of all in-hospital mortality). The Readmission indicator captures all urgent patient readmissions within 30 days. The average LOS indicator is a sum of all valid days spent in hospital, divided by the total number of

inpatient cases. Detailed technical notes on these indicators,[14] and on hospital facility characteristics,[15] are made available by CIHI through its Indicator Library.

Both hospital deaths (HSMR) and readmission indicators are risk adjusted. Hospital deaths (HSMR) risk-adjustment variables are: age, sex, LOS, admission category, comorbidity (Charlson Index Score) and transfers. As the readmission indicator is an aggregate of four subcategories of readmission (medical, surgical, obstetric, paediatric), the readmission risk-adjustment variables are not constant across the four subcategories; this range of risk-adjustment variables are: age, sex, acute care hospitalisations in previous 6 months, admission category, comorbidity (Charlson Index Score) and casemix groupings. Detailed information on model specifications and coefficients used in calculations are available elsewhere.[16, 17]

CIHI classifies the approximately 600 hospitals in Canada into four distinct peer-group types: teaching hospitals; community-large hospitals; community-medium hospitals and community-small hospitals. This classification facilitates meaningful comparisons across hospitals of similar structural characteristics, patient volume and clinical complexity.[18] Since characteristics of hospitals are not included in risk-adjustment models, any comparison of two or more hospitals' individual performance should be done within their respective hospital peer-groups.

A hospital is designated as 'teaching' by provincial/territorial ministries of health, or was identified as such in the provincial/territorial ministry's submission to CIHI's Management Information System Database. Community-large hospitals meet two of the following three criteria: more than 8000 inpatient cases; more than 10 000 weighted cases; or more than 50 000 inpatient days.

In order to qualify for public reporting of results for the hospital deaths (HSMR) indicator, a hospital must meet a minimum of 2500 eligible hospital deaths (HSMR) cases for each of the most recent three consecutive years.[19] Consequently, no community-small hospitals met this criteria to have publicly reported hospital deaths (HSMR) results. Of the 93 community-medium hospitals only 11 hospitals met the minimum reporting requirements and had hospital deaths (HSMR) results reported. Since this represents only 8.5% of the entire peer-group, it was decided to also exclude community-medium hospitals, alongside community-small hospitals, in this analysis. Hospitals with only 1 year of data available, for both readmission and hospital deaths (HSMR) indicators, for either 2013–2014 or 2017–2018 only, were excluded from performance trend analysis. Therefore, a total of 119 hospitals were included in the overall study, 53 Teaching hospitals and 66 community-large hospitals (representing 67.9% and 68.2% of all hospitals in their respective peer-group totals in the available online dataset). A subset of 81 hospitals were included in the performance trend analysis.

Statistical analyses

Descriptive statistics for the analysis of LOS, hospital deaths (HSMR) and readmission indicators are presented by range of values, peer-group means and 95% CIs and coefficient of variation (CoV) (see table 1). Trend over time is calculated as the percent-change difference between first and last year of data (2013–14 and 2017–18). A paired t-test was used to determine whether absolute changes in rates between 2013–2014 and 2017–2018 were significant.

To compare indicator rates per hospital across 2013–2014 to 2017–2018, three possible outcomes are inferred: a decrease in rate (2013–2014>2017–2018); an increase in rate (2013–2014<2017–2018); and no change in rate (2013–2014=2017–2018). Multiplying these three outcomes by the two indicators of interest (hospital deaths (HSMR) and readmission), in tandem, yields a total of nine trend outcomes (see table 2).

Graphical representation of the aforementioned tests are shown via scatterplots depicting: (1) percent change over time for hospital deaths (HSMR) and readmission (delineated by peer-group) (see figure 1) and (2) 2017–2018 data year results on hospital deaths (HSMR) and readmission, with LOS depicted as the size of the bubble plot (see figures 2 and 3).

A Spearman's rank correlation test examines the association between LOS, hospital deaths (HSMR) and readmission on 2017–2018 data year values (with breakdowns for teaching and community-large hospital peer-groups). Strengths of correlations, the absolute value of R_s (positive and negative) are defined as: 0.00–0.19 very weak; 0.20–.39 weak; 0.40–0.59 moderate; 0.60–0.79 strong; 0.80–1.0 very strong.[20]

Lastly, a Spearman's rank correlation test was also used to assess the correlation between eight hospital facility characteristics against LOS, hospital deaths (HSMR) and readmission values for 2017–2018. All analyses were performed on R V.3.5.0 (R Foundation for Statistical Computing, Vienna, Austria).

Patient and public involvement

Patients or public were not involved in the design of this longitudinal, observational study. However, all data used are available in the public domain.

Results

Combined performance of hospital mortality (HSMR) and readmission over time

In comparing 2013–2014 and 2017–2018 indicator rates, hospital deaths (HSMR) largely declined, while readmissions increased (see table 1). A paired t-test showed statistically significant changes in trend over time for both indicators: hospital deaths (HSMR) improved by a mean of −5.1 (95% CI −7.33 to −2.9, p<0.001), and readmission rates increased by a mean of 0.15% (95% CI 0.04% to 0.26%, p=0.006). While not statistically significant, the community-large hospital peer-group showed a greater mean improvement in hospital deaths (HSMR) by −6.0% (95% CI −9.1% to −2.8%), while teaching hospitals improved by −4.1% (95% CI −7.5% to −0.8). Both hospital peer groups experienced a mean increase in readmission rates, with community-large hospitals at 1.6% (95% CI −0.3% to 3.4%) and teaching hospitals at 2.1% (95% CI 0.7% to 3.6%). When examining the 2017–2018 data year, community-large hospitals had a statistically significant lower rate of readmissions at 8.9 (95% CI 8.7 to 9.1) compared with teaching hospitals at 9.4 (95% CI 9.2 to 9.6). Table 2 provides a lens on how individual hospitals performed in both indicators. Nine possible outcomes of performance are shown. Overall, 56 (69%) out of the total 81 hospitals assessed decreased their hospital deaths (HSMR), while only 23 (28%) hospitals decreasing their readmissions rates.

Table 1 – Descriptive statistics for combined analysis of Hospital Deaths (HSMR), Readmission and LOS

NO OF HOSPITALS, N	TEACHING HOSPITALS				COMMUNITY-LARGE HOSPITALS			
	36				45			
RANGE OF VALUES FOR 2017–2018 DATA YEAR	**RANGE OF VALUES**	**TEACHING PEER-GROUP MEAN* (95% CI)**	**COEFFICIENT OF VARIATION, % (95% CI)**	**MEDIAN (IQR Q1–Q3)**	**RANGE OF VALUES**	**COMMUNITY-LARGE PEER-GROUP MEAN* (95% CI)**	**COEFFICIENT OF VARIATION, % (95% CI)**	**MEDIAN (IQR Q1–Q3)**
LOS (days)	4.6 to 9.2	7.1 (6.7 to 7.4)	16 (13 to 21)	6.9 (6.4–7.8)	4.5 to 13.7	6.5 (6.1 to 6.9)	24 (20 to 29)	6.2 (5.7–7.1)
Hospital deaths (HSMR)	66 to 118	91.8 (87.8 to 95.7)	14 (11 to 18)	92 (82–100)	65 to 144	87.5 (83.9 to 91)	16 (13 to 19)	86 (77–96.5)
Readmission (%)	7.4 to 10.6	9.4 (9.2 to 9.6)	8 (7 to 11)	9.5 (9–9.9)	7.4 to 10.7	8.9 (8.7 to 9.1)	8 (7 to 10)	8.8 (8.5–9.63)
PER CENT-CHANGE DIFFERENCE 2013–2014 VS 2017–2018 (%)	**RANGE OF % CHANGE**	**MEAN TEACHING PEER-GROUP % CHANGE* (95% CI)**			**RANGE OF % CHANGE**	**MEAN COMMUNITY-LARGE PEER-GROUP % CHANGE* (95% CI)**		
Hospital deaths (HSMR)	−21 to 22	−4.1 (−7.5 to −0.8)			−33 to 21	−6.0 (−9.1 to −2.8)		
Readmission (%)	−12 to 12	2.1 (0.7 to 3.6)			−14 to 17	1.6 (−0.3 to 3.4)		

*Calculated by summing values of all hospitals within peer-group and dividing by number of hospitals

HSMR, hospital standardised mortality ratio; LOS, length of stay.

Table 2 – Performance trend outcomes on Hospital Deaths (HSMR) and Readmission (2013-2014 to 2017-2018)

TREND OUTCOME	HOSPITAL DEATHS (HSMR)	READMISSION	TEACHING HOSPITALS (TOTAL N=36) NO, (%)	COMMUNITY-LARGE HOSPITALS (TOTAL N=45) NO, (%)	TOTAL OF ALL HOSPITALS, NO, (%)
Decrease in both HSMR and readmission	↓	↓	5 (13.9)	14 (31.1)	19 (23.5)
Decrease in HSMR, increase in Readmission	↓	↑	20 (55.6)	14 (31.1)	34 (42.0)
Decrease in HSMR, no change in readmission	↓	=	1 (2.8)	2 (4.4)	3 (3.7)
Increase in HSMR, decrease in readmission	↑	↓	2 (5.6)	1 (2.2)	3 (3.7)
Increase in both HSMR and readmission	↑	↑	7 (19.4)	8 (17.8)	15 (18.5)
Increase in HSMR, no change in readmission	↑	=	1 (2.8)	0	1 (1.2)
No change in HSMR, decrease in readmission	=	↓	0	1 (2.2)	1 (1.2)
No change in HSMR, increase in readmission	=	↑	0	4 (8.9)	4 (4.9)
No change in both HSMR and readmission	=	=	0	1 (2.2)	1 (1.2)

*↑ signifies increasing rate; ↓ signifies decreasing rate; = signifies no change

Figure 1 illustrates the combined percent change of hospital deaths (HSMR) and readmissions rates (comparing 2013–2014 and 2017–2018 individual hospital rates) delineated by hospital peer group. While coefficient of variation values are largely similar between the two peer-groups for the two outcome indicators, nearly three times as many community-large hospitals (n=14) showed greater improvement in the bottom left quadrant of figure 1 (decrease in both hospital deaths (HSMR) and readmission), than teaching hospitals (n=5). These clear trends of overall decreasing hospital deaths and rising readmissions have been confirmed in our previous analysis.[21]

Figure 1 – Scatterplot of percent-change between 2013–2014 and 2017–2018 for Readmission and Hospital Deaths (HSMR) (by hospital peer-group).

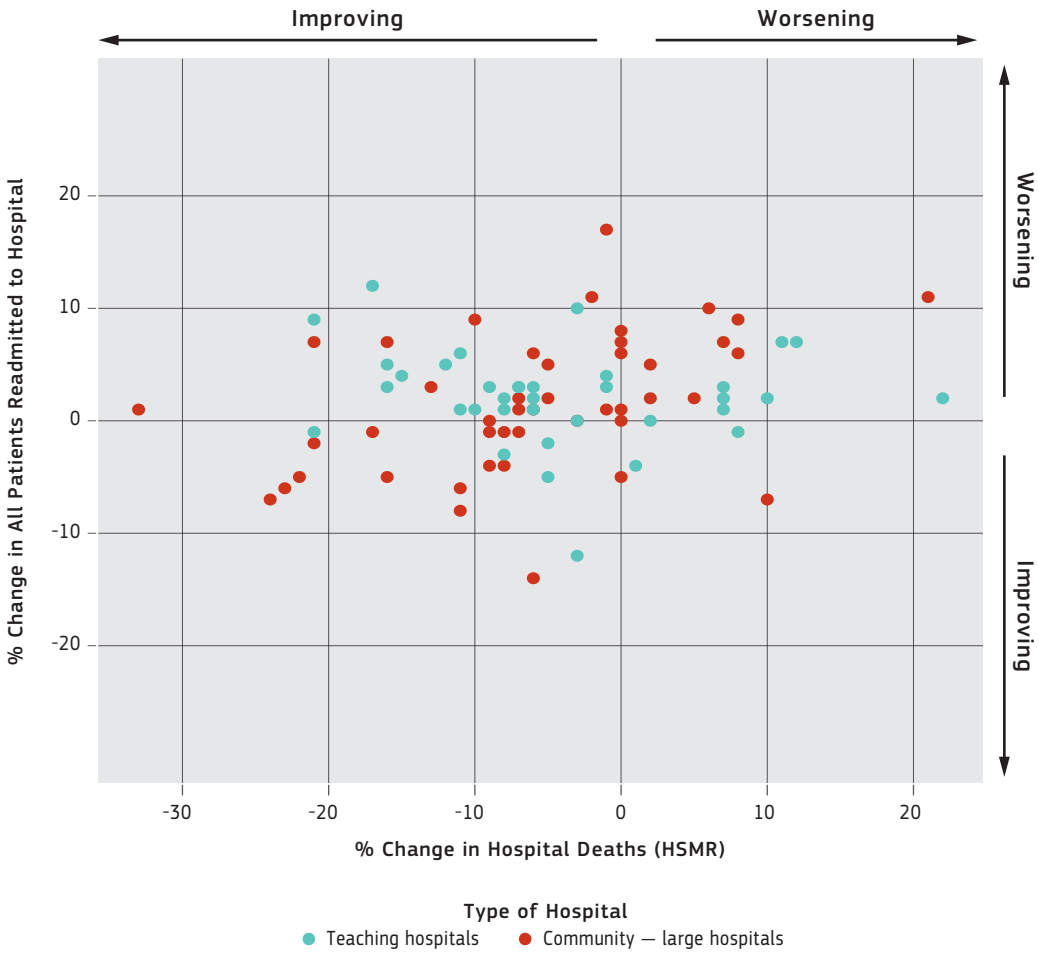


Figure 2 – Scatterplot of teaching hospital values for Hospital Deaths (HSMR), Readmission and LOS (2017–2018).

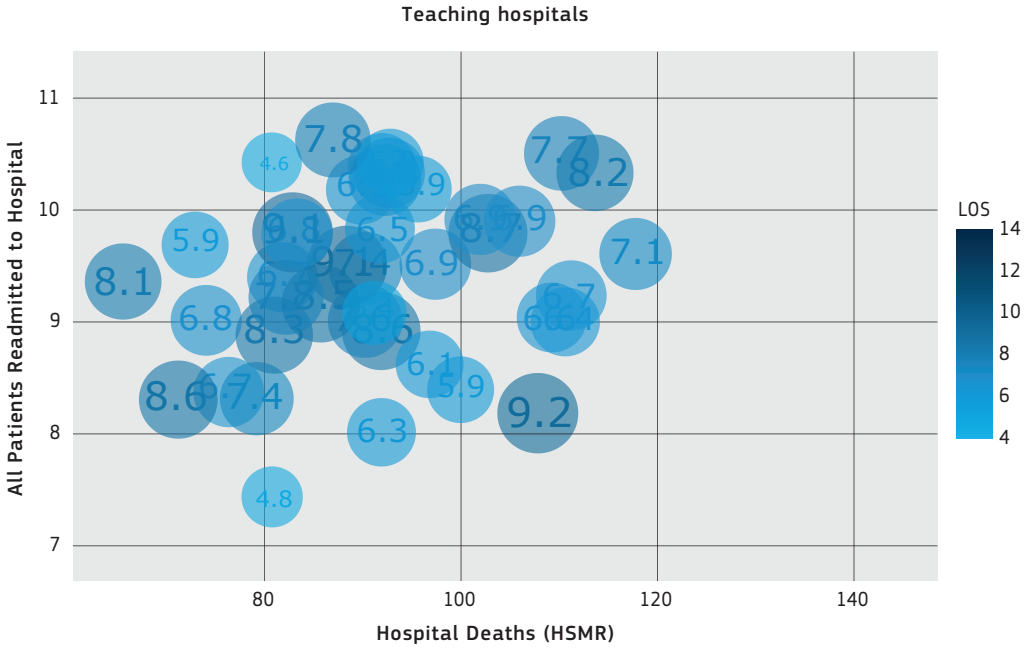
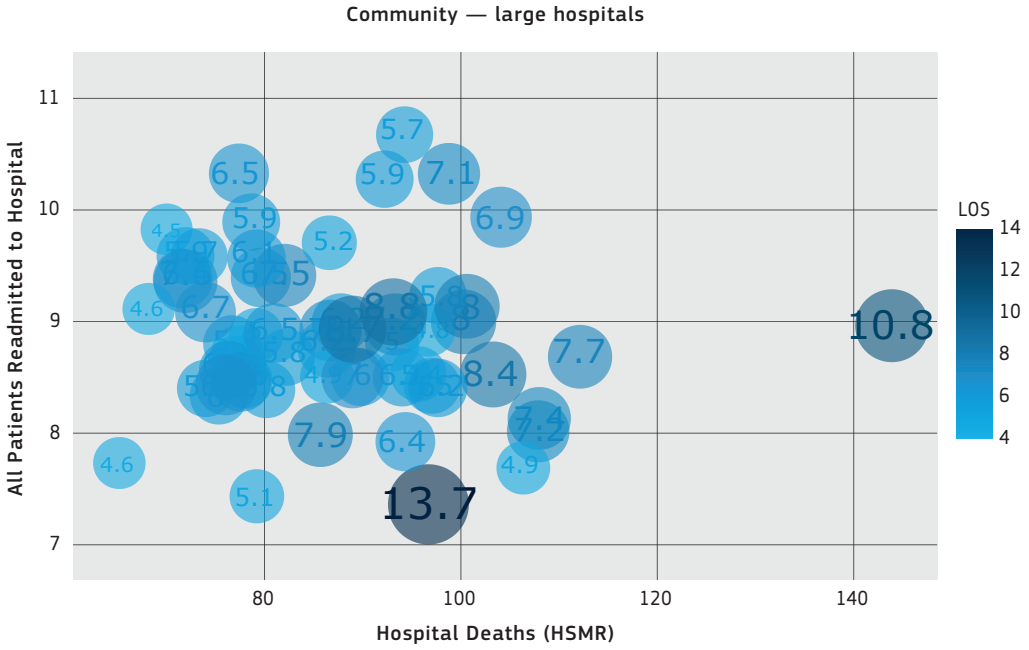


Figure 3 – Scatterplot of community-large hospital values for Hospital Deaths (HSMR), Readmission and LOS (2017–2018).



Hospital deaths (HSMR), readmissions and LOS (2017–2018)

In examining hospital deaths (HSMR), readmission and LOS for potential associations, only very weak to weak non-statistically significant results were observed (see table 3). The community-large hospital peer-group showed greater variation in LOS values (CoV=24%, 95% CI 20% to 29%) compared with the teaching hospital peer-group (CoV=16%, 95% CI 13 to 21). While not statistically significant, the community-large hospital peer group had a shorter mean LOS of 6.5 days (95% CI 6.1 to 6.9) compared with the teaching hospital peer group of 7.1 days (95% CI 6.7 to 7.4) (see table 1). Figures 2 and 3 illustrate LOS, hospital deaths (HSMR) and readmission values for the 2017–2018 data year (with LOS delineated in size and shading of bubble plot) for teaching and community-large hospitals respectively.

Table 3 – Correlations between hospital deaths (HSMR), readmission and LOS (breakdowns by teaching and community-large hospitals) (2017–2018)

		LOS	HOSPITAL DEATHS (HSMR)	
Readmission	Teaching:	−0.04 (−0.41 to 0.33)	Teaching:	0.22 (−0.09 to 0.54)
	Community-Large:	0.04 (−0.23 to 0.31)	Community-Large:	−0.13 (−0.42 to 0.15)

*Direction of correlation is shown as blue (positive) and red (negative) and intensity of cell-colouring reflects strength of correlation. Correlation strength classification: 0.00–0.19 very weak; 0.20–0.39 weak; 0.40–0.59 moderate; 0.60–0.79 strong; 0.80–1.0 very strong.
HSMR, hospital standardised mortality; LOS, length of stay.

Correlation between hospital characteristics, LOS, hospital deaths (HSMR) and readmission

Table 4 shows the correlation between hospital characteristics and LOS, hospital deaths (HSMR) and readmissions. LOS was largely positively correlated (and statistically significant) with the series of eight hospital characteristics. Hospital deaths (HSMR) was largely weak to very weakly negatively correlated. Readmissions were mixed with positive and negative weak to very weak correlations. Correlations between hospital deaths (HSMR) and readmissions with the eight hospital characteristics were largely not statistically significant (aside from patient days in alternate level of care, patients admitted through the emergency department and average acute care RIW).

The number of acute care hospital stays was only statistically significantly correlated with LOS (negatively weakly) in community-large hospitals (r=−0.36, 95% CI −0.59 to −0.13, p<0.01). Teaching hospitals had a moderate positive and statistically significant correlation in the number of acute care beds and LOS (r=0.5, 95% CI 0.23 to 0.76, p<0.01). The number of emergency department visits and LOS were negatively moderately correlated in community-large hospitals (r=−0.44, 95% CI −0.7 to −0.17,

p<0.01). The average acute care RIW was positively strongly correlated with LOS (r=0.68, 95% CI 0.56 to 0.8, p<0.01) when assessing both hospital peer groups. With respect to hospital deaths (HSMR), the average acute care RIW was positively moderately correlated in community-large hospitals (r=0.53, 95% CI 0.32 to 0.74, p<0.01). Total acute care RIW was only moderately positively correlated with LOS for teaching hospitals (r=0.43, 95% CI 0.06 to 0.7, p<0.01). Hospital occupancy rate was only statistically significantly correlated with LOS for teaching hospitals (r=0.37, 95% CI 0.07 to 0.67, p<0.05). With respect to hospital deaths (HSMR), a hospital's occupancy rate is very weak to weakly negatively correlated (and not statistically significant). Patients admitted through the emergency department had a positive weak to moderate correlation with LOS (teaching hospitals r=0.47, 95% CI 0.18 to 0.75, p<0.01; community-large hospitals r=0.39, 95% 0.16 to 0.61, p<0.01) and a positive weak correlation with readmissions (teaching hospitals r=0.29, 95% CI 0 to 0.58, p<0.05; community-large hospitals r=0.27, 95% CI 0.03 to 0.52, p<0.05). The percentage of patient days in alternate level of care (a measurement of days patients spend in inpatient acute care, when unneeded, while waiting for discharge to home care or other supports are ready) had a positive weak correlation with LOS in Teaching hospitals (r=0.36, 95% CI 0.06 to 0.66, p<0.05), and a weak negative correlation with readmissions for all hospitals combined (r=−0.29, 95% CI −0.5 to −0.09, p<0.01).

Online supplemental data files include descriptive statistics (mean/per cent change values, CIs, range of values and number of hospitals) by indicator, facility characteristics, provincial/territorial jurisdiction, and hospital type/size, and correlation matrix scatterplots.

Table 4 – Correlations between hospital characteristics on LOS, Hospital Deaths (HSMR) and readmission (2017–2018)

HOSPITAL CHARACTERISTIC	UNIT	LENGTH OF STAY CORRELATION COEFFICIENT (95% CI)		HOSPITAL DEATHS (HSMR) CORRELATION COEFFICIENT (95% CI)		READMISSION CORRELATION COEFFICIENT (95% CI)	
# OF ACUTE CARE HOSPITAL STAYS	# of days	All:	-0.04 (-0.24 to 0.16)	All:	-0.14 (-0.34 to 0.05)	All:	0.07 (-0.12 to 0.26)
		Teaching:	0.26 (-0.02 to 0.54)	Teaching:	-0.30 (-0.61 to 0.01)	Teaching:	0.07 (-0.23 to 0.37)
		Community-Large:	-0.36* (-0.59 to -0.13)	Community-Large:	-0.20 (-0.45 to 0.05)	Community-Large:	-0.11 (-0.36 to 0.15)
# OF ACUTE CARE BEDS	# of beds	All:	0.24* (0.05 to 0.42)	All:	-0.01 (-0.20 to 0.19)	All:	0.03 (-0.16 to 0.22)
		Teaching:	0.50* (0.23 to 0.76)	Teaching:	-0.24 (-0.54 to 0.07)	Teaching:	-0.03 (-0.35 to 0.29)
		Community-Large:	-0.02 (-0.24 to 0.20)	Community-Large:	0.01 (-0.25 to 0.26)	Community-Large:	-0.17 (-0.41 to 0.07)
# OF EMERGENCY DEPARTMENT VISITS	# of visits	All:	-0.13 (-0.37 to 0.10)	All:	0.03 (-0.21 to 0.27)	All:	0.04 (-0.18 to 0.27)
		Teaching:	0.17 (-0.20 to 0.55)	Teaching:	-0.14 (-0.53 to 0.26)	Teaching:	0.18 (-0.16 to 0.52)
		Community-Large:	-0.44* (-0.70 to -0.17)	Community-Large:	0.13 (-0.20 to 0.46)	Community-Large:	-0.20 (-0.49 to 0.09)
AVERAGE RIW	Average RIW	All:	0.68* (0.56 to 0.80)	All:	0.39* (0.20 to 0.57)	All:	0.15 (-0.04 to 0.35)
		Teaching:	0.55* (0.31 to 0.80)	Teaching:	0.00 (-0.31 to 0.31)	Teaching:	0.12 (-0.20 to 0.45)
		Community-Large:	0.76* (0.62 to 0.89)	Community-Large:	0.53* (0.32 to 0.74)	Community-Large:	-0.20 (-0.44 to 0.05)
TOTAL RIW	Total RIW	All:	0.13 (-0.06 to 0.33)	All:	-0.02 (-0.22 to 0.17)	All:	0.13 (-0.06 to 0.32)
		Teaching:	0.43* (0.16 to 0.70)	Teaching:	-0.25 (-0.55 to 0.06)	Teaching:	0.11 (-0.20 to 0.41)
		Community-Large:	-0.16 (-0.40 to 0.08)	Community-Large:	-0.06 (-0.32 to 0.19)	Community-Large:	-0.13 (-0.39 to 0.12)

HOSPITAL CHARACTERISTIC	UNIT	LENGTH OF STAY CORRELATION COEFFICIENT (95% CI)		HOSPITAL DEATHS (HSMR) CORRELATION COEFFICIENT (95% CI)		READMISSION CORRELATION COEFFICIENT (95% CI)	
HOSPITAL OCCUPANCY RATE	% of occupancy	All:	0.09 (-0.12 to 0.29)	All:	-0.14 (-0.37 to 0.08)	All:	0.01 (-0.20 to 0.23)
		Teaching:	0.37^ (0.07 to 0.67)	Teaching:	-0.28 (-0.61 to 0.06)	Teaching:	0.00 (-0.34 to 0.34)
		Community-Large:	-0.12 (-0.39 to 0.14)	Community-Large:	-0.10 (-0.41 to 0.21)	Community-Large:	0.01 (-0.27 to 0.29)
PATIENTS ADMITTED THROUGH THE EMERGENCY DEPARTMENT	% of patients	All:	0.30* (0.13 to 0.48)	All:	-0.11 (-0.31 to 0.08)	All:	0.12 (-0.08 to 0.31)
		Teaching:	0.47* (0.18 to 0.75)	Teaching:	-0.04 (-0.41 to 0.32)	Teaching:	0.29^ (0.00 to 0.58)
		Community-Large:	0.39* (0.16 to 0.61)	Community-Large:	-0.10 (-0.36 to 0.16)	Community-Large:	0.27^ (0.03 to 0.52)
PATIENT DAYS IN ALTERNATE LEVEL OF CARE	%	All:	0.23^ (0.03 to 0.43)	All:	-0.01 (-0.24 to 0.22)	All:	-0.29* (-0.50 to -0.09)
		Teaching:	0.36^ (0.06 to 0.66)	Teaching:	0.02 (-0.37 to 0.42)	Teaching:	-0.28 (-0.62 to 0.05)
		Community-Large:	0.24 (-0.04 to 0.52)	Community-Large:	0.07 (-0.27 to 0.40)	Community-Large:	-0.13 (-0.43 to 0.17)

* p less than.01; ^ p less than.05; Direction of correlation is shown as Blue (positive) and Red (negative), and intensity of cell-colouring reflects strength of correlation.

Correlation strength classification:.00-.19 very weak;.20-.39 weak;.40-.59 moderate;.60-.79 strong;.80-1.0 very strong. RIW (Acute Care Resource Intensity Weight)

Discussion

In recent years, there has been growing interest in the association between hospital deaths, readmission and LOS.[7] It is logical to investigate the strength and directionality of correlation between these three components of hospital performance, and with hospital characteristics. There is wide heterogeneity in the available evidence in this research area. Aside from the natural differences across studies that narrow their scope in terms of disease or procedure-specific indicators, limited clinical settings within hospitals, and small denominator groups, even a change in the unit of analysis on the same underlying data, from patient-level data to hospital-level data, can yield disparate results.[10]

This secondary analysis of hospital performance data aimed to provide a high level overview of the association between hospital deaths, readmission and LOS across a majority of teaching and community-large hospitals in Canada between 2013–2014 and 2017–2018. The classification and assignment of hospital peer groups allows for more meaningful and valid comparisons of performance of hospitals across similar structural characteristics, patient volumes and clinical services offered. Therefore, any comparison of individual hospital performance should be restricted to within a respective peer-group. Delineating the results of this study's analyses by teaching and community-large hospitals allows for a more granular interpretation of hospital performance at peer-group level.

Of the three outcome indicators, only with the readmissions indicator was there a statistically significant result of community-large hospital peer-group showing a lower peer-group average than that of the teaching peer-group.

Detailed data on eight hospital characteristics were also available in the dataset published by the data steward. As this study was exploratory in nature, we additionally included these hospital characteristics in the correlation analyses to explore any meaningful relationships with the aforementioned three main indicators, and delineated by hospital peer-group type.

Our earlier research[21] established that, over time, Canadian hospitals have largely improved on in-hospital mortality; readmission rates have been trending upward; and that good or bad performance in one domain of care does not automatically reflect the same performance in other domains. What this present study aimed to add is whether a hospital's improvement or weakening performance over time, in either hospital deaths (HSMR) or readmission, had a positive or negative association on the other; our results showed that 42% of hospitals, the largest proportion across the possible outcomes, in fact decreased hospital deaths (HSMR) while increasing readmission rates. Furthermore, we added LOS to the research question as a proxy of hospital efficiency. Eight hospital characteristics showed trends in strength and

directionality of correlation with hospital deaths (HSMR), readmission and LOS. As this study was exploratory in nature, in both using aggregate hospital-level data and hospital characteristics in the analyses, we did not have an explicit hypothesis on the degree of association between hospital characteristics and the three outcome indicators. We note (and continued to include in the analyses) an outlier hospital (see figure 3) with a high hospital deaths (HSMR) indicator value, a long LOS, and average readmission rate.

Strengths and limitations of this study

The main strengths of this study are the quality and extent of data used; all teaching and community-large hospitals across Canada that had publicly available reported performance results were included in the analysis. The 'all readmission' indicator captures, as the title suggests, all readmission to hospital within 30 days; the hospital deaths (HSMR) indicator captures ~80% of all in-hospital mortality; and the LOS indicator quantifies the mean duration across all hospitalisations. Eight diverse hospital characteristics also provided summary measures that capture numerous aspects of a hospital's performance context. While results for LOS and the eight hospital characteristics were only available for the most-recent year (2017–2018), for hospital deaths (HSMR) and readmission indicators, five fiscal year data points were available to measure trend over time differences.

There are limitations in this study with respect to its generalisability beyond Canada; differences in risk-adjustment methodologies, indicator definitions and calculation methods, and hospital type/size definitions, pose challenges to make apples-to-apples comparisons across countries. However, the categorical outcomes of performance simultaneously comparing hospital deaths and readmission, along with the correlation tests of these indicators and hospital characteristics, is available and worthwhile to other settings. Community-medium and community-small hospitals in Canada treat fewer patients, and offer less-complex clinical services. This large group of hospitals (comprising more than half within the country) are omitted from this study due to an absence of publicly reported indicator values for hospital deaths. Furthermore, as a result of mergers between disparate hospitals, historic indicator values (ie, 2013–2014 data year) are omitted from the reporting platform. Thus, this inhibits a longitudinal comparison (ie, performance trend over time). However, current indicator values and hospital characteristics data are available and was included in analyses that only required 2017–2018 data year (namely, correlation analyses on hospital characteristics).

An important limitation of this study, inherent to the constraints of using aggregate-level hospital data, is the inability to perform more complex analyses. Previous, more granular analyses by researchers have been able to employ more sophisticated

statistical techniques, including modelling, controlling for confounding factors, calculation of composite indicators, application of more refined case inclusion/exclusion criteria and stratification of analyses across different disease groups. Another such example of a limitation exists with the LOS measure reflecting the average of all hospitalisations, and the inability to select just those applicable to hospital deaths (HSMR) or readmission patients, respectively. Acknowledging these limitations of performing secondary analyses on aggregate, publicly available hospital performance data, we nonetheless pursued our four research questions, with the data available at hand, to determine what, if any, level of association exists at the hospital indicator level.

The two main outcome indicators themselves, hospital deaths (HSMR) and readmission, also have methodological limitations due to the inability of including non-hospital death data. The hospital deaths (HSMR) indicator, unlike the summary hospital-level mortality indicator, can only account for deaths that occur in hospitals. Similarly, the readmission indicator cannot exclude patients from the denominator that have passed away in the community following hospital discharge. While the indicators of hospital deaths (HSMR) and readmission are risk adjusted (as described in the Methods section), not all risk-factors can be adjusted for (due to reasons such as viability).[22] For example, detailed data on patient sociodemographics or access to primary care services is unavailable for risk-adjustment modelling. Lastly, as correlation does not equal causation, the correlation-based results of this study should be interpreted with caution.

Reflections on the study's findings

Public reporting of performance results poses challenges to hospital administrators and the broader public. Public reporting has become a staple in health systems and hospital performance management. But the practice of public reporting is not without concerns.[23] Tunnel vision and myopia by hospital governance and performance managers can run the risk of suboptimisation; the unintended consequences of shifting concentration disproportionately towards areas prioritised for immediate measurement at the expense of other areas of care and broader/long-term organisational goals.[24]

Pay for performance schemes are commonplace in hospital governance. A governance model that assesses hospitals through isolated performance measures, runs the risk of unintended consequences in other factors of care and performance not under immediate scrutiny.[8] The results and methods of this study support the notion that quantification of hospital performance should not be done via isolated or single measures at a time, but rather in a more broad and informed mechanism of considering complementary aspects of hospital performance (such as those in the

CIHI hospital performance framework: access to services, clinical effectiveness, safety, coordination of care, patient-centredness and hospital efficiency).[25] Furthermore, a poorly conceptualised pay-for-performance scheme may be mal-aligned to take into consideration the correlation (and potential causality) of intensifying efforts to reduce, for example, LOS or hospital mortality, on the increase of readmission rates.

Moreover, government officials charged with hospital governance must take into account inequality across hospital facilities and hospital corporations. Beginning in the 1990s, but increasing rapidly in recent years, there has been a trend of mergers between multiple hospitals and between hospitals and rehabilitation institutes into a singular hospital corporation.[26] These larger hospital corporations in turn have near-exclusive coordination of care between acute care patients served in hospitals and subsequently their transfer to rehabilitation services. Rural and more-remote hospitals (especially those without paired rehabilitation services) could face higher LOS and occupancy rates, greater number of days and percentage of patients in alternate level of care, and greater resource utilisation. If analysis of these amalgamated hospitals and rehabilitation services proves they perform better than hospitals without direct rehabilitation services, this consideration should also be included in the contextual interpretation (and perhaps risk adjustment) of hospital performance and governance. Similarly, readmission to hospital may also be a proxy of the strength and availability of primary healthcare services in the community. Thus, the necessity to consider hospital performance in the broader context of an integrated health service delivery system, a tenet of the accountable care organisation movement.[27]

Government bodies and professional associations charged with supporting quality improvement initiatives can use the methods and findings of this type of analysis to identify best practices and top-performing hospitals so as to learn from their effective practices. Similarly, hospitals in an unfavourable quadrant (long LOS, and high hospital mortality and readmissions) should receive tailored programmes to support their improvement in quality and efficiency of care.

The general public, too, requires consideration when publicly reporting performance results. Efforts in describing indicators in plain language and providing a framework for contextualisation can increase the public's assimilation of performance results (especially demographic groups with fewer skills or resources).[28] CIHI's applies these practices in their online YHS tool, providing their health system performance[29] and hospital performance frameworks[25] as a basis for the curation of performance results, and describing both performance indicators and hospital characteristics in plain language.

The results of this study do not provide a definitive outcome to the debate on the complementarity between LOS, hospital deaths, readmission and hospital characteristics. The underlying pathways and differences between hospitals in

functions, and scope of services provided, makes the hospital a complex unit of analyses. The corpus of past studies illustrates the wide heterogeneity of research methods and degree of association outcomes. The embedding of this type of analysis into hospital governance formulation can only better-inform those charged with policy-making and administrators of hospitals. Subdividing the research methods of this study, into disease and/or procedure-specific analysis, can help facilitate addressing quality improvement concerns on specific clinical areas; but caution is stressed so as to not unintentionally cause clinicians and hospital administrators to experience tunnel vision.

Conclusions

This study shows that secondary analyses of publicly reported hospital performance results can reveal meaningful insights into the association among outcome indicators and hospital characteristics. Good or bad hospital performance in one care domain does not necessarily reflect similar performance in other care domains. Thus, caution is warranted in a narrow use of outcome indicators in the design and operationalisation of hospital performance measurement and governance models (namely pay-for-performance schemes). Analysis such as this can also inform quality-improvement strategies and targeted efforts to address domains of care experiencing declining performance over time; further granular subdivision of the analyses, for example by hospital peer-groups, can reveal notable differences in performance.

References

1. Groene O, Skau JKH, Frølich A. An international review of projects on hospital performance assessment. Int J Qual Health Care 2008;20:162–71.

2. Eckhardt H, Smith P, Quentin W. Pay for Quality: using financial incentives to improve quality of care. In: Busse R, Klazinga N, Panteli D, et al., eds. Improving healthcare quality in Europe. characteristics, effectiveness and implementation of different strategies. Copenhagen: WHO Regional Office Europe, 2019: 233–64.

3. Litvak E, Bisognano M. More patients, less payment: increasing Hospital efficiency in the aftermath of health reform. Health Aff 2011;30:76–80.

4. Shahian DM, Iezzoni LI, Meyer GS, et al. Hospital-Wide mortality as a quality metric: conceptual and methodological challenges. Am J Med Qual 2012;27:112–23.

5. Fischer C, Lingsma HF, Marang-van de Mheen PJ. Is the readmission rate a valid quality indicator? A review of the evidence. PLoS One 2015;10:e0118968.

6. Cylus J, Papanicolas I, Smith PC. Conclusions. In: Cylus J, Papanicolas I, Smith PC, eds. Health system efficiency: how to make measurement matter for policy and management. health policy series. Brussels, Belgium: European Observatory on Health Systems and Policies, 2016: 225–41.

7. Lingsma HF, Bottle A, Middleton S, et al. Evaluation of hospital outcomes: the relation between length-of-stay, readmission, and mortality in a large international administrative database. BMC Health Serv Res 2018;18:116.

8. Kaboli PJ, Go JT, Hockenberry J, et al. Associations between reduced Hospital length of stay and 30-day readmission rate and mortality: 14-year experience in 129 Veterans Affairs hospitals. Ann Intern Med 2012;157:837–45.

9. Dharmarajan K, Wang Y, Lin Z, et al. Association of changing Hospital readmission rates with mortality rates after hospital discharge. JAMA 2017;318:270–8.

10. Hofstede SN, van Bodegom-Vos L, Kringos DS, et al. Mortality, readmission and length of stay have different relationships using hospital-level versus patient-level data: an example of the ecological fallacy affecting Hospital performance indicators. BMJ Qual Saf 2018;27:474–83.

11. Auger KA, Teufel RJ, Harris JM, et al. Children's hospital characteristics and readmission metrics. Pediatrics 2017;139:e20161720. doi:10.1542/peds.2016-1720

12. Paterson JM, Williams JI, Kreder HJ, et al. Provider volumes and early outcomes of primary total joint replacement in Ontario. Can J Surg 2010;53:175–83.

13. Canadian Institute for Health Information. Your Health System. In: Depth. Ottawa: CIHI, 2019. https://yourhealthsystem.ca

14. Canadian Institute for Health Information. Indicator library. Ottawa: CIHI, 2019. https://www.cihi.ca/en/indicator-library

15. Canadian Institute for Health Information. Your Health System. In: Depth. technical notes for contextual measures. Ottawa: CIHI, 20192019.

16. Canadian Institute for Health Information. Model specifications — clinical indicators. 2019. Ottawa: CIHI, 2019.

17. Canadian Institute for Health Information. Hospital Standardized Mortality Ratio - Technical Notes, September 2019. Ottawa, ON: CIHI, 2019.

18. Canadian Institute for Health Information. Indicator library: peer group methodology. Ottawa: CIHI, 2016.

19. Canadian Institute for Health Information. HSMR: frequently asked questions. Ottawa: CIHI, 2020. https://www.cihi.ca/en/hospital-standardized-mortality-ratio-hsmr-frequently-asked-questions#_faq22

20. BMJ. Correlation and regression. London; BMJ, 2020. Available: https://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one/11-correlation-and-regression [Accessed 13 Apr 2020].

21. Fekri O, Manukyan E, Klazinga N. Appropriateness, effectiveness and safety of care delivered in Canadian hospitals: a longitudinal assessment on the utility of publicly reported performance trend data between 2012-2013 and 2016-2017. BMJ Open 2020;10:e035447.

22. Canadian Institute for Health Information. Indicator library: general methodology notes – clinical indicators may 2020. Ottawa: CIHI, 2020.

23. Marshall M, Davies H. Public release of information on quality of care: how are health services and the public expected to respond? J Health Serv Res Policy 2001;6:158–62.

24. Smith P. On the unintended consequences of publishing performance data in the public sector. International Journal of Public Administration 1995;18:277–310.

25. Canadian Institute for Health Information. A performance measurement framework for Canadian hospitals, 2013. Ottawa: CIHI, 2013.

26. Howlett K. Health-Care providers unite in Bid to improve care, cut costs, 2011. Available: https://www.theglobeandmail.com/news/toronto/health-care-providers-unite-in-bid-to-improve-care-cut-costs/article575685/ [Accessed 23 Dec 2019].

27. Huynh TM, Baker GR, Bierman A. Exploring accountable care in Canada: integrating financial and quality incentives for physicians and hospitals. Ottawa: Canadian Foundation for Healthcare Improvement, 2014.

28. Hibbard JH, Greene J, Daniel D. What is quality anyway? performance reports that clearly communicate to consumers the meaning of quality of care. Med Care Res Rev 2010;67:275–93.

29. Canadian Institute for Health Information. A performance measurement framework for the Canadian health system. Ottawa: Canadian Institute for Health Information, 2013.

GENERAL DISCUSSION

While the breadth, depth, and quality of outcomes measurement in health care has increased in recent years in Canada, questions have arisen on its ability to capture patient outcomes of concern, their ongoing utility, validity, priority, and degree of interrelatedness. This thesis aims to examine these issues and contribute findings from the Canadian health system and hospital performance contexts. Five research questions were investigated.

The specific research questions of this thesis were:

1. What is outcomes measurement and its state of use in Canada?
2. How are health system and hospital performance indicators evaluated and prioritized?
3. What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?
4. What are the performance trends on hospital outcome indicators?
5. What is the degree of association between hospital performance outcome indicators?

This discussion section will reflect on the findings of the studies and their validity, generalizability, and their application towards future research and policy.

State of Outcomes Measurement in Canada

In chapter one, the first research question of *"What is outcomes measurement and its state of use in Canada?"* is addressed through the publication entitled *"Measuring Outcomes in the Canadian Health Sector: Driving Better Value from Healthcare"*[1].

The chapter provides an overview of the status quo on the field of outcomes measurement, its current state of application in Canada and beyond as assessed in 2015, and provides specific recommendations to increase their scope, quality, and accuracy of their use in Canada to improve quality of care and advance Canada's healthcare goals.

A review of the literature and examples from other nations showed that the latest advancements in outcomes measurement as reported in 2015 are trending towards capturing the patient perspective through PROMS and PREMS. Clinical registries, comprehensive clinical assessment tools, and data linkages across disparate health (and non-health) datasets also serve to advance outcomes measurement.

However, while equipped with a strong health information infrastructure, Canada is lacking capacity in several key domains of outcomes measurement.

Using the '5Ds'[2] rubric of death, disease, disability, discomfort and dissatisfaction, Canada's comparative progress on outcomes measurement was assessed. At each successive stage of the 5Ds rubric, more complex, diverse, and disparate data collection, sources and linkages are required in order to truly capture each domain. The clear pattern of Canada's ability to measure each of these outcome domains shows strong capacity at the top of the rubric, and decreasing at each successive stage towards more granular measurements of outcomes. For example, Canada has a robust capacity to quantify life and death (through comprehensive vital statistics registries); to less ability to measure disease prevalence, incidence and severity (due to localized and limited use of disease-specific registries); there is limited measurement of disability and discomfort (which is mainly conducted in long-term care or rehab settings); and, to only a recent endeavor towards beginning to capture dissatisfaction through PREMS[3].

Through this inventory of Canadian capacity to measure outcome domains, it is evident that existing capabilities are few, largely restricted to hospital and institutional care settings, and done so in isolation. Clearly, there are multiple chasms throughout the continuum of care. Aside from the first domain of death, the subsequent four outcome domains increasingly require PROMs. Unsurprisingly, the political, managerial, and clinical arguments to imbed and increase PROMS in Canada have not been pronounced (as in other nations). In order to enhance outcomes measurement in Canada, targeted efforts are required at all four levels: at the national-level through pan-Canadian agencies; provincial/territorial authority level (policy, funding, system-management levels); health care provider level; and patient level.

The chapter concludes that Canada can build on its existing infrastructure and tradition of high-quality administrative hospital abstraction data to expand to the remaining components of patient outcomes along the continuum of care. Beginning in 2011, targeted efforts were made to develop a national, standardized approach to systematic measurement of patient experience. Harnessing the power of technology in health care, expansion and use of electronic health and medical records are crucial elements for collecting outcomes data, and generation of provincial/territorial and pan-Canadian disease-specific registries. Provincial/territorial and national health information and health care quality agencies, along with research organizations, are well-placed to spearhead efforts to make data linkages, not only across the continuum of care, but also importantly across the social determinants of health. While not commonplace in Canada, datasets and linkages can be augmented with data from the private sector and arm's length government agencies, for example, from the insurance sector, or workplace safety boards; such data linkages can address significant gaps in

the understanding of patient outcomes in the community, however, there is warranted caution to such secondary use and linkage of data from non-governmental sources. Appropriate safeguards on data security and privacy/anonymity are of the utmost importance in this endeavor.

Another practice that can be explored from neighbouring health systems is the analysis and reporting of patient outcomes at the level of the treating clinicians. Such analyses are not new, but should nonetheless be explored cautiously; sufficient research and development is required on calculation, attribution, and risk-adjustment methods. Indeed, as with the implementation of any new health indicator, adequate clinician and coder training is necessary, and with initial reporting done so in a private schedule (so as to not lead to unintended consequences linked with public reporting).

Evaluation and Prioritization of Health System and Hospital Performance Indicators

In chapter two, the second research question of "*How are health system and hospital performance indicators evaluated and prioritized?*" reports the results of an original research study entitled *"A systematic approach to evaluating and confirming the utility of a suite of national health system performance indicators in Canada: a modified Delphi study"*[4].

The proliferation of health indicators presented challenges for both data providers and indicator producers in Canada[5]; this phenomenon was dubbed "indicator chaos". As the national health information steward mandated with producing health system performance indicators, CIHI sought to address indicator chaos in a systematic, objective, participatory, and transparent manner.

A review of the literature in 2014 rendered an absence of documented examples and criteria for how health indicator producers (i.e., national health information statistics offices), both within and beyond Canada, should evaluate and prioritize the indicators they report on[6]. Nonetheless, criteria and processes from established practices of indicator selection[7], data quality frameworks[8], and consensus modalities[9] were valuable to inform a novel proposal.

Four discrete steps were identified as necessary for a comprehensive exercise:

1) **An internal research and development phase for the design of the evaluation exercise**: to determine evaluation criteria that were measurable and meaningful, each criterion was identified, tested, and applied against the suite of 56 indicators. In total, a final list of 18 criteria were selected and applied to each of the 56 indicators, with some more informative than others.

2) **A two-step internal process to conduct an initial evaluation of the suite of indicators**: first, with a group of internal technical experts (comprising of statisticians, methodologists, and epidemiologists), and secondly with a senior leadership group (comprised of senior managers and researchers) to draw upon their complementary contributions reflecting strategic considerations (in terms of external client/partner needs). During each of the two steps, the results of individual assessments were anonymized, but summarized and presented openly in the broader group. Such a transparent and inclusive practice ensured a comprehensive review of all feedback collected in a summative step-wise approach. Furthermore, technical/methodological considerations of indicators are equally important to strategic and resource considerations.

3) **A pre-Consensus Conference online survey**: After a consolidation of internal findings and recommendations, an online survey was distributed to stakeholders throughout Canada to solicit initial feedback on the proposed recommendations to retire, renew, or continue the production of select indicators. Soliciting initial feedback in an online survey in advance of convening the in-person conference of stakeholders proved to be an efficient and transparent process.

4) **In-person national Consensus Conference**: Lastly, an in-person presentation of the indicator recommendations and results of the online survey were discussed, and subsequently ratified by conference stakeholders. There was also agreement on the evaluation criteria, process, and approach to periodically evaluate indicators (in five-year cycles). Of the 56 indicators included in the evaluation, nine measures were ratified for retirement, seven were identified for additional consultation, and three for additional research and development (for refinement).

The pilot exercise to systematically, inclusively, and transparently evaluate health indicators presented numerous important benefits (for both indicator producers and users). It allowed for a discussion to reprioritize the health indicator agenda, formulated through a national consensus ratification process. Each indicator was objectively assessed, both as a single measure, and as a suite of measures, capturing complementary components of health system performance. Furthermore, it offered both at the micro and macro levels to comprehensively review data quality and indicator calculation methods. Ultimately, resources were redistributed away from indicators of less utility, and instead directed towards prioritized, new and redeveloped indicators (as decided by stakeholders and health indicator users).

Evaluating the Validity of the Hospital Standardised Mortality Ratio Indicator

Chapter 3, the third research question of "*What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?"* reports the results of an original research study entitled *"Palliative care coding practices in Canada since the introduction of guidelines and the HSMR indicator"*[10].

As discussed in the previous chapter's findings, it is beneficial and informative to periodically assess the validity, utility, and essentially the overall quality of suites of health indicators. However, unlike the previous study, it is also necessary to perform a more substantive evaluation on a single indicator that is of high-importance or requiring investigation. Such necessity arose with the big-dot, high-profile health indicator quantifying in-hospital mortality – the Hospital Standardized Mortality Ratio – following concerns raised on the impact of palliative care practices, and the degree with which it influenced the indicator's results.

The analysis showed that, indeed, palliative care coding is a critical component of the HSMR indicator. However, contrary to previous analyses[11], the increase in palliative care coding cannot entirely account for the improvement of improving hospital performance in the HSMR indicator.

The trends of increases in the number and severity of comorbidities (as measured by the Charlson Score Index) had notable implications on risk-adjustment correlation coefficients for the HSMR indicator. Crude mortality, both among all hospitalizations and among HSMR cases, showed significant decline. Conversely, the proportion of Canadians dying outside of hospital setting increased over the years.

The study appropriately presented the historical context of an absence of palliative care coding guidelines prior to the HSMR indicator. Targeted training was delivered to hospital abstract coders on the appropriate use of the palliative care code. Therefore, the sudden rise in incidence of palliative care coding was anticipated, and should not be equated to a reactionary event of hospitals desiring to lower mortality rates. Importantly, the study discussed the high-adherence rate on appropriate use of the palliative care code (as measured through the coding of secondary diagnoses to substantiate palliative care); the results of re-abstraction studies showed an independent second coder confirming the valid use of the palliative care code in 96.4% of applicable hospitalizations.

The preceding analysis performed by independent researchers utilized an older range of data years as the baseline for their calculations, and potentially overestimated the influence palliative care coding. Conversely, a critical strength of the data steward in conducting the analyses is the comprehensive access to all hospitalization data, to

perform sensitivity analyses, to examine all hospitalizations (even those non-HSMR), and to assess historic data trends.

The study concluded that any impact of palliative care coding on the HSMR indicator remains modest (at best), and that other justifiable factors are contributing to improvements in HSMR performance. Nonetheless, such critical analyses of indicators are worthwhile efforts to understand coding-practices, broader trends in patient composition and hospital performance, and whether any improvements are required to indicators in order to improve their validity, utility, and ultimately their quality.

Trends in the Performance of Hospital Outcomes

Chapter 4, the fourth research question of "*What are the performance trends on hospital outcome indicators?"* reports the results of an original research study entitled *"Appropriateness, effectiveness and safety of care delivered in Canadian hospitals: a longitudinal assessment on the utility of publicly reported performance trend data between 2012–2013 and 2016–2017"*[12].

To date, there had been little to no published evidence assessing the comprehensive performance of Canadian hospitals. This study aimed to provide much-needed evidence on how Canadian hospitals performed in more than one care domain, delineated by hospital size/type and jurisdiction, and across multiple years (performance trend over time).

The analysis showed that there are no outlier hospitals in terms of improving or weakening performance over time; of the nearly 500 hospitals assessed, no single hospital improved or weakened in performance in more than two out of the seven indicators assessed. Furthermore, no single jurisdiction accounted for a disproportionate number of hospitals trending in improving or weakening performance.

Across the board, readmissions to hospital were on the rise, while in-hospital mortality declined. Teaching hospitals accounted for the largest proportion of improving hospitals, followed by Community-Large, Community-Medium, and lastly Community-Small hospitals. Assessing performance across hospital peer-groups proved informative, as clear trends emerged, indicating where targeted efforts were required to address systematic weakening performance.

The analysis also highlighted that the performance results of a significant proportion of Canadian hospitals, Community-Small hospital facilities (accounting for nearly half of the approximately 600 facilities in Canada), are not well-suited for performance trending reporting. The bulk of performance trend results for these hospitals appear

as "no change over time" largely due to the small counts of cases, and subsequently unstable rates of these facilities. The study highlighted that a more refined approach to performance trend measurement of Community-Small (and perhaps Community-Medium) hospitals is necessary in order to glean more meaningful findings.

At a macro-level, the results confirmed the understanding that hospital performance assessment, whether it be for public-reporting, accountability/governance, or funding schemes, should not be done in an isolated manner. Tying hospital performance assessment to a single or narrow group of indicators can potentially do unanticipated harm to other aspects of hospital care. It is also logical to examine the degree of association across hospital outcome indicators. This type of analysis was performed in the subsequent chapter.

Interrelatedness of Hospital Outcomes

Chapter 5, the fifth research question of "*What is the degree of association between hospital performance outcome indicators?"* reports the results of an original research study entitled *"Associations between Hospital Deaths (HSMR), Readmission and Length of Stay (LOS): a longitudinal assessment of performance results and facility characteristics of teaching and large-sized hospitals in Canada between 2013-14 to 2017-18"*[13].

In the previous study, it was demonstrated that a performance trend in one hospital outcome domain was unlikely to be mirrored in another. Two notable conclusions of that analysis were the cautioning not to quantify hospital performance in a narrow focus, and that significant and meaningful trends can emerge when stratifying performance across hospital peer-groups.

This present study aimed to add to a growing body of international health services research on the degree of association across hospital performance outcomes; of specific interest were the level of association when comparing in-hospital mortality, hospital readmission, length of stay, and eight hospital facility characteristics.

Hospital performance was assessed over time to determine a significant trend of improving or weakening performance, or no significant change in either direction. The largest proportion of outcomes (across both Teaching and Community-Large hospitals) was an improvement of in-hospital mortality, while hospital readmission rates increased. The degree of association across in-hospital mortality, readmission and length of stay was less definitive (with non-significant correlations for these three outcome measures). Meanwhile, the analysis of eight hospital characteristic

measures was more conclusive, showing more significant associations, namely with length of stay.

Similar to the recommendations of authors from previous studies, this complex inquiry on hospital-level outcome associations requires further research and caution in interpretation (as an ecological fallacy may occur)[14]. This exploratory analysis on the interrelatedness of hospital outcomes in Canada provides a baseline of results that can be eventually expanded to include calculating outcomes association at the patient-level (using the same underlying hospital abstraction data).

Reflections on the Validity of the Findings

The following section will reflect on the validity of the findings through a critical assessment of the methodologies used to carryout the studies.

State of Outcomes Measurement in Canada

The analysis undertaken in chapter one is not presented as a conventional research study; it is framed as a Policy Commentary for a target audience of health systems-decision makers, funders, administrators, and broader government. There is a growing use of 'scoping review'-type analyses to provide a preliminary assessment on a research question. This publication contains traditional elements of a background, analysis/findings, discussion and recommendations. However, a systematic literature review was not part of the methodology.

The purpose of the review was not to capture all scientific and grey literature, but to highlight notable examples from other countries on outcomes measurement, and to compare those international developments with the state of use in Canada. Therefore, the method of a scoping review, published in the form of a policy commentary, was chosen.

A further reflection on the validity of the findings is regarding any new developments since publication of the study. Since 2015, there have been concerted efforts to advance outcomes measurement throughout Canada. With respect to PROMs, this has been notably in the domains of hip and knee replacement surgeries. Following CIHI's development of national data collection standards, Ontario launched a pilot project to capture PROMs of hip and knee replacements. The collected data is made available to clinical providers (matched to patient electronic medical records), and

forwarded to CIHI for pan-Canadian analyses (as a greater number of jurisdictions participate). Subsequently, the results are pooled for international comparisons through the OECD's Patient-Reported Indicators Survey (PaRIS) Initiative[15, 16].

With respect to PREMs, in 2019 CIHI published the initial results of the Canadian Patient Experiences Survey on Inpatient Care (CPES-IC). The report includes data from five provinces (New Brunswick, Ontario, Manitoba, Alberta and British Columbia) on measures covering communication and explanation of care, the coordination of care, and support leaving hospital[17].

The establishment of new clinical registries remains low in Canada, especially those of pan-Canadian reach. However, a bottom-up initiative that has succeeded is the Brain Tumour Registry of Canada (BTRC). While in the 2000s, advocacy efforts reached the House of Commons to pass a Bill for the creation of guidelines on national surveillance of both malignant and non-malignant tumours, lack of funding and organization resulted in provinces implementing the law to varying degrees. The Brain Tumour Foundation of Canada worked to resolve this gap and initiated a pan-Canadian registry. In 2019, their first ever Incidence and Survival Reports were published based on data from four provinces (British Columbia, Alberta, Manitoba, and Ontario) capturing 70% of the Canadian population[18]. While this is a success story, it remains difficult for other bottom-up initiatives to succeed without sufficient funding and government mandates.

In 2016, when medical assistance in dying (MAID) was decriminalized in Canada, it soon became evident for the need to have a standard approach for capturing data on MAID events. A practical action required was CIHI's interim guidance and standards on coding MAID events[19], in addition to consultation with stakeholders across the country on a Provisional Framework for MAID System Information Needs[20]. It has been argued that a reporting system through a registry[21] would allow for identification of effectiveness of MAID, disparity in access, the safety and quality of care. Overall, the aforementioned developments since 2015 support the initial recommendations of chapter 1 towards expansion and strengthening of outcomes measurement in Canada.

Evaluation and Prioritization of Indicators

For chapter two, in the absence of existing examples and frameworks from scientific and grey literature, a mixed methods research approach was undertaken as a pilot and research and development project. While a sizeable number of evaluation criteria were used (n=18), there was a limitation to utilize the available data, or data that could have been adequately collected within a six-month period. For example, a systematic search of online examples of stakeholders using HSP indicators produced by CIHI would have proved too difficult to systematically undertake. Instead, to assess this criterion, the expert knowledge and assessment of senior CIHI HSP staff were gathered on their awareness on the usage of the indicators in the Canadian HSP landscape.

Furthermore, it could be argued that the initial modified-Delphi evaluation cycle performed by technical and leadership HSP groups at CIHI could have been also involved external stakeholders. However, the sheer information required for the review rendered such an exercise unrealistic, as there were over 1,000 criteria points to consider, and the level of certain criterion were beyond the assessment capabilities of external audiences. As such, the results of the internal modified-Delphi sessions were summarized and presented to external stakeholders for their review and assessment in advance of their evaluation scoring.

The pre-Consensus Conference Survey aimed to survey a diversity of stakeholders across the country, but was mainly of decision-makers. Although the specific stakeholder group of clinicians was not formally structured into the exercise, some of the decision-makers held dual roles of administrators and clinicians (i.e., within hospitals). In a narrower evaluation scale, it can be beneficial to share the initial findings of the evaluation with clinicians to solicit their feedback prior to finalization[22].

Similarly, as the opinions of patients and the public were not solicited for this pilot exercise, in the future, feedback for these groups can be similarly sought towards the latter-half of the evaluation cycle, in a manner intuitive for the audience, such as seeking feedback on areas of HSP deemed more pertinent than others for patients and the public. However, through the Consensus Conference on Evaluating Priorities for Canada's Health Indicators, health system stakeholders identified a number of recommendations on new priority areas for indicator development: PROMs; trajectory and transition of care; system responsiveness of patient needs; value for money; and, palliative and end of life care[23]. These priority areas mirror the recommendations outlined in chapter 1 for the advancement of outcomes measurement in Canada.

The methods used in chapter two's study have been similarly deployed in order for CIHI to select pan-Canadian indicators for Access to Mental Health and Addiction Services, and to Home and Community Care[24]; these include the evaluation and ranking of potential indicators, utilizing Delphi-based methods for consensus exercises, and presentation of recommended indicators for selection, development and ongoing reporting. Moreover, components of the evaluation are similarly used to inform CIHI's Indicator Development Cycle[25]. Furthermore, new indicators have been under development with patient-centeredness and outcomes in mind, such as an indicator on Frailty of Seniors, and a safety indicator on in-hospital Sepsis[26, 27].

HSMR & Palliative Care Coding

In chapter three, numerous and robust statistical analyses were utilized to comprehensively assess the impact of palliative care coding on the HSMR indicator. Such a thorough analysis was required in order to asses claims of potential manipulation of the palliative care code[28].

Nearly two dozen analytical elements were considered in order to comprehensively carryout the study, including the entire calculation of HSMR rates with palliative care cases included in the model. In conclusion of the study, it was found that palliative care coding only accounted for a quarter of the overall HSMR improvement observed throughout the country.

There are numerous other possible drivers of improving HSMR rates, such as quality improvement in clinical care delivery, and the underlying make-up of rising levels of patient comorbidity; however, the study did not have sufficient space to additionally assess those analytical areas. Such undertakings would require their own comprehensive assessments. Nonetheless, the findings on the degree of impact palliative care coding has had on the HSMR indicator was conclusively determined through the study's methodology.

While in-hospital mortality continues to decline, accurate palliative care coding remains of importance. Since the publication of the study, CIHI has made available for providers (in a private view) the proportion of their palliative care coding rates in the context of their HSMR results. In a 2019 study, Canadian researchers focused on the coding practices in the provision of inpatient palliative care services for cancer patients; their findings suggest disparity in palliative care service delivery within and between jurisdictions, and the underservice of cancer patients who require palliative care[29]. There continues to be greater emphasis on the accurate capture of palliative care services throughout Canada, notably since the decriminalization of MAID.

Trends in Hospital Performance and Interrelatedness of Hospital Outcomes

Both chapters four and five utilized data from CIHI's Your Health System online tool (where all available results are publicly-reported on a periodic cycle). Data for some indicators and reporting dimensions are not available depending on the size and volume of the treating hospital. Community-Medium and Community-Small hospitals account for more than half of the ~600 Canadian hospitals. Their inherent nature of treating fewer and less complex patients, and offering limited clinical services, can result in their suppression or exemption from some hospital performance indicators in public-reporting. Accordingly, in chapter four, a large number of Community-Medium and Community-Small hospitals showed fewer statistically significant changes in performance over time compared to Teaching and Community-Large hospitals, or did not meet the minimum counts to have values reported.

Similarly, in chapter five's analysis, no Community-Small hospital had HSMR indicator results available, and only 11 Community-Medium hospitals met the minimum case criteria for HSMR calculation. Therefore, both hospital peer-groups were excluded from the study to ensure stable and representative results (specifically to the Teaching and Community-Large hospitals). Therefore, the reliance on utilizing publicly-available performance results for smaller-sized hospitals can hamper the validity of findings for Community-Medium and Community-Small hospitals.

A related limitation to the use of aggregate, publicly-reported results for analysis is the inability to perform more-complex analysis. In chapter five's analysis seeking to understand the level of interrelatedness across hospital outcome measures, the limitation of summary data comes to the forefront. Unlike other studies on the subject who selected a particular cohort of patients (either by disease group or a by the indicator's denominator), chapter five's analysis utilized all patient records across the three outcome indicators and facility characteristics. For example, the LOS indicator provides a measure of the average LOS of all hospitalizations, not just those applicable to HSMR or Readmission cases. Similarly, the facility characteristics measures are of all hospitalizations, and not of those solely related to HSMR or Readmission to hospital.

Previous research has shown that in the switch of the unit of analysis (between patient-level and hospital-levels), an ecological fallacy may occur with divergent associations[14]. Therefore, to improve the validity of analysis on the associations between hospital outcomes, it is necessary to also perform analysis on the underlying patient-level records (at the patient-level unit), and additionally on select patient records (by outcome denominators).

Overall, it is important to caution that correlation does not equal causation. The health system performance indicators discussed in this thesis are risk-adjusted calculations inferring an outcome, most often reported as a rate or percentage of hospitalizations. These are not absolute quantifications of actual events; rather, the patient case-mix of all Canadian hospitalizations are used to derive risk-factors, and the anticipated patient outcome. Based on complex statistical modelling these 'expected' patient outcomes are applied against 'observed' patient outcomes, and summed at either the level of the treating hospital facility, geographic administrative region, province/territory, and as a national rate.

Generalizability of Findings

This dissertation set out to assess the state of outcomes measurement in Canada through the use of health system and hospital performance measures. All analyses of this dissertation are based on the Canadian hospital and health system performance contexts. Some aspects of the dissertation were novel and exploratory in nature (evaluation of health system and hospital performance indicators, and hospital performance trend quantification), while others built on established concepts of health services research queries from other countries (HSMR and palliative care coding, and association of hospital outcomes). The generalizability of this dissertation can be categorized two-fold: within Canada and beyond Canada.

The analyses endeavored to provide evidence and policy/research recommendations that spanned the 13 Canadian provincial/territorial jurisdictions, and the four hospital peer-groups. Four of the five studies utilized data and indicators derived from the Canadian Discharge Abstract Database (DAD) – a comprehensive database of all admissions to the ~600 hospitals in Canada. All applicable hospitalisations across the country, for a given indicator, are used to risk-adjust coefficients to build into indicator calculation models to derive observed and expected outcomes of hospitalisation events. A hospital or administrative region's performance is calculated by comparing against the patient outcomes from across the entire country. Peer-group averages reflect the mean of each of the four hospital levels.

Based on Canada's strength of largely standardized hospital abstraction data collection and reporting to a single national health information institute, pan-Canadian comparisons and generalizability is permissible. Where there are minor limitations of generalizability within Canada occurs with respect to data limitations from Quebec, and Community-Medium and Community-Small hospitals.

With respect to chapter three's investigation of palliative care coding practices and the HSMR indicator, due to differences in coding standards in the province of Quebec to identify palliative care cases, the province was excluded from the analysis to ensure a more valid analyses across the remaining provinces/territories and hospitals. The results of the are therefore not generalizable to the province of Quebec.

In chapter four's analysis of hospital performance trends, a large number of Quebec Community-Large and Community-Medium hospitals underwent mergers in 2015; this in turn caused a break in series for hospital performance trending calculations for these hospitals, and were thus excluded by CIHI in the public reporting of hospital results. The performance of the much smaller sample of Quebec hospitals within the study, therefore, cannot be generalizable to the entire province. However, since publication of the study, in the subsequent years that these hospital corporations accumulated sufficient performance trend data, they are now included in provincial and nation-wide performance trend reporting. Overall, there is strong generalizability of this dissertation's findings with respect to the Canadian context.

However, with respect to the generalizability of the findings beyond Canada, caution is warranted. While the analytical methods used within this dissertation and by CIHI can be extrapolated to the contexts of other countries, there are numerous assumptions to consider. Chapter two's national consensus on prioritization of HSP indicators was feasible due to the convening ability of CIHI and Statistics Canada (through legislated mandates in a federal system) to gather stakeholders from across the country for deliberation and decisions. For such an undertaking in other countries, there would need to be strong will and participation, potentially through government mandate, for disparate, autonomous jurisdictions and health authorities to participate in such pan-national exercises. Nonetheless, the evaluation criteria and processes can be extrapolated to other environments and narrower topics requiring consensus.

Aside from international coding standards prescribed through the International Statistical Classification of Diseases and Related Health Problems (ICD), a country, sub-national jurisdiction, or even treating facility can apply local interpretations on what qualifies as a palliative care designation. Such variations limit international comparability, although there are general efforts made where possible to ensure consistency within and beyond countries. The findings of chapter three cannot be generalized beyond Canada due to the nuanced guidance on coding standards to identify palliative care patients, as well as the underlying unique clinical patient characteristics and subsequent HSMR rates of hospitals of Canadian hospitals. However, the methods used to critically assess the extent of palliative care coding on the HSMR indicator can be modified and applied to other jurisdictions.

For public reporting in Canada, CIHI categorizes hospitals into four distinct peer-groups; the requirements to be classified into a Teaching, Community-Large, Community-Medium or Community-Small hospital are unique to the Canadian context and do not reflect an international standard. Similarly, CIHI's methodology to designate a performance trend of Improving, Weakening, or No Change over time is dependent on statistical model specifications derived from Canada's patient cohort. Furthermore, the performance data used to assign hospital designations of Above Average, Below Average, and Same as Average, cannot be interpreted towards hospital performance in other countries. As such, the findings of chapter four's analysis are not easily generalizable to other settings; although the underlying methodology can be tailored to meet the local context and needs.

Analyzing the interrelatedness of hospital outcomes beyond the originating country can be heavily misleading. There are numerous significant factors that can affect the interpretation of results towards another environment. As noted earlier, the administrative coding practices and underlying patient cohort of a nation are very unique, and in-turn influence risk-adjustment methodologies and indicator-specific calculations. How care services, both within hospitals and in the community, are organized will impact the patient health outcomes themselves. There is however a growing body of studies utilizing aggregate internationally-comparative hospital abstract databases[30], novel robust statistical methods are required in order to provide for more generalizable and meaningful studies[31].

Relevance to Outcomes Measurement at the International Level

At the level above national health system and hospital performance assessments, international comparisons can provide meaningful opportunities to identify and learn from best practices of other countries. However, in the absence of common methodological approaches, valid comparisons may not be feasible. The OECD, WHO and other international agencies continue to promote the benefits of international standardized comparison projects. Through internationally-agreed frameworks and indicators, such as financial expenditure indicators reported through the System of Health Accounts (SHA)[32], or the Health Care Quality Indicators Project[33], multi-country comparisons have occurred for several years.

However, in the absence of specific internationally-agreed measurement frameworks, benchmarking and inter-country comparisons face considerable concerns on their validity. At a fundamental level, the approaches to health system performance

naturally vary across countries. For example, a review of the frameworks used in the Netherlands and Ontario showed the necessity to first resolve important contextual and conceptual differences before attempting benchmarking and comparative studies[34]. Nonetheless, there are opportunities to extract best-practices from other settings on operationalizing outcomes measurement.

Whilst undertaking this doctoral thesis, several international health outcomes comparative projects were also carried out at the WHO Regional Office for Europe. Although the level and settings of analyses in the European Region were different than those covered in Canada, common themes in health outcomes measurement were observed to those raised in the studies of this dissertation.

To produce a baseline on the HSPA practices across the WHO European Region, a research study was conducted to identify the HSPA domains and indicators used by Member States. A total of 30 Member State HSPA reports, published between 2002 to 2015 (available in the English language) were used for the analysis. Overall, wide heterogeneity was found with respect to the number of indicators and domains included in a country's HSPA report[35]. While health financing measures observed across countries were consistent with the international SHA reporting framework, few other internationally agreed standardized comparative measures were found. Therefore, there are research and policy requirements for countries to actively participate in international comparison frameworks and to report on indicators with common specifications.

The WHO European Health Information Initiative (EHII) strives to strengthen the health information capacities of Member States through capacity-building efforts and the promotion and establishment of common measurement projects. A frequent concern of Member States to participate in international or regional comparative projects is the burden of data collection and reporting (similar to the notion of 'indicator chaos' observed in Canada). As such, in order to lessen this barrier to performing international comparisons of health outcomes, a comparative analysis was performed[36] of the health indicators reported by Member States across three disparate measurement frameworks: the WHO Health 2020 European Policy for Health Framework; the 2030 Sustainable Development Goals; and, the Global Action Plan for the Prevention and Control of Noncommunicable Diseases (NCD) 2013-2020.

The mapping exercise showed considerable alignment across the three measurement frameworks; three-quarters of Health 2020 indicators were aligned to SDG indicators (even though Health 2020 indicators were introduced several years prior to the adoption of the SDG measurement framework); also, over half of the NCD indicators were aligned to SDG indicators; and, one-third of Health 2020 indicators aligned with the Global NCD Framework indicators. This high-degree of overlap presented an opportunity to

encourage Member States to participate in an international comparison initiative at no additional burden of data reporting (as the indicators were already reported to disparate international organizations). The results of the analysis were presented to Member States at the 66th Regional Committee of the WHO European Region in 2016, and in the subsequent Regional Committee, a resolution was adopted to develop a Joint Monitoring Framework to facilitate reporting on a common indicator set[37]. Similar to the methodology used in chapter two, various expert groups and consultations with stakeholders were subsequently held in order to agree on the common set of indicators.

Additionally through the EHII, capacity-building efforts were carried out towards specific measurement projects, such as Burden of Disease (BoD) analyses. A European Burden of Disease Network was established in 2016 to promote comparable BoD studies through harmonized methods across WHO European Region Member States[38]. Together, with the Institute for Health Metrics and Evaluation (IHME), a BoD Manual was developed for European Region Member States to undertake rigorous local BoD studies, while utilising uniform methods that would provide for comparative assessments across Member States.

Another common issue observed was the implications of low and unstable counts in health indicators. While in Canada, the issue is most prominent in the results of Community-Small hospitals (as shown in the limitations of chapters four and five), in the international or sub-regional levels, the indicator results of small countries are also subject to instability and wide swings. In order to address the broader capacity-building needs of the small countries of the WHO European Region (comprising of eight Member States with a population of less than one million inhabitants), a Small Countries Health Information Network (SCHIN) was launched in 2016 through the European Health Information Initiative[39]. The network aims to increase the health information capacities of small countries, including to provide comparable inter-country comparisons (mindful of the unique challenges small countries face when grouped into regional and global measurement frameworks with countries of considerable population sizes). For example, the maternal mortality rate indicator (per 100 000 live births), can fluctuate greatly year over year due to small and unstable counts, exacerbated by a small denominator population. As such, through the SCHIN, efforts were taken to agree on changes to indicator calculation methodologies to ensure smooth rolling averages that were sensitive to the health outcome rates of small countries with a population of less than one million.

The experiences of conducting health outcomes measurement across the WHO European Region have emphasized the reoccurring methodological and practical issues observed in the analyses of this dissertation. In the subsequent sections, more specific research and policy implications raised through this dissertation and resultant studies will be discussed for the Canadian health system and hospital contexts.

Implications for Research

The contributions of this thesis to the broader research community may prompt the following considerations for future avenues of research:

Outcomes Measurement in Canada

The research community occupies an important role in the continuous research and development of patient reported outcome and experience measures. In subsequent years in Canada, following the gradual implementation of PROMS and PREMS, valid research questions can be presented surrounding the level of association between clinical outcome indicators and the experience and outcomes as described by patients. This type of analysis may show that health service providers that have good-performing outcome indicators generally favour better among patient reported outcome and experience indicators. Alternatively, the analysis may be inconclusive (showing an incongruence between the experience and outcomes patients perceive, and those derived from administrative data). This would prompt a greater need to re-examine outcome indicators derived from administrative data.

Evaluation and Prioritization of Health System and Hospital Performance Indicators

As health system and hospital performance outcome indicators continue to increase in numbers and use[40,41], they require periodic evaluations to determine whether they remain fit for purpose. The frequency and criteria with which these indicators could be evaluated requires further investigation, piloting, and sharing of experiences with the broader research and practitioner community. Researchers are accustomed to using evaluation criteria in the *selection* of outcome indicators for purposeful evaluations. However, what is still lacking is evidence on the efficacy of various evaluation criteria, and an understanding of local and unpublished practices of indicator evaluation. Here, the research community can assist by conducting an updated synthesis of practices and technical methodologies of indicator evaluations. In a separate effort, further research is required to align hospital outcome indicators with the outcome indicators of the health system as a whole. There is opportunity to cascade and complement the underlying health information systems that are used within and beyond hospitals to better measure health outcomes throughout the continuum of care.

Evaluating the Validity of the Hospital Standardised Mortality Ratio Indicator

Critical and in-depth evaluations on hospital mortality, namely HSMR, has shown that a broader range of evaluation methods are required in order to arrive at more informed opinions on the validity of indicators. A particular implication of the research methodology and outcome of the analysis showed the need and importance of utilizing granular and complete patient abstraction data in order to conduct rigorous analysis. Meso and macro-level analyses can be suited for particular research questions; however, for the complete and rigorous analysis of patient-level data, it may be best-suited for the authoritative health information steward (with complete access to the data) to conduct the analysis.

There are, however, limitations to conducting extensive analyses, both for independent researchers and health information stewards. While data-sharing mechanisms are in place for external researchers to request access to patient-level records for independent analyses, these records are often truncated due to their sheer number and scale, and concerns of privacy. On the other hand, health information stewards may not have the resources to conduct extensive research analysis beyond their core mandate. A proposed solution here could be for health information stewards to increase the co-investigation of research questions with external experts. Such benefits would include: staying abreast of the research community's current research interests; sharing the workload of analysis and interpretation of findings; and arriving at a more-informed analysis that can provide greater reach and impact in the field.

Trends in Performance of Hospital Outcomes

Assessing the performance and outcomes of smaller-sized hospitals (Community-Small and to a lesser degree Community-Medium hospitals) proved a lack of sensitivity due to low volume rates. Stratification of performance and outcomes across Canada's four hospital peer groups is generally lacking in the scientific literature and potentially in policy-use. Tailored research techniques are required to develop more sensitive calculation methods for the reporting of performance and outcomes of smaller-sized hospitals. This may require standalone modelling techniques and reporting of results that only apply to smaller-sized hospitals with low volume rates.

Interrelatedness of Hospital Outcomes

The often very narrow scientific analyses of hospital performance may be omitting important considerations of unintended consequences and underlying associations between outcome indicators that require careful considerations for measurement. While the measurement of association between outcome indicators is not new, there is currently no widely-agreed upon methodology for these types of analyses. While the research community has provided ample analyses on the association between outcome indicators, the wide array of methodologies utilized has shown a lack of consensus on which level of data and unit of measurement to apply[14].

Overall, the health services research community would benefit from a dialogue whereby international experts would exchange and discuss best-practices of analytical methodologies to assess the interrelatedness of health outcomes. The use of patient-level data for interrelatedness analyses provides a higher degree of sensitivity, compared to hospital-level performance results; however, wide-scale availability of open-access and anonymized data to support this type of analyses is not yet commonplace. The research community also holds an important position to encourage access to such data and the exploration of interrelatedness analyses.

Outcomes Measurement for Integrated Care

It is commonplace in Canada to consider hospital care and community care as distinct entities with demarcated lines of responsibility. Yet, the care a patient receives in one environment will be highly affected by the other. Readmission to hospital, for example, is not entirely a reflection of the quality of care a hospital delivered, but also dependent on the availability and quality of community care available to the patient (through home care or primary care follow-up). Rather than viewing the discrete levels of health care (primary, secondary, tertiary, etc.) as responsible only for their mandated domains, it is necessary to recognize the continuum of care and cascading nature of how health systems are realized.

However, in recent years, momentum has increased towards introducing integrated models of care in Canada that connect hospital and community services in order to have a more responsive and functioning health system. The concept of Accountable Care Organizations (ACO) has proliferated in the United States, likely as a by-product of a decentralized system, and mixture of for-and-non-profit governance models. But the understanding of how an ACO model would apply in the Canadian context remains limited[42].

Despite these limitations, ACO-like programs are being introduced in Canada; one such example from Ontario is the concept of 'Health Links', whereby groups of providers collectively and in a coordinated manner support the care of patients with multiple chronic conditions. However, in order to assess the effectiveness of such models and policies, novel research and analytical methods are required. For example, in an integrated care model, the patient is not seen in isolation, but rather throughout a continuum of care ranging from primary care, hospital care, tertiary care, community and homecare by a large group of providers.

Yet, to be able to connect the various disparate services a patient seeks, purposeful data linkages are required, not only for essential data sharing on the patient's progress, but also for follow-up on the outcomes and experience of care. An enabler of integrated models of care is the shared access of providers to patient electronic medical records. Provider access to patient measures of outcomes and experiences are key components to timely and informed support to patients with complex and multiple chronic conditions. Therefore, as integrated models of care are expanded, there needs to be concerted efforts to not only expand PROMs, but to ensure that these are comprehensively made available to providers across the continuum of care[43].

Implications for Policy

This thesis encompassed several policy components of health system and hospital management. The five chapters and analytical components specifically evaluated current performance reporting practices. Towards an ever more responsive and valid performance measurement and management landscape, policy revisions and improvements are required based on the best available research synthesis. Implications for the policy arena, stirred through the findings of this thesis, are described below:

Outcomes Measurement in Canada

A significant limitation in the quantification of outcome measures has been the minimal degree to which the patient perspective is solicited and incorporated into the measurement and reporting of quality health care[44, 45]. There are also varying patient perspectives (across a spectrum of health statuses) to consider in the design and delivery of health care[46]. While not only an issue in Canada, administrators and providers of health services, in any country, grapple with the difficult task of capturing subjective aspects of an otherwise objective field. Some countries have advanced more so than others[47]; the Netherlands, for example, has reflected in their Dutch Health Care Performance Report the importance of capturing patient perspectives, and their central role in the assessment of quality health care[48]. Research arguments

have been repeatedly made to support the efficacy of soliciting patient-reported experience and outcome measures[49]. Thus, it appears inhibiting factors lie in the lack of political and professional will to implement and expand such accountability and reporting mechanisms. Nonetheless, as the patient perspective continues to gain significance more broadly, targeted efforts are required by policy-makers to embed this complementary perspective into routine outcomes measurement.

Evaluation and Prioritization of Health System and Hospital Performance Indicators

The pilot exercise conducted in this thesis for the systematic evaluation of a suite of health system performance indicators sheds light on practical and administrative benefits of assessing their usability, priority, validity, and feasibility. What remains absent in the policy arena is a more far-reaching discussion on institutionalizing these exercises regularly. Health system governance and performance management schemes are substantial undertakings; it is important to ensure indicators are periodically evaluated by their users and producers not in the least to assure common ownership. Equally consequential to the actionability of performance indicators is clarity on their fitness for use and fitness for purpose (including methodological, contextual and managerial considerations)[50]. The number and diversity of stakeholders involved should also be expanded in earnest by administrators of indicator evaluations; as noted, the patient perspective is often omitted, and similarly, feedback from front-line clinicians could also be included in the evaluation and prioritization of indicators[51].

Evaluating the Validity of the Hospital Standardised Mortality Ratio Indicator

Especially with instances where a considerable component of a performance measurement/management scheme relies heavily, or exclusive, on a single measure, it is vital to critically evaluate the validity of said measure to ensure the efficacy of the scheme. The HSMR indicator carries with it a perennial debate, and has both its strengths and its weaknesses. At the very least, it is clear that in-hospital mortality is among the most scrutinized components of hospital performance and quality care delivery.

As such, in policy practice, governance schemes require ongoing monitoring to evaluate efficacy and validity of indicators used. This may, for example, include additional complementary indicators and summary statistics to provide context on an otherwise standalone measure. Aside from ongoing monitoring, it is important for policy actors to

decide at appropriate end-points to retire schemes and/or indicators. There can naturally be a plateau in which performance has improved to the point where performance measurement and management components are less-sensitive or effective. As described, there are numerous, independent factors that influence the probability of death in hospital. A final policy consideration, as a result of this analysis, can be to steer away from narrowly-focused governance schemes. Hospital performance spans multiple domains (including effectiveness, efficiency, appropriateness and safety of care), and should be considered as a whole, so as to not introduce conflicting and unintended consequences in other domains (as discussed in subsequent sections).

Trends in Performance of Hospital Outcomes

Particularly at the meso and macro-level management of hospital performance, policy-level stakeholders with mandates to oversee governance schemes or setting quality improvement agendas, should make common practice to evaluate the utility of performance data and its reporting thereof. There are valid questions to be periodically asked: has an indicator's performance plateaued (requiring modification to the governance scheme); are particular hospitals or peer-groups performing particularly better or worse (than others); are there outliers in performance, or patterns therein; are performance data used in hospital governance schemes ill-fitted for smaller-sized hospitals with low and unstable rates; and, what are the trends of hospital performance across disparate domains of care?

Interrelatedness of Hospital Outcomes

Lastly, continuing along the lines of encouraging further action in the management of health system performance governance mechanisms, policy actors must be cognizant of the interrelatedness across disparate domains of care. This is not meant to deter from discrete measurement of performance; rather, it is a caution to understand that, beyond the unintended consequences of myopia and tunnel vision, provision of care and outcomes of patients are interrelated and can at times be opposing across the continuum of care. What if driving performance in one domain unintentionally drove worse outcomes in another? Are clinical pathways contradictory when assessed through the lens of disparate domains of care? It is, therefore, important to not use outcome indicators in isolation. The frequent monitoring of the interconnectedness

between outcomes can ensure timely awareness for the need to re-evaluate performance management mechanisms.

Implications as a Result of the COVID-19 Pandemic

More recently, the COVID-19 pandemic has challenged governments and health authorities throughout the world to produce and use the most up-to-date data to respond to the virus. Traditionally, health system and hospital performance indicators are calculated at the closure of fiscal or calendar years; in part, this is to ensure the necessary time to perform data quality assurances, and to produce a representative cohort to base risk-adjustment models. However, in recent years, CIHI began to provide health authorities and hospitals with secure access on select analyses based on 'open-year' data, refreshed approximately each month. Still, the submission of hospital admission data to a national health information authority can be quite delayed, for example, due to their processing only once the patient has been discharged (which can extend potentially several weeks for prolonged hospital stays).

The COVID-19 pandemic has thus necessitated even more timely access and use of data. Electronic medical record systems used in hospitals operate at near-real-time, and can aid quicker and more informed decision-making at the hospital and local health system levels[52]. Their use can, for example, aid in real-time predictive modelling to identify hospitalized patients at higher risk of mortality[53]; another use case can be to support more timely monitoring of adverse reactions, including thrombosis, after vaccines; such detections can occur more quickly through EMR data than traditional health outcomes performance monitoring.

The COVID-19 pandemic has also highlighted the importance of designing public-reporting dashboards in ways to increase their actionability[54]. And in the post-acute phase of the pandemic, the measurement and management of backlog treatments and deteriorating health status will need to be addressed through additional and tailored health indicators[55]. What can be said definitively is that the COVID-19 pandemic has given renewed urgency and impetus to digitize health information systems[56], and to apply performance intelligence in preparation for and response to pandemics[57].

Final Reflections

Through the findings of five studies in this dissertation, a series of recommendations on outcomes measurement are proposed for the research community and policy-makers (see table 1). While mainly focused on the Canadian context, the recommendations have a degree of generalizability that can be applied to other countries also maturing in health outcomes measurement. Recommendations are categorized with respect to the five research questions of the dissertation: on the use of outcomes measurement; the evaluation and prioritization of national health system performance indicators; the validity of outcome measures; performance trends in hospital outcomes; and, the interrelatedness of hospital outcomes.

Table 1 – Recommendations for research and policy based on the findings of the dissertation

RESEARCH QUESTIONS	RECOMMENDATIONS
What is outcomes measurement and its state of use in Canada?	1. **Outcomes Measurement in Canada** • Outcome measures need to be expanded beyond in-patient care so to capture as much of the continuum of care as possible. • PREMs and PROMs offer valuable insights into the delivery of quality health care that pertains to the perspective of patients. • Health information agencies need to make targeted efforts to collect and report on outcomes data. • Further implementation and use of EHRs and EMRs can inform outcomes measurement in an efficient manner. • Data linkages (within health and across non-health data) can help close the gap across the continuum of care. • Establishing disease-specific clinical registries are foundational to outcomes measurement.
How are health system and hospital performance indicators evaluated and prioritized?	2. **Evaluation and Prioritization of Health System and Hospital Performance Indicators** • Indicator sets require comprehensive assessments to ensure fit for purpose use. • Attention is required to have an adequate, but not excessive, number of indicators for measurement and production. • Indicators should be assessed for retirement, continued reporting, further research and development and/or consultation with stakeholders. • The application of systematic criteria can ensure objectivity and validity in the exercise. • An inclusive and transparent approach can enhance its rigour and acceptance.

RESEARCH QUESTIONS	RECOMMENDATIONS
What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?	3. **Evaluating the Validity of the Hospital Standardised Mortality Ratio (HSMR) Indicator** • Individual indicators require in-depth evaluations to determine ongoing reliability. • Use of comprehensive data holdings can negate risks of biased findings. • Assessing complementary data may reaffirm initial findings. • Assess contextual factors, such as coding guidelines, to capture non-data driven findings. • Performing sensitivity analyses can quantify the degree of impact on the indicator.
What are the performance trends on hospital outcome indicators?	4. **Trends in Performance of Hospital Outcomes** • Assessment of hospital performance, across disparate domains, is feasible and informative when using publicly-reported performance results. • Subdivision of performance, by hospital peer-group, can show stark contrasts of relative performance. • Trending data of performance over time can help inform ongoing validity of performance management schemes. • Outcome indicators should not be viewed or utilized in an isolated manner. • A systems-level view on hospital performance can identify clear trends of clinical pathways that may hold promise or detriment to improved quality of care. • Performance results of smaller-sized hospital require innovative and more rigorous statistical approaches to improve their sensitivity.
What is the degree of association between hospital performance outcome indicators?	5. **Interrelatedness of Hospital Outcomes** • It should be understood whether performance in one domain of care correlates negatively or positively with another domain. • Hospital facility characteristics, if available, can also be included in correlation analyses with outcome measures. • The design of performance management schemes should include safeguards to not unintentionally lower performance in a disparate domain.

The following high-level research and policy recommendations can be derived from this thesis:

- Outcomes measurement requires expansion, particularly through patient reported outcome and experience measures, to offer valuable insights into the delivery of quality health care, notably in areas aside from hospital care.
- Outcome measures require periodic evaluation for continued fitness for use and prioritization through an inclusive, transparent, systematic manner involving all relevant categories of stakeholders.
- Outcome measures should be periodically critically assessed for their validity, data quality, and adherence to coding standards.

- Macro-level stakeholders should comprehensively review hospital performance trends in order to identify system-level governance and quality improvement considerations.
- Hospital outcome measures are interrelated, and must be assessed as such in the comprehensive overview of hospital performance, spanning from governance models to clinical care delivery.

A century has passed since Ernest Codman presented his vision of tracking patients for the 'end-result'. Yet, only in recent decades has there been meaningful progress in outcomes measurement. The studies presented in this thesis offer considerations into furthering outcomes measurement within the Canadian health systems and hospitals contexts.

References

1. Veillard, J, Fekri O, Dhalla I, Klazinga N. Measuring Outcomes in the Canadian Health Sector: Driving Better Value from Healthcare (November 12, 2015). C.D. Howe Institute Commentary 438.

2. Lohr KN. Outcome measurement: concepts and questions. Inquiry. 1988 Spring;25(1):37-50. PMID: 2966125.

3. Hadibhai S, Lacroix J, Leeb K. Developing the first pan-Canadian acute care patient experiences survey. Patient Experience Journal 2018 Vol. 5: Iss. 3, Article 5.

4. Fekri O, Leeb K, Gurevich Y. Systematic approach to evaluating and confirming the utility of a suite of national health system performance (HSP) indicators in Canada: a modified Delphi study. BMJ Open 2017;7:e014772.

5. Saskatchewan Health Quality Council. Think big, start small, act now: tackling indicator chaos: a report on a national summit. Saskatoon, 30–31 May 2011. http://hqc.sk.ca/Portals/0/documents/tracking-indicator-choas.pdf Accessed 20 March 2021.

6. Mattke S. When should measures be updated? Development of a conceptual framework for maintenance of quality-of-care measures. Qual Saf Health Care 2008;17:182–6

7. Hurtado M, Swift E, Corrigan J, eds. Committee on the National Quality Report on Health Care Delivery, Board on Health Care Services. Envisioning the National Health Care Quality Report. Washington, DC: National Academy Press, 2001.

8. Canadian Institute for Health Information. The CIHI Data Quality Framework, 2009. Ottawa. 2009.

9. Fitch K, Bernstein S, Aguilar M, et al. The RAND/UCLA appropriateness method user's manual. Santa Monica, CA: RAND Corporation, 2001.

10. Fekri O, Amuah JE, Herasimovich V, et al Palliative care coding practices in Canada since the introduction of guidelines and the HSMR indicator BMJ Open 2015;5:e008753.

11. Chong CA, Nguyen GC, Wilcox ME. Trends in Canadian hospital standardised mortality ratios and palliative care coding 2004–2010: a retrospective database analysis. BMJ Open 2012;2:pii:e001729.

12. Fekri O, Manukyan E, Klazinga N. Appropriateness, effectiveness and safety of care delivered in Canadian hospitals: a longitudinal assessment on the utility of publicly reported performance trend data between 2012–2013 and 2016–2017 BMJ Open 2020;10:e035447.

13. Fekri O, Manukyan E, Klazinga N. Associations between hospital deaths (HSMR), readmission and length of stay (LOS): a longitudinal assessment of performance results and facility characteristics of teaching and large-sized hospitals in Canada between 2013–2014 and 2017–2018. BMJ Open 2021;11:e041648.

14. Hofstede SN, van Bodegom-Vos L, Kringos DS, et al. Mortality, readmission and length of stay have different relationships using hospital-level versus patient-level data: an example of the ecological fallacy affecting hospital performance indicators. BMJ Quality & Safety 2018;27:474-483.

15. Patient Reported Outcome Measures (PROMs): PROMs Collection and Reporting Requirements. February 14, 2018. PowerPoint Presentation. https://quorum.hqontario.ca/Portals/0/Users/104/88/10088/PROMs%20Webinar%20Deck%20(2018-01-31)%20v.%208.pdf?ver=2018-06-11-113213-030. Accessed 25 March 2021.

16. CIHI. Patient-reported outcome measures (PROMs). Website. https://www.cihi.ca/en/patient-reported-outcome-measures-proms Accessed 25 March 2021.

17. CIHI. Patient Experience in Canadian Hospitals. Website https://www.cihi.ca/en/patient-experience/patient-experience-in-canadian-hospitals Accessed 25 March 2021.

18. Smith T, Yuan Y, Walker EV, Davis FG. Brain Tumour Registry of Canada (BTRC): Incidence Report 2010-2015. Brain Tumour Registry of Canada (BTRC) A Surveillance Research Collaborative, 2019.

19. CIHI. Medical Assistance In Dying. Website https://www.cihi.ca/en/medical-assistance-in-dying. Accessed 25 March 2021.

20. CIHI. Medical Assistance in Dying: A Framework for Mapping Information Needs; Ottawa, CIHI. 2017.

21. Carter RM, Rodgerson B, Grace M. Medical Assistance in Dying: Canadian Registry Recommendations, 2018 56-1 Alberta Law Review 55, 2018 CanLIIDocs 167.

22. Santana MJ, Stelfox HT, Asbridge M, et al. Development and evaluation of evidence-informed quality indicators for adult injury care. Ann Surg 2014;259:186–92

23. CIHI. Rethink, Renew, Retire: Report from the Fourth Consensus Conference on Evaluating Priorities for Canada's Health Indicators. Ottawa. 2015.

24. CIHI. Selecting Pan-Canadian Indicators for Access to Mental Health and Addiction Services, and to Home and Community Care: Progress Report. Ottawa: CIHI; 2018.

25. CIHI. How is an indicator developed at CIHI? Website https://www.cihi.ca/en/how-is-an-indicator-developed-at-cihi. CIHI, Ottawa, 2021. Accessed 3 April 2021

26. D'Silva J, Amuah JE, Sovran V, MacLaurin A, Rodgers J, Johnson T, Leeb K, Kossey S. New Tools for Measuring and Improving Patient Safety in Canadian Hospitals. Healthc Q. 2017;20(2):10-13.

27. CIHI. CIHI's Analytical Plan, 2020 to 2022. Ottawa: CIHI; March 2021.

28. Chong CA, Nguyen GC, Wilcox ME. Trends in Canadian hospital standardised mortality ratios and palliative care coding 2004–2010: a retrospective database analysis. BMJ Open 2012;2:pii:e001729

29. Tung J, Chadder J, Dudgeon D, Louzado C, Niu J, Rahal R, Sinnarajah A. Palliative care for cancer patients near end of life in acute-care hospitals across Canada: a look at the inpatient palliative care code. Curr Oncol. 2019 Feb;26(1):43-47.

30. Lingsma HF, Bottle A, Middleton S, Kievit J, Steyerberg EW, Marang-van de Mheen PJ. Evaluation of hospital outcomes: the relation between length-of-stay, readmission, and mortality in a large international administrative database. BMC Health Serv Res. 2018;18(1):116. Published 2018 Feb 14.

31. CeyisakarIE, van Leeuwen N, Dippel DWJ et al. Ordinal outcome analysis improves the detection of between-hospital differences in outcome. BMC Med Res Methodol 21, 4 (2021).

32. OECD. A system of health accounts; Version 1.0. 2000; OECD, Paris.

33. Kelley E, Hurst J. (2006), "Health Care Quality Indicators Project: Conceptual Framework Paper", OECD Health Working Papers, No. 23, OECD Publishing, Paris,

34. Tawfik-Shukor AR, Klazinga N, Arah OA. Comparing health system performance assessment and management approaches in the Netherlands and Ontario, Canada. BMC Health Serv Res. 2007 Feb 23;7:25. Erratum in: BMC Health Serv Res. 2007;7:44. PMID: 17319947; PMCID: PMC1810529.

35. Fekri O, Macarayan E, Klazinga N. (2018). Health system performance assessment in the WHO European region: which domains and indicators have been used by Member States for its measurement. World Health Organization. Regional Office for Europe.

36. WHO Regional Office for Europe. (2016) Facilitating health reporting in the WHO European Region: A comparative analysis of indicators across Health 2020, the Sustainable Development Goals and the Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020. https://www.euro.who.int/__data/assets/pdf_file/0005/322718/Facilitating-health-reporting.pdf

37. WHO Regional Office for Europe (2018). Regional Committee Decision: Joint monitoring framework in the context of the roadmap to implement the 2030 Agenda for Sustainable Development, building on Health 2020, the European policy for health and well-being. https://www.euro.who.int/__data/assets/pdf_file/0006/382155/68ds01e_JMF_decision_180674.pdf

38. WHO Regional Office for Europe (2016). First meeting of the European Burden of Disease Network (EBoDN) London, United Kingdom 20-21 September 2016. https://www.euro.who.int/__data/assets/pdf_file/0008/370376/1st-ebodn-meeting-report-eng.pdf

39. WHO Regional Office for Europe (2016). First meeting of focal points of the Small Countries Health Information Network (SCHIN) Valetta, Malta 3-4 March 2016. https://www.euro.who.int/__data/assets/pdf_file/0003/314418/1st-SCHIN-Report_Malta.pdf

40. Klazinga N, Fischer C, ten Asbroek A. Health services research related to performance indicators and benchmarking in Europe. J Health Serv Res Policy 2011:16:38–47.

41. Klazinga N, Stronks K, Delnoij D, et al. Indicators without a cause. Reflections on the development and use of indicators in health care from a public health perspective. Int J Qual Health Care 2001;13:433–8.

42. Peckham A, Rudoler D, Bhatia D, Fakim S, Allin S, Marchildon G. (2018). Accountable Care Organizations and the Canadian Context. Toronto: North American Observatory on Health Systems and Policies. Rapid Review (No. 9).

43. Olde Rikkert MGM, van der Wees PJ, Schoon Y, Westert GP. Using Patient Reported Outcomes Measures to Promote Integrated Care. Int J Integr Care. 2018;18(2):8. Published 2018 Apr 19.

44. OECD. Measuring What Matters: the Patient-Reported Indicator Surveys. Patient-reported indicators for assessing health system performance. 2019. https://www.oecd.org/health/health-systems/Measuring-what-matters-the-Patient-Reported-Indicator-Surveys.pdf

45. Kampstra NA, Zipfel N, van der Nat PB et al. Health outcomes measurement and organizational readiness support quality improvement: a systematic review. BMC Health Serv Res. 2018; 18, 1005.

46. Peckham A, Wright JG, Marani H, et al. Putting the Patient First: A Scoping Review of Patient Desires in Canada. Healthc Policy. 2021;16(4):46-69.

47. Fujisawa R, Klazinga N. (2017), Measuring patient experiences (PREMS): Progress made by the OECD and its member countries between 2006 and 2016, OECD Health Working Papers, No. 102, OECD, Paris, https://doi.org/10.1787/893a07d2-en.

48. van den Berg MJ, Kringos DS, Marks LK, et al. The Dutch health care performance report: seven years of health care performance assessment in the Netherlands. Health Res Policy Sys 12, 1 (2014). https://doi.org/10.1186/1478-4505-12-1

49. Black N. Patient reported outcome measures could help transform healthcare BMJ 2013; 346:f167

50. Barbazza E, Klazinga N, Kringos DS. Exploring the actionability of healthcare performance indicators for quality of care: a qualitative analysis of the literature, expert opinion and user experience. BMJ Quality & Safety Published Online First: 07 May 2021.

51. Santana MJ, Stelfox HT, Asbridge M, et al. Development and evaluation of evidence-informed quality indicators for adult injury care. Ann Surg 2014;259:186–92.

52. Manuel DG, van Walraven C, Forster AJ. A commentary on the value of hospital data for covid-19 pandemic surveillance and planning. Int J Popul Data Sci. 2021;5(4):1393. Published 2021 Mar 3.

53. Schwab P, Mehrjou A, Parbhoo S, et al. Real-time prediction of COVID-19 related mortality using electronic health records. Nat Commun. 2021;12(1):1058. Published 2021 Feb 16.

54. Ivanković D, Barbazza E, Bos V, et al. Features Constituting Actionable COVID-19 Dashboards: Descriptive Assessment and Expert Appraisal of 158 Public Web-Based COVID-19 Dashboards. J Med Internet Res. 2021;23(2):e25682. Published 2021 Feb 24.

55. Wang J, Vahid S, Eberg M, et al. Clearing the surgical backlog caused by COVID-19 in Ontario: a time series modelling study. CMAJ. 2020 Nov 2;192(44):E1347-E1356.

56. Horgan D, Hackett J, Westphalen CB, et al. Digitalisation and COVID-19: The Perfect Storm. Biomed Hub 2020;5:1-23.

57. Kringos D, Carinci F, Barbazza E, et al. Managing COVID-19 within and across health systems: why we need performance intelligence to coordinate a global response. Health Res Policy Sys 18, 80 (2020).

SUMMARY

The performance of health systems has been an area of concern in many countries over the years, with hospitals constituting a significant component of care delivered and financial resources required. In the assessment of the performance of both health systems and hospitals, progress has been made away from more rudimentary measures of resources and output performance towards more meaningful measures of outcomes. Within health systems, this is reflected through the overall contribution of health care to the health of populations (rather than solely the provision of services); likewise, hospital outcome measures needed to improve from a simple binary outcome of in-hospital mortality to more complex measures capturing the degree with which a patient's health improved or worsened, as related to the quality of care a patient received.

Scrutiny on the performance of health systems and hospitals in Canada has increased in recent years. While the nation's 13 provincial and territorial governments are responsible for the provision of health services, the Canada Health Act stipulates a set of principles that must be followed in order to receive federal transfer payments to support financing; this, and a series of investments in the uniform capture of data on health systems and hospital services, has facilitated pan-Canadian assessments of performance of both health systems and hospitals through outcome measures.

However, health system and hospital performance outcome measures have inherent limitations and deficiencies to accurately and adequately reflect their contribution towards the realization of health in populations and patients. Outcome measures, therefore, require ongoing evaluation to determine their validity and fitness for use, their relevance, how they are used in public reporting programs to support transparency and accountability requirements. Furthermore, it should be better understood to what degree outcome measures are interrelated, complementary, or even divergent (for example, given the competing interests in the goals of efficiency and effectiveness).

The research community occupies an important role in advancing the understanding and use of outcome measures to support health system and hospital performance measurement. This dissertation is composed of five research questions and resultant studies on outcomes-based measurement in the Canadian health system and hospital contexts: it explores their state of use and ability to capture patient outcomes of concern; their selection, utility, and prioritization; their ongoing validity; their performance trends over time; and their degree of interrelatedness.

The specific research questions of this thesis were:

1. What is outcomes measurement and its state of use in Canada?
2. How are health system and hospital performance indicators evaluated and prioritized?

3. What is the validity and impact of the palliative care code on the Hospital Standardised Mortality Ratio (HSMR) indicator?
4. What are the performance trends on hospital outcome indicators?
5. What is the degree of association between hospital performance outcome indicators?

Chapter one presents a background on health outcomes measurement and its state of use in Canada. It establishes the gaps that remain in Canada to arrive at a mature-level of practice seen in other countries. Particular deficiencies are identified, notably in the minimal use of patient reported outcome and experience measures, the utilization and linkage of data beyond hospitalization abstracts, and the adequate use of patient registries to monitor the health status of patients in the community.

Chapter two describes the pilot experience of a systematic evaluation and prioritization of health system performance indicators in Canada. In absence of established methodologies to carry out such an exercise, a pilot project was undertaken through a process of research and development. A total of 18 evaluation criteria were applied to the 56 health system performance indicators produced by the Canadian Institute for Health Information (CIHI). Through a series of internal and external modified-Delphi evaluation exercises, CIHI technical experts and leadership groups reviewed all indicators and evaluation criteria. Initial recommendations for indicators were presented to senior stakeholders throughout the country (first through an online pre-conference survey, followed by an in-person national Consensus Conference to deliberate and ratify recommendations). The evaluation results and piloted methodology were fit-for-purpose to achieve a systematic, inclusive, transparent and repeatable process for a national health information agency to undertake.

Chapter three examines the impact of palliative care coding on the HSMR indicator (in response to increased scrutiny on validity in the use of the code). An analysis was conducted to assess longitudinal trends in the indicator and on palliative care coding practices since the introduction of new coding guidelines. The analysis found that while palliative care coding rates had increased, adherence to coding standards remained quite high. Prior to the introduction of the HSMR indicator, the coding of palliative care cases was not mandatory, thus requiring a national coding standard to ensure appropriate and complete identification of relevant cases. Numerous other independent factors have improved HSMR rates over the years, most notably a significant decline of in-hospital mortality, and increase of admissions of patients with a greater number of comorbidities.

Chapter four assesses the appropriateness, effectiveness and safety of care delivered in Canadian hospitals. The study utilized performance trend data for eight hospital

outcome measures covering the period 2012-13 to 2016-17. A total of 489 of the roughly ~600 Canadian hospitals had publicly-reported data available for inclusion in the study. The findings showed that in-hospital mortality has largely declined, but that readmission to hospital have increased. Teaching and larger-sized hospitals accounted for the largest proportion of overall performance improvement observed. Roughly half of the hospitals in the study showed no change in performance trend for at least four of the eight indicators. No single hospital was observed to be improving or weakening in performance for more than two indicators. The overall assessment of hospital performance trends can be expanded more systematically to glean more-granular and meaningful insights on hospital performance.

In chapter five, the interrelatedness of hospital outcome measures is assessed for Teaching and Community-Large hospitals between the period 2013-14 to 2017-18. The main outcomes of interest were in-hospital mortality, readmission to hospital, and length of stay, in addition to a series of eight hospital facility characteristics. The analysis highlights the diverging trends of hospitals improving on in-hospital mortality, while increasing readmission rates. Length of stay was largely positively and statistically significantly correlated with hospital facility characteristics. The findings raise awareness that hospital outcome measures are interrelated, and as such, require a holistic approach to analysis.

Generalizability

Findings of the dissertation hold wide generalizability within the Canadian context due to supporting factors: standardized data collection, uniform indicator calculation methods, and legislated provision of universal coverage of services throughout the country. Where possible, as close to pan-Canadian representation was ensured throughout the studies. However, the findings are limited in their applicability to other countries (due to uniqueness of the underlying patient data, indicator calculation methodologies, and organization of health and hospital services). Nonetheless, the health system and hospital performance evaluation methodologies utilized in this dissertation can be extrapolated and applied to other settings (provided that appropriate modifications are met to serve local needs).

Implications for Research and Policy

The findings of this dissertation pose additional areas of research necessary to better understand and utilize health outcome measures. The systematic evaluation of health system performance indicators is not yet commonplace, and requires further research to arrive at standardised and agreed-upon processes. The analytical methods of assessing hospital performance trends identified the additional research needs to improve the lack of statistical sensitivity in observing performance changes in smaller-sized hospitals. There remains a lack of agreement on the validity of research methods to identify the interrelatedness of outcome measures.

This dissertation also raises important policy considerations both in terms of gaps in practice for optimizing and introducing health outcome measures, but also for critical review of existing policies and governance models that rely on and involve select outcome measures. For example, in recent years, hospital governance models in Canada stipulated programs to target and reduce in-hospital mortality; but these efforts may have come at the expense of rising readmission rates (which may not have been sufficiently considered). It is therefore necessary to holistically assess hospital performance outcomes, rather than in a narrow view, so as to avoid unintended consequences in other care domains.

Recommendations

The following high-level research and policy recommendations can be derived from this thesis:

- Outcomes measurement requires expansion, particularly through patient reported outcome and experience measures, to offer valuable insights into the delivery of quality health care, notably in areas aside from hospital care.
- Outcome measures require periodic evaluation for continued fitness for use and prioritization through an inclusive, transparent, systematic manner involving all relevant categories of stakeholders.
- Outcome measures should be periodically critically assessed for their validity, data quality, and adherence to coding standards.
- Macro-level stakeholders should comprehensively review hospital performance trends in order to identify system-level governance and quality improvement considerations.
- Hospital outcome measures are interrelated, and must be assessed as such in the comprehensive overview of hospital performance, spanning from governance models to clinical care delivery.

SAMENVATTING

De prestaties van gezondheidsstelsels zijn de afgelopen jaren in veel landen een punt van zorg, waarbij de prestaties van ziekenhuizen, als een belangrijk onderdeel van de geleverde zorg en de daarvoor benodigde financiële middelen, extra in de belangstelling staan. Bij de beoordeling van de prestaties van zowel gezondheidsstelsels als ziekenhuizen is vooruitgang geboekt van rudimentaire metingen van de kosten en output naar meer betekenisvolle metingen van uitkomsten (outcomes). Binnen de gezondheidsstelsels komt dit tot uiting door een beter inzicht in de bijdrage van de gezondheidszorg aan de algemene gezondheid van de bevolking (in plaats van alleen de levering van diensten); Evenzo wordt gewerkt aan de verbetering van de uitkomstmaten van ziekenhuizen van een relatief eenvoudige binaire uitkomstmaat zoals ziekenhuissterfte naar meer verfijnde maar complexe uitkomstmaten die de mate bepalen waarin de gezondheid van een patiënt verbeterde of verslechterde, gerelateerd aan de kwaliteit van de verleende zorg.

De gerichte aandacht voor de prestaties van gezondheidsstelsels en ziekenhuizen in Canada is de afgelopen jaren toegenomen. Terwijl de 13 provinciale en territoriale regeringen van het land primair verantwoordelijk zijn voor het verstrekken van gezondheidsdiensten, bepaalt de Canada Health Act een reeks principes die moeten worden gevolgd om federale overdrachtsbetalingen te ontvangen ter ondersteuning van de provinciale financiering; dit, en een reeks investeringen in het uniform vastleggen van gegevens over gezondheidsstelsels en ziekenhuisdiensten, heeft pan-Canadese beoordeling van de prestaties van zowel provinciale en territoriale gezondheidsstelsels als ziekenhuizen mogelijk gemaakt door middel van uitkomstmaten.

De uitkomstmaten van de provinciale/territoriale gezondheidsstelsels en de prestaties van ziekenhuizen hebben echter inherente beperkingen en tekortkomingen om de bijdrage aan het realiseren van gezondheid bij populaties en patiënten nauwkeurig en adequaat weer te geven. Uitkomstmaten vereisen daarom voortdurende evaluatie om hun validiteit en geschiktheid voor gebruik,hun relevantie en hoe ze worden gebruikt in openbare rapportages ter ondersteuning van transparantie- en verantwoording te bepalen. Bovendien wordt de vraag gesteld in welke mate uitkomstmaten onderling samenhangen, complementair zijn of zelfs divergeren (bijvoorbeeld door tegenstrijdige belangen bij de doelstellingen van efficiëntie en effectiviteit).

De onderzoeksgemeenschap speelt een belangrijke rol bij het vergroten van het begrip en het gebruik van uitkomstmaten ter ondersteuning van de prestatiemeting van gezondheidssystemen en ziekenhuizen. Dit proefschrift is opgebouwd uit vijf onderzoeksvragen en de daaruit voortvloeiende studies over op uitkomsten gebaseerde metingen in Canadese gezondheidssystemen en Canadese ziekenhuizen. De studies verkennen de stand van zaken rond uitkomstmetingen en het vermogen betekenisvolle uitkomsten te bepalen; de selectie, bruikbaarheid en prioritering van

uitkomstmaten; de voortdurende geldigheid; de trends in de tijd; en de mate van onderlinge samenhang.

De specifieke onderzoeksvragen van dit proefschrift zijn :

1. Wat is de stand van zaken rond het meten van uitkomsten van zorg in Canada?
2. Hoe worden de prestatie-indicatoren van het gezondheidssysteem en het ziekenhuis geëvalueerd en geprioriteerd?
3. Wat is de validiteit en impact van de palliatieve zorgcode op de Hospital Standardised Mortality Ratio (HSMR)-indicator?
4. Welke zijn de trends op het gebied van ziekenhuisuitkomstindicatoren?
5. Wat is de mate van samenhang tussen verschillende prestatie-uitkomstindicatoren van ziekenhuizen?

Hoofdstuk één beschrijft de achtergrond over het meten van gezondheidsuitkomsten en de stand van zaken in Canada. De studie identificeert lacunes die in Canada bestaan mede in vergelijking tot de situatie in andere landen. Er worden specifieke tekortkomingen vastgesteld, met name in het beperkte gebruik van door de patiënt gerapporteerde uitkomst- en ervaringsmaten (PROMs/PREMs), het gebruik en de koppeling van gegevens die zorgpaden bestrijken welke verder gaan dan ziekenhuisopnames, en het adequate gebruik van registraties om de gezondheidstoestand van patiënten in de gemeenschap te monitoren.

Hoofdstuk twee beschrijft de bevindingen van een systematische evaluatie en prioritering van prestatie-indicatoren voor gezondheidssystemen in Canada. Bij gebrek aan gevestigde methodes om een dergelijke exercitie uit te voeren, werd een proefproject uitgevoerd door middel van een proces van onderzoek en ontwikkeling (R&D). In totaal zijn 18 evaluatiecriteria toegepast op de 56 prestatie-indicatoren van het gezondheidssysteem die ten tijde van de studie waren opgesteld door het Canadian Institute for Health Information (CIHI). Door middel van een reeks interne en externe evaluaties met gebruikmaking van een gemodificeerde Delphi techniek, hebben groepen van inhoudelijke experts en ontwikkelaars van CIHI alle indicatoren en evaluatiecriteria beoordeeld. De concept aanbevelingen voor indicatoren werden voor consultatie gedeeld met belanghebbenden in het hele land (eerst via een online enquête voorafgaand aan de conferentie, gevolgd door een nationale consensusconferentie om aanbevelingen te bediscussiëren en te ratificeren). De evaluatieresultaten en de geteste methodologie waren geschikt voor het doel om een systematisch, inclusief, transparant en herhaalbaar proces te realiseren dat door

een nationaal instituut met verantwoordelijkheden op het terrein van het verstrekken van informatie over de kwaliteit van de zorg kon worden ondernomen.

Hoofdstuk drie onderzoekt de impact van de praktijk van palliatieve zorgcodering op de HSMR-indicator (als reactie op toegenomen kritische opmerkingen over validiteit bij het gebruik van de code). Er is een analyse uitgevoerd om longitudinale trends in de indicator en in de coderingspraktijken in de palliatieve zorg sinds de introductie van nieuwe coderingsrichtlijnen te beoordelen. Uit de analyse bleek dat hoewel de coderingspercentages van palliatieve zorg waren toegenomen, de naleving van de specifieke coderingsnormen vrij hoog bleef. Voorafgaand aan de introductie van de HSMR-indicator was het coderen van palliatieve zorggevallen niet verplicht, waardoor een nationale coderingsstandaard nodig was om een passende en volledige identificatie van relevante gevallen te garanderen.

Talloze andere onafhankelijke factoren hebben de HSMR-cijfers in de loop der jaren verbeterd, met name een significante daling van de mortaliteit in het ziekenhuis en een toename van het aantal opnames van patiënten met een groter aantal nevendiagnoses (comorbidities).

Hoofdstuk vier analyseert de geschiktheid, effectiviteit en veiligheid van de zorg die in Canadese ziekenhuizen wordt geleverd op basis van uitkomstmaten. De studie maakte gebruik van prestatietrendgegevens voor acht uitkomstmaten van ziekenhuizen voor de periode 2012-13 tot 2016-17. In totaal hadden 489 van de ongeveer ~600 Canadese ziekenhuizen openbaar gerapporteerde gegevens beschikbaar voor inclusie in het onderzoek. De bevindingen tonen aan dat de sterfte in het ziekenhuis grotendeels is afgenomen, maar dat de heropname in het ziekenhuis is toegenomen. Opleidingsziekenhuizen- en grotere ziekenhuizen waren verantwoordelijk voor het grootste deel van de waargenomen algehele prestatieverbetering. Ongeveer de helft van de ziekenhuizen in het onderzoek liet voor ten minste vier van de acht indicatoren geen verandering in de prestatietrend zien. Van geen enkel ziekenhuis werd waargenomen dat het beter of slechter ging presteren voor meer dan twee indicatoren. De algemene beoordeling van trends in ziekenhuisprestaties kan systematisch worden uitgebreid om meer gedetailleerde en zinvolle inzichten over ziekenhuisprestaties te verkrijgen.

In hoofdstuk vijf wordt de onderlinge samenhang van uitkomstmaten van ziekenhuizen beoordeeld voor opleidings- en grotere algemene ziekenhuizen in de periode 2013-14 en 2017-18. De onderzochte uitkomstmaten zijn ziekenhuis sterfte, heropname en verblijfsduur, gerelateerd aan een reeks van acht ziekenhuiskenmerken. De analyse brengt de uiteenlopende trends aan het licht waarin ziekenhuizen de mortaliteit in het ziekenhuis verbeteren en de heropnames verhogen. De verblijfsduur was grotendeels positief en statistisch significant gecorreleerd met kenmerken van de

ziekenhuizen. De bevindingen vergroten het bewustzijn dat uitkomstmaten van ziekenhuizen met elkaar samenhangen en als zodanig een holistische benadering van analyse vereisen.

Generaliseerbaarheid

De bevindingen van het proefschrift zijn breed generaliseerbaar binnen de Canadese context vanwege het bestaan van: een gestandaardiseerde gegevensverzameling, uniforme indicatorberekeningsmethoden en wettelijke levering van gegevens over de universele dekking van diensten in het hele land. Waar mogelijk werd in de uitgevoerde analyses gezorgd voor een zo goed mogelijke pan-Canadese representatie. De bevindingen zijn echter beperkt in hun toepasbaarheid op de situatie in andere landen vanwege de uniciteit van de onderliggende patiëntgegevens, indicatorberekeningsmethoden en de organisatie van gezondheidssystemen- en ziekenhuizen. Desalniettemin kunnen de methodes voor evaluatie van de uitkomsten van gezondheidssystemen en de ziekenhuisuitkomsten die in dit proefschrift worden gebruikt, worden geëxtrapoleerd en toegepast in andere settings (op voorwaarde dat aan de juiste aanpassingen wordt voldaan om aan de lokale behoeften te voldoen).

Implicaties voor Onderzoek en Beleid

De bevindingen van dit proefschrift geven richting aan verder onderzoek dat nodig is om gezondheidsuitkomstmaten beter te begrijpen en te gebruiken. De systematische evaluatie van prestatie-indicatoren van gezondheidssystemen is nog geen gemeengoed en vereist verder onderzoek om tot een verdergaand gestandaardiseerde en breed gedragen aanpak te komen. De analytische methoden gebruikt in dit proefschrift om de prestatietrends van ziekenhuizen te beoordelen maken de noodzaak voor vervolgonderzoek duidelijk om het gebrek aan statistische gevoeligheid bij het observeren van veranderingen in uitkomsten in kleinere ziekenhuizen te verbeteren. Er blijft een gebrek aan overeenstemming bestaan over de validiteit van onderzoeksmethoden om de onderlinge samenhang van uitkomstmaten te bepalen.

Dit proefschrift werpt ook belangrijke beleidsvragen op, zowel wat betreft hiaten in de praktijk voor het optimaliseren en introduceren van gezondheidsuitkomstmaten, maar ook voor een kritische beoordeling van bestaand beleid en “governance modellen” die gebaseerd zijn op geselecteerde uitkomstmaten. In de afgelopen jaren zijn vanuit principes van uitkomststuring in Canada ziekenhuis programma’s geïnitieerd om de sterfte in het ziekenhuis aan te pakken en te verminderen; maar deze inspanningen

zijn mogelijk ten koste gegaan van stijgende her-opnamecijfers (waar misschien niet voldoende rekening mee is gehouden). Het is daarom noodzakelijk om de resultaten van ziekenhuisprestaties holistisch te beoordelen, in plaats van in een smalle visie, om onbedoelde gevolgen in andere zorgdomeinen te voorkomen.

Aanbevelingen

De volgende algemene onderzoeks- en beleidsaanbevelingen kunnen uit dit proefschrift worden afgeleid:

- Het meten van resultaten vereist uitbreiding, met name door middel van door de patiënt gerapporteerde uitkomst- en ervaringsmetingen, om waardevolle inzichten te bieden in de levering van hoogwaardige gezondheidszorg, met name op andere gebieden dan ziekenhuiszorg.
- Uitkomstmetingen vereisen een periodieke evaluatie voor blijvende geschiktheid voor gebruik en prioritering door middel van een inclusieve, transparante, systematische manier waarbij alle relevante categorieën belanghebbenden worden betrokken.
- Uitkomstmaten moeten periodiek kritisch worden beoordeeld op hun validiteit, gegevenskwaliteit en naleving van coderingsnormen.
- Belanghebbenden op macroniveau moeten de prestatietrends van ziekenhuizen uitgebreid en in brede zin beoordelen bij het overwegen van maatregelen op het gebied van governance en kwaliteitsverbetering op systeemniveau.
- Uitkomstmaten van ziekenhuizen zijn onderling gerelateerd en moeten als zodanig worden beoordeeld in het uitgebreide overzicht van ziekenhuisprestaties, als onderdeel van van governance modellen en klinische zorgverlening.

ACKNOWLEDGEMENTS

Acknowledgements

This thesis would not have been possible without the support of my academic advisors, co-authors and colleagues, friends and family.

I have been most fortunate to be a pupil of Niek Klazinga, a distinguished researcher and practitioner in the fields of outcomes measurement and quality of care. In addition to the academic learnings, which were truly rich, extensive and insightful, I am also grateful for his genuine friendship and mentorship. I also had in my co-promotor, Joseph Emmanuel Amuah, an expert biostatistician and researcher to learn from. He has been a kind and generous mentor ever since my days at CIHI, and a dear friend throughout. In addition to obtaining a doctorate, I gained through this experience life-long friendships with you both. Sincerest thanks for your time, wisdom, care, teachings, and friendship. I could not have asked for better advisors.

I remain appreciative to the University of Amsterdam, the Amsterdam University Medical Centers and its Amsterdam Public Health Institute for the opportunity to pursue doctoral studies. Thank you, Marleen van Ee, for professional and helpful guidance throughout the administrative processes.

Many thanks to my co-authors and colleagues at CIHI. In particular, I would like to sincerely thank and acknowledge Edgar Manukyan, who freely shared his time and expertise to pursue research questions and innovative approaches to statistical programming.

Throughout my undergraduate studies, Radu Guiasu imparted onto me academic skills and values, that I still draw upon today. Professor Guiasu, you nurtured my academic growth in the natural sciences, and provided me with the best-possible launch through higher education. I will always remember your enjoyable lectures.

I am forever indebted to the following friends (most of which I met two decades ago as colleagues at the Toronto Public Library). John, Bill, Shelley, Patrick, Brent, Marc, Ronald, Cynthia, and Geri: you provided me with endless support, encouragement, and sustenance (both nutritional and intellectual). You gave your time freely to review and edit my nascent writings; I came to enjoy and develop a passion for writing through your help. You introduced me to art, music, literature, cooking and travel, in addition to important life-skills and learnings.

I am forever grateful to my aunt Hamideh and uncle Jafar for their role in my family emigrating to Canada in 1989. As scientists and academics, they have been my greatest source of inspiration. Their life-story and impactful journey to Canada gave me the hope and courage to push forward in higher education, and to pay it forward to future generations.

I received unwavering support and encouragement from my parents and extended family. I dedicate this thesis in the memory of my loving mother, Farideh. As with the experiences of many immigrant families, my parents, aunt and uncle, made significant sacrifices so that their children would have a chance to live their lives to the fullest, and to pursue their passions without limits; for this, I am truly and eternally thankful.

Last but not least, and most-important recently, I am grateful to my loving girlfriend, Sophia. Even in the midst of your own studies, you provided me with invaluable support. I hope to reciprocate this same support to you, as you soon near the completion of your doctorate.

ABOUT THE AUTHOR

About the Author

Omid Fekri (1983) was born in Tabriz, Iran, and emigrated to Canada in 1989. He completed a bilingual Liberal Arts undergraduate degree at York University's Glendon College (Toronto) in 2010, specializing in Environmental and Health Studies, where he graduated First Class. Combining his interests in health and information science, he completed a Master of Health Informatics at University of Toronto in 2012. In 2014, he co-developed the curriculum and teaching of a MSc/PhD course on Health System Performance Management at University of Toronto's Institute of Health Policy Management & Evaluation (garnering a teaching faculty award for excellence in curriculum development). He began doctoral studies at the Academic Medical Centre of the University of Amsterdam in 2014.

Between 2013 to 2016, Omid worked within the Health System Performance Branch of the Canadian Institute for Health Information (CIHI). In addition to performing health systems and hospital analyses, he contributed towards thematic studies and publications, as well as developing a novel framework to evaluate and prioritize Canada's health system performance indicators, requiring national consensus among senior government stakeholders.

Omid joined the WHO Regional Office for Europe (Division of Information, Evidence, Research and Innovation) initially as a Consultant in 2016, and as of 2017, a Technical Officer. His analysis identified the degree of congruence between the Agenda 2030 SDG indicators and measurement frameworks of the WHO, which was subsequently presented and adopted at Regional Committees. He contributed towards health information analyses and initiatives to increase the capacities of Member States to measure population health outcomes. The work involved the development and publishing of large numbers of health indicators and qualitative resources in the WHO European Health Information Gateway online portal. More recently, he works within the Regional Director's Division, supporting the many aspects of the Regional Office's response to the COVID-19 pandemic. Concurrently, he coordinated the WHO effort to support the Independent Panel for Pandemic Preparedness and Response with their assessment of WHO's response to the pandemic.

A continuous tenure between the ages of 14 to 28, Omid worked in a series of successive roles of increasing responsibility at the Toronto Public Library (the busiest urban public library system in the world). There, he supervised teams and libraries to deliver a variety of library services, including programs in support of newcomers to Canada and people of diverse socioeconomic backgrounds.

PHD PORTFOLIO

Name PhD student: Omid Fekri

PhD period: August 2014 - November 2021

Promotor: prof. dr. N.S. Klazinga

Co-promotor: dr. J.E. Amuah

1. PHD TRAINING	YEAR
ESP42: Methods of Health Services Research Netherlands Institute for Health Sciences (NIHES) Erasmus University Rotterdam, Netherlands.	2014

2. TEACHING	YEAR
HAD 7001H Issues related to Health System Performance Management (MSc/PhD) Institute of Health Policy, Management & Evaluation University of Toronto	2014

3. PRESENTATIONS, CONFERENCES, MEETINGS, WORKSHOPS	YEAR
CIHI & Statistics Canada – Fourth Consensus Conference on Evaluating Priorities for Canada's Health Indicators. Toronto.	2014
International Health Data Linkage Conference. Vancouver.	
Canadian Association for Health Services & Policy Research. Montreal.	2015
WHO/Europe Health System Performance Assessment (HSPA) Expert Workshop. Copenhagen.	2016
WHO/Europe Expert group meeting to enhance Health 2020 monitoring and reporting. Copenhagen.	
WHO/Europe First meeting of focal points of the Small Countries Health Information Network. Valletta.	
WHO/Europe First meeting of focal points of the European Burden of Disease Network. London.	
WHO/Europe Fourth meeting of the European Health Information Initiative Steering Group. Copenhagen.	
WHO/Europe Fifth meeting of the European Health Information Initiative Steering Group. Copenhagen.	

3. PRESENTATIONS, CONFERENCES, MEETINGS, WORKSHOPS	YEAR
United Nations Economic Commission for Europe First Expert Meeting on Statistics for SDGs. Geneva.	2017
WHO/Europe Workshop on the European Health Information Gateway. Moscow.	
Registered Nurses' Association of Ontario – Long-Term Care Best Practice Spotlight Organization (LTC-BPSO). Toronto.	2019
Health Quality Ontario – Variations of Care. Toronto.	
OECD Working Party on Health Care Quality and Outcomes. (virtual)	2020

4. OTHER ACTIVITIES	YEAR
Abstract Reviewer for Annual Canadian Association for Health Services & Policy Research (CAHSPR) Conference	2016 to present
Editorial Advisor – Bulletin of the World Health Organization	2020 to present
Canadian Medical Association Journal (CMAJ) (invited peer review)	2016

5. PUBLICATIONS	YEAR
Peer-reviewed publications	
Fekri O, Manukyan E, Klazinga N. Associations between hospital deaths (HSMR), readmission and length of stay (LOS): a longitudinal assessment of performance results and facility characteristics of teaching and large-sized hospitals in Canada between 2013–2014 and 2017–2018. BMJ Open 2021;11:e041648.	2021
Fekri O, Manukyan E, Klazinga N. Appropriateness, effectiveness and safety of care delivered in Canadian hospitals: a longitudinal assessment on the utility of publicly reported performance trend data between 2012–2013 and 2016–2017. BMJ Open 2020;10:e035447.	2020
Fekri O, Macarayan E, Klazinga N. Health system performance assessment in the WHO European Region: which domains and indicators have been used by Member States for its measurement? Copenhagen: WHO Regional Office for Europe; 2018 (Health Evidence Network (HEN) synthesis report 55).	2018
Fekri O, Leeb K, Gurevich Y. Systematic approach to evaluating and confirming the utility of a suite of national health system performance (HSP) indicators in Canada: a modified Delphi study. BMJ Open 2017;7:e014772.	2017
Fekri O, Amuah JE, Herasimovich V, et al. Palliative care coding practices in Canada since the introduction of guidelines and the HSMR indicator. BMJ Open 2015;5:e008753.	2015
Veillard J, **Fekri O**, Dhalla I, Klazinga N. *Measuring outcomes in the Canadian health sector: driving better value from health care*. CD Howe Institute, Toronto. No. 438, November 2015.	

5. PUBLICATIONS	YEAR
WHO Regional Office for Europe	
Report of the Regional Director: the work of WHO/Europe in 2019–2020.	2020
Strengthening and adjusting public health measures throughout the COVID-19 transition phases: policy considerations for the WHO European Region, 24 April 2020.	
Facilitating health reporting in the WHO European Region: a comparative analysis of indicators across Health 2020, the Sustainable Development Goals and the Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020.	2016
Expert group meeting to enhance Health 2020 monitoring and reporting.	
Report of the fourth meeting of the European Health Information Initiative (EHII) Steering Group.	
Report of the fifth meeting of the European Health Information Initiative (EHII) Steering Group.	
First meeting of focal points of the Small Countries Health Information Network (SCHIN).	
First meeting of focal points of the European Burden of Disease Network.	
Republic of Moldova – Profile of Health and Well-being.	
Republic of Moldova – Highlights on Health and Well-being.	
Core Health Indicators in the WHO European Region 2016. Special focus: 2030 Agenda for Sustainable Development.	
Targets and indicators for Health 2020 (Version 3).	
Canadian Institute for Health Information	
Rethink, Renew, Retire: Report From the Fourth Consensus Conference on Evaluating Priorities for Canada's Health Indicators.	2015
Deceased Organ Donor Potential in Canada.	2014
Sources of Potentially Avoidable Emergency Department Visits.	

THE PERFORMANCE OF HEALTH SYSTEMS AND HOSPITALS IN CANADA

STUDIES ON OUTCOMES MEASUREMENT