April 2014

Analysis in Brief

Health System Efficiency in Canada: Why Does Efficiency Vary Among Regions?

Supporting Factors Influencing Health

Key Findings

This study examines how efficient the health system is in Canada and sheds light on the clinical, operational and contextual factors that affect variations in efficiency across Canada's health regions. Here, the term "health system" refers to all activities under the jurisdiction of provincial and territorial ministries of health.

The objective of the health system that we measure efficiency against, as we determined through consultation with senior health decision-makers across Canada, is to provide Canadians with access to timely and effective health care when they are sick or need care. In this study, this broad objective was measured as the reduction in potential years of life lost (PYLL) from treatable causes of death; efficiency was measured as the effectiveness with which health systems use their resources to reduce PYLL due to treatable causes of death.

Results suggest that health regions vary in their ability to reduce treatable causes of death. These variations in health system efficiency emerged even though we compared only regional health systems that shared similar environmental characteristics, such as the proportions of recent immigrants, non-Aboriginal persons and individuals with post-secondary education.

The results also suggest that if all health regions were able to maximize their efficiency, deaths due to treatable causes could be reduced by 18% to 35%, on average. This translates to the potential prevention of 12,600 to 24,500 premature deaths in Canada per year, without incurring additional costs.

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To lead the development and maintenance of comprehensive and integrated health information that enables sound policy and effective health system management that improve health and health care.

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This study also suggests that health regions can increase their efficiency not only by improving their management and organizational practices, but also by addressing modifiable risk factors for ill health and their causes. Statistically significant associations with efficiency emerged for the following factors:

- Lower prevalence of smoking, obesity, physical inactivity and multiple chronic conditions—this highlights the importance of prevention efforts as a way of improving efficiency.
- Fewer urgent returns to hospitals, greater investment in primary care and shorter lengths of stay among patients designated as "alternate level of care."
- More equitable access to doctors—in other words, health system managers may be able to improve efficiency by improving access to care for the lower income groups.

Finally, since regions may need different amounts of resources to achieve their objectives because of their specific environmental characteristics, the findings from this study also have implications for the design of provincial and regional funding formulas.

Glossary of Terms

Efficiency

Efficiency refers to how effectively resources are used to achieve an objective. Efficiency is not only about managers and professionals working hard and effectively. It is also influenced by factors beyond their control.

Resources

Health system resources are the inputs that health system managers can use to achieve their objectives. This study measures resources in monetary terms: per capita spending on the main health sectors at the health region level. An alternative approach would be to measure resources in physical terms, such as numbers of health care providers, hospital beds and pieces of technical equipment. However, stakeholders and decision-makers supported measuring resources in monetary terms to account for the fact that some regions may be able to negotiate lower prices for their professionals, drugs and technical equipment.

Objectives

Objectives refer to the outcomes we get for the resources we invest in the health system. In this study, the objective we measure efficiency against is Canadians having access to timely and effective health services. To measure this objective, we used an indicator called treatable potential years of life lost, which measures the number of years of life lost before age 80 to causes of death that are considered to be treatable by health care interventions. We also conducted the analysis with the age-standardized mortality rate from treatable causes of death (rather than PYLL) and with different age cut-offs for defining premature death (75 and 85), and results were largely unchanged.

Introduction

In recent years, the public discourse on health system performance in Canada has shifted away from increasing available resources to recognizing that more efficient use of existing resources is what the health system needs. The goal of this study is to measure health system efficiency in Canada in order to examine why some regions are more efficient than others. When we refer to the "health system" in this study, we include all activities under the jurisdiction of provincial and territorial ministries of health.

Measuring health system efficiency has been the focus of several high-profile international studies, including ones by the World Health Organization (WHO)[1] and the Organisation for Economic Co-operation and Development (OECD).[2] These studies provide insight into potential health improvements that could be brought about, not by increasing resources, but by improving the efficiency with which those resources are used. For example, an OECD study found that greater efficiency in Canada's health system could increase average life expectancy by about two years.[2] However, these studies do not account for the fact that responsibility for health care delivery and administration is highly decentralized in Canada. This is an important gap. Decentralized responsibility must be considered to identify locally relevant actions that enable policy-makers to improve performance.

To address this gap in the research, the Canadian Institute for Health Information (CIHI) developed a model for measuring health system efficiency that would be relevant and applicable within the Canadian context.[3] Accordingly, development of the model was informed by interviews with senior Canadian health ministry officials,[4] as well as by a facilitated dialogue with health system leaders and stakeholders.[5]

In this study, we use this model to measure health system efficiency in Canada. Variations in efficiency are examined at the health region level to gain insight into the interplay among the clinical, operational and contextual factors (see text box below) that affect health system efficiency. Health regions are responsible for providing a range of health services to residents within a specified geographic area, although the range varies across the country.

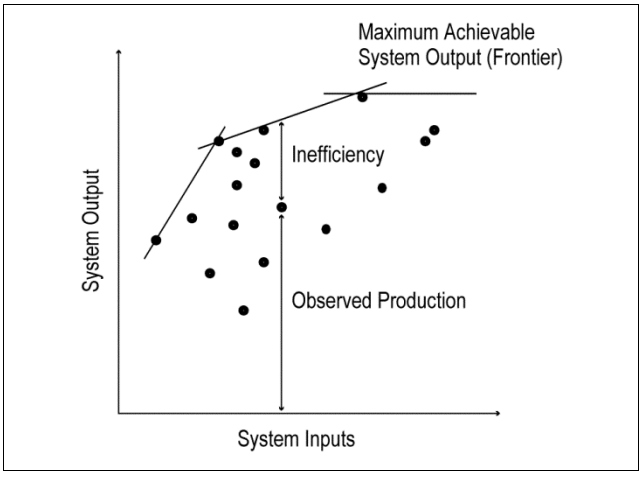
This study focuses on technical efficiency, which refers to the extent to which health systems achieve their objectives given the resources available. The economics literature refers to objectives as "outputs" and to resources as "inputs." Put simply, an analysis of technical efficiency assesses how effectively inputs (resources) are converted into outputs (achieved objectives). Inputs include the major components of health spending—hospitals, physician services, pharmaceuticals, residential care facilities and community care—measured in dollars. Efficiency was measured against the objective of Canadians having access to timely and effective health care when they are sick or need care. This broad objective was measured using reduced PYLL due to treatable causes of death. The efficiency estimates were adjusted for key environmental factors (see text box below).

Approach

We used data envelopment analysis (DEA) to estimate efficiency at the health region level. An exploratory regression analysis then identified some of the factors associated with higher levels of efficiency.

DEA is the most widely used approach for measuring efficiency in the health sector.[6] This descriptive approach determines that a region is inefficient when another region with the same level of inputs (resources) generates more outputs.[7] DEA uses linear programming to estimate an optimal level of health system efficiency (the "frontier" in Figure 1); inefficiency is the gap between a region's actual outputs (the observed production) and the frontier.

Figure 1: DEA Approach to Measuring Efficiency



Source
Adapted from Canadian Institute for Health Information. *Developing a Model for Measuring the Efficiency of the Health System in Canada*. Ottawa, ON: CIHI; 2012.

Factors That Affect Efficiency

Environmental Adjustors

In the first phase, this analysis adjusts for three key external, or environmental, factors that are beyond the direct responsibility of the health system but that have an important influence on the health system objective of reducing treatable PYLL: proportions of recent immigrants, non-Aboriginal people and people with post-secondary education in a region. This adjustment allows us to compare regions that operate in similar environments.

Contextual Factors

Not all external factors that can affect efficiency can be adjusted for; therefore, in the second phase, the analysis also considers a set of contextual factors: the age and gender structure of the population, as well as measures of socio-economic status and inequalities in income and access to health care.

Clinical Factors

Inefficiency in the health system could be driven by clinical factors, which include unsuccessful prevention efforts and providing health care that is harmful or ineffective. In this study, clinical factors are measured by a set of indicators, including the prevalence of traditional risk factors for ill health—such as smoking and obesity—as well as multiple chronic conditions and rates of readmission to hospital.

Operational Factors

Inefficiency in the health system could also be driven by organizational and managerial factors that make care more expensive to provide than it could be. Examples are providing care in high-cost settings such as hospitals when it could be effectively provided in the community, and health professionals not working within their full scopes of practice.

The environment in which a health system operates can significantly affect its ability to improve health with a given set of resources.[7] For instance, the prevalence of conditions that are considered treatable by the health system, such as asthma and pneumonia, can be affected by broader external determinants of health, such as peoples' education level, immigrant status and Aboriginal status.[8, 9] In the interest of comparing health regions with similar operating environments, this study controlled for these three external factors, which we refer to as "environmental adjustors." Regions with a better-educated population, a greater concentration of recent immigrants and a smaller concentration of individuals who identify as Aboriginal have, on average, significantly lower rates of treatable causes of death.

After estimating efficiency through DEA, which accounted for three environmental adjustors, we used a stepwise multivariate regression analysis to examine the factors that are significantly associated with efficiency; these fall into one of three categories:

1. Contextual factors: Indicators of the external environment, such as the age and gender structure of the population, as well as measures of socio-economic status and inequalities, which were not adjusted for when estimating efficiency.
2. Clinical factors: Indicators of successful prevention efforts, such as lower prevalence of smoking, obesity and multiple chronic conditions; and indicators of effective and appropriate use of services, such as fewer avoidable hospitalizations and lower readmission rates.
3. Operational factors: Outcomes of management decisions and practices, such as hospital lengths of stay, administrative expenses and investment in primary care.

Data from CIHI and Statistics Canada was used to determine values for the inputs (resources), outputs (objectives achieved) and other factors considered in this analysis. Table A1 in the appendix and a new CIHI study, *Measuring the Level and Determinants of Health System Efficiency in Canada*, provide more information on the data used for this analysis.

Results and Discussion

Efficiency varies among health regions, even when their health systems operate in similar environments. On average, health regions could possibly reduce deaths due to treatable causes by 18% to 35% without additional spending if they operated with maximum efficiency. This translates to 12,600 to 24,500 premature deaths that could potentially be prevented in Canada in a given year.

We used a two-stage approach to measure and explain efficiency in this study. This approach identified a set of factors—contextual, clinical and operational—that are likely to be important in understanding efficiency. Table 1 presents the results of the second stage of analysis: a stepwise multivariate regression of the identified factors' effect on the efficiency estimates produced from the first stage of the analysis.

Clinical factors were found to be significantly associated with efficiency, specifically indicators of successful prevention efforts (smoking, physical inactivity and multiple chronic conditions) and readmissions to hospital. These findings are in line with a study of OECD countries in which higher levels of tobacco consumption and obesity were found to be associated with lower efficiency.[10] Investing in prevention efforts and improving the management of chronic diseases could potentially generate improvements in health system efficiency.[11–13]

Similarly, continued efforts to reduce hospital readmissions could enhance regional managers' ability to improve health outcomes within fixed budgets. Studies show that, while readmissions relate in part to the characteristics and management practices of hospitals,[14–16] they are also affected by coordination efforts and partnerships between hospitals and community care providers,[17] as well as by timely and effective follow-up care provided by physicians.[18]

Table 1: Regression Results With Contextual, Clinical and Operational Factors as Predictors of the Log of Robust Efficiency Estimate

Variables	Coefficient	Standard Error	P>|t|	Range of R^2 Explained
Contextual Factors				**7% to 14%**
Average Income (Logarithm)	-0.304*	0.098	0.003	
Inequity in the Likelihood of Visiting a Physician in Past 12 Months	-1.737†	0.862	0.047	
Clinical Factors				**14% to 26%**
Daily Smoking (%)	-0.010†	0.004	0.015	
Physical Inactivity (%)	-0.007*	0.002	0.004	
Multiple (Three or More) Chronic Conditions (%)	-0.013*	0.004	0.001	
30-Day Overall Readmission (Rate per 100)	-0.021†	0.009	0.028	
Operational Factors				**12% to 22%**
GPs (% of All Physicians)	0.005*	0.001	0.000	
ALC Length of Stay (Days)	-0.002*	0.001	0.003	

Notes

* Indicates statistical significance at p<0.001 level.

† Indicates p<0.05 level.

GPs: General practitioners.

ALC: Alternate level of care.

Robust efficiency estimates were calculated by applying statistical methods to detect outliers as well as a type of bootstrapping designed specifically for the DEA method.

Source

Canadian Institute for Health Information calculations.

Operational factors, including the level of investment in primary care and some hospital-based indicators, were also significantly associated with health system efficiency. The number of general practitioners as a percentage of total physicians in the region is an imperfect indicator of primary care investment, in part because the number of specialists in a region is affected by the presence of hospitals. Nevertheless, strong primary care is widely recognized as an important determinant of health system performance.[19, 20] This is consistent with the trend seen in jurisdictional policy agendas throughout the 2000s, which sought to reform and increase investment in primary care.[21]

Hospital-based indicators that related to efficiency included shorter alternate level of care (ALC) length of stay. This suggests that efforts across jurisdictions to facilitate the transfer of ALC patients, who are mostly seniors,[22] from hospital to a more appropriate care setting may contribute to efficiency gains. Sensitivity analyses found that two additional factors were associated with efficiency: hospital cost per weighted case (that is, the average cost of a hospital stay) and nursing hours per weighted case (results not shown). As hospitals represent the largest component of health system spending, it is not surprising that higher average costs of a hospital stay were related to lower health system efficiency. The number of nursing hours per weighted case was positively associated with efficiency, which suggests that efforts to increase nursing supply in hospitals could improve efficiency at a system level.

The results of the study also suggest that more equitable access to physician care may generate further efficiency gains; as shown in Table 1, inequitable access to physician care was related to reduced efficiency. Ensuring equitable access to primary care, including to physicians and other health professionals, is an important element of health system performance.[23] Efforts under way in most jurisdictions to improve accessibility of primary care could also contribute to improved equity. The results suggest that there is no trade-off between equity and efficiency. Health system managers can improve performance by improving access to care for the lower income groups.

Overall, this study identified some of the key factors associated with health system efficiency; together, the variables included in the analysis explained almost 50% of the variation in efficiency among comparable health regions. The operational and clinical factors contributed roughly the same amount to the explained variation in efficiency; the contextual factors were slightly less prominent, which was expected, as the analysis controlled for three key environmental factors.

Limitations and Future Research

There are some limitations with the method used; these were addressed to some extent through sensitivity analyses and a type of bootstrapping developed specifically for the DEA method, as well as by applying methods to detect outliers. However, there is no method to identify whether the DEA model includes the correct inputs and adjustors. Therefore, results are suggestive rather than conclusive and should be interpreted with caution.[24] Furthermore, there are some methodological challenges with the two-stage approach used in this study that may limit our ability to draw firm conclusions from the results of the regression.[25] In spite of these limitations, this approach is widely used and provides useful information that can help guide future research efforts.

This study was unable to explain half of the variation in efficiency that was observed across Canada's health regions. It is possible that variation is driven, in part, by patient or population characteristics that are more difficult to measure, as well as by clinical practice variations[26] and additional operational and clinical indicators. These potential indicators include measures of quality improvement and patient safety, such as the use of clinical practice guidelines (like those for cardiovascular disease and diabetes), the use of team-based care models and the implementation of continuous quality improvement initiatives, such as Lean.[21, 27]

Future research would benefit from improved availability and comparability of data on spending and health system characteristics, specifically more precise measurement of patient flows across regions and a more comprehensive account of spending in the non-physician and non-hospital sectors.

Further research could leverage qualitative analytical methods, such as case studies, to disentangle some of the processes and factors that affect health system efficiency. Furthermore, more research could explore the relationship between efficiency and factors related to integrating and coordinating care across sectors, such as

- Integrating information technology like electronic health records to reduce duplication and improve care processes;
- Implementing quality improvement processes to reduce harmful incidents; and
- Expanding scopes of practice (such as for pharmacists and nurses) that could allow more cost-effective care to be provided.

Conclusion

Regional health systems vary in their ability to achieve the measurable objective of reducing treatable causes of death. This variation emerged even though we compared health systems operating in environments with similar socio-economic characteristics, such as level of post-secondary education, concentration of recent immigrants and proportion of individuals not identifying as Aboriginal.

Operational and clinical factors were both significantly associated with efficiency. Clinical factors included indicators of successful prevention efforts and hospital readmission rates, while operational factors related to investment in primary care and the appropriate use of hospital resources. This study also found that equitable access to physician care is positively associated with efficiency. This finding suggests that reducing inequities in access will improve not only the primary care experiences of population groups that have traditionally encountered barriers but also health system efficiency.

Overall, these findings suggest that system inefficiencies cannot be addressed solely by targeting management and organizational practices. Moreover, there may be some value in expanding the scope of the efficiency agenda to focus greater attention on the modifiable risk factors for ill health, such as smoking and physical inactivity, among others. These findings also have implications for the structure of regional and provincial funding formulas, as regions may need different amounts of resources to achieve their objectives because of their specific environmental characteristics.

This Analysis in Brief summarizes a new CIHI study, *Measuring the Level and Determinants of Health System Efficiency in Canada*.

Appendix

Table A1: Description of the Health System Input and Output Variables Used in DEA, Including Environmental Adjustors, 84 Regions

Inputs: Spending per Capita, $	Mean	Standard Deviation	Range	
			Minimum	Maximum
Hospitals	1,718.93	520.40	951.32	3,826.39
Prescription Drugs	545.60	123.50	288.53	884.25
Physicians	471.15	122.42	177.01	816.72
Residential Care Facilities	336.42	164.00	74.20	901.83
Community Nurses	54.49	18.51	19.59	98.68
Inputs: Environmental Adjustors				
Education (High School or More) (%)	82.33	6.85	63.30	94.00
Recent Immigrants (%)	3.16	4.21	0.10	16.70
Non-Aboriginal Persons (%)	92.74	9.21	49.50	99.60
Output				
PYLL From Treatable Causes (Before Age 80), per 100,000 Population, Age-Standardized	1,666.34	317.92	1,066.6	2,452.6

Notes

Since DEA estimates can be sensitive to the choice of inputs and outputs, analyses were conducted to test the sensitivity to the choice of environmental adjustors included as inputs. The models included one environmental adjustor (education), two environmental adjustors (education and recent immigrants) and the baseline model (all three variables). Analyses were also conducted to test the sensitivity of the DEA estimates to the measurement of system output, including changing the age cut-off for defining premature deaths to age 75 and age 85; calculating the reduction of PYLL by subtracting the observed estimate by a large number (800 million) versus by inverting PYLL as 1 ／ PYLL; and measuring the age-standardized mortality rate (ASMR) from treatable causes of death versus PYLL.

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Canadian Institute for Health Information; 2006 Census, Statistics Canada; and Statistics Canada custom calculations.

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