Making Sense of Health Indicators

Statistical Considerations

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Canadian Institute for Health Information
Institut canadien d'information sur la santé

Who We Are

Established in 1994, CIHI is an independent, not-for-profit corporation that provides essential information on Canada's health system and the health of Canadians. Funded by federal, provincial and territorial governments, we are guided by a Board of Directors made up of health leaders across the country.

Our Vision

To help improve Canada's health system and the well-being of Canadians by being a leading source of unbiased, credible and comparable information that will enable health leaders to make better-informed decisions.

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List of Acronyms

ACSC	ambulatory care sensitive condition
AMI	acute myocardial infarction
CABG	coronary artery bypass graft
CI	confidence interval
CIHI	Canadian Institute for Health Information
COPD	chronic obstructive pulmonary disease
DAD	Discharge Abstract Database
LTC	long-term care
PCI	percutaneous coronary intervention

Executive Summary

Health care administrators, providers and consumers rely on a host of measures as they make judgments regarding the quality of care and the health status of residents in their communities. Some of these measures are qualitative; for example, they are based on reports of the experiences of friends and neighbours. In recent years, however, the science of measuring health and health care and the development of health care databases have resulted in a more quantitative approach to guiding health care decision-making.

Since 2000, the Canadian Institute for Health Information (CIHI) and Statistics Canada have collaborated on the Health Indicators project to provide comparative data on a range of health and health system measures for Canada's health regions, provinces and territories. While many of the indicators appear to be straightforward, questions may arise when trying to interpret what the indicators signify in terms of quality of care or a community's success in maintaining the health of its population relative to other jurisdictions.

The purpose of this paper is to provide guidance on interpreting statistical issues pertinent to health indicators, especially when comparisons are being made between jurisdictions or over time. Three questions provide the framework for the paper:

- When comparing health indicators across jurisdictions, what assurance is there that it is a fair comparison, that apples are being compared to apples?
- How can I tell if my jurisdiction's health status or health system performance is different from that of another jurisdiction?
- How can I tell if my jurisdiction's health status or health system performance is improving or getting worse?

When addressing these three questions, the paper first discusses, in non-technical terms, the statistical adjustments made to the indicators to help ensure that regional differences in age distribution or health status are taken into account and that such underlying differences do not compromise the value of comparisons that are made. Second, the paper reviews the statistical testing of differences in health indicator values, with a focus on interpreting confidence intervals. Finally, the paper identifies challenges associated with making judgments about time trends on the basis of indicator measures.

Introduction

CIHI is dedicated to providing timely, accurate and comparable information to support the effective delivery of health care.[1] Each year CIHI and Statistics Canada publish *Health Indicators*, with more than 80 measures, to help decision-makers gauge population health and health care from pan-Canadian, provincial, territorial and regional perspectives.

The health indicators provide insights into the nation's health status and health system characteristics and performance. While many of the indicators appear to be straightforward (for example, the occurrence of death within 30 days of being hospitalized for stroke or the rate of hip replacement surgery) questions may arise when trying to interpret what the indicators signify in terms of quality of care or a community's success in maintaining the health of its population relative to other jurisdictions.

The purpose of this paper is to provide guidance on interpreting statistical issues pertinent to health indicators, especially when comparisons are being made between jurisdictions or over time. The paper uses the annual *Health Indicators* report published by CIHI and Statistics Canada to illustrate certain statistical issues, but the principles described are generally applicable when interpreting other indicator sets. The paper focuses on three questions frequently asked by those interpreting health indicators for their populations:

- When comparing health indicators across jurisdictions, what assurance is there that it is a fair comparison, that apples are being compared to apples?
- How can I tell if my jurisdiction's health status or health system performance is different from that of another jurisdiction?
- How can I tell if my jurisdiction's health status or health system performance is improving or getting worse?

The paper addresses these three questions. First, it discusses the statistical adjustments made to the indicators to help ensure that regional differences in age distribution or health status are taken into account and that such underlying differences do not compromise the value of comparisons that are made. Second, it reviews the statistical testing of differences in health indicator values, with a focus on interpreting confidence intervals. Finally, the paper identifies challenges associated with making judgments about time trends on the basis of indicator measures.

The paper is limited in scope to statistical issues commonly encountered when interpreting health indicators and is not intended to provide a comprehensive review of statistics. The paper targets an audience without a statistical background and uses, to the extent possible, non-technical language to describe statistical concepts. For an in-depth review of these issues, readers can refer to textbooks on statistics in medicine.[2–4]

While an understanding of statistical issues is important in interpreting health indicators, identifying statistically significant findings is usually just the first step of any analysis. Just as important is the "unpacking" of findings to identify the underlying factors that can explain them and guide actions to improve health and health care.

This paper is the second in a series of methodology papers. The first such paper, *Making Sense of Health Rankings*, was published jointly with Statistics Canada in 2008.[5] This paper is published by CIHI in response to a request from the Sparsely Populated Panel.[i]

Health Indicators

Introduction

Since 1999, CIHI has worked collaboratively with Statistics Canada to identify indicators that capture key dimensions of health and the health care system.[ii] The indicators provide regional, provincial, territorial and national stakeholders with information to support evidence-based decision-making. The original set of 13 indicators has now grown to more than 80.

The Health Indicator Framework

Box 1 shows the 21 indicators produced by CIHI that will be discussed in this paper. They are listed according to the Health Indicator framework—a conceptual model developed by CIHI and Statistics Canada that features measures of health status, non-medical determinants of health, health system performance, and community and health system characteristics. In addition, Equity is a cross-cutting theme that spans all of the features of the Health Indicator framework.

Both the health status of a community and the performance of its health care system need to be measured on many dimensions. In terms of health status, the indicators serve a surveillance function for certain conditions (such as heart attack and stroke). Health system performance measures include such indicators as mortality, wait times, readmission rates and potentially avoidable admissions. These health system measures attempt to capture aspects related to clinical practice patterns and system capacity.

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i. The Sparsely Populated Panel is an advisory group of senior administrators from rural and remote health authorities and other entities constituted to provide ongoing advice to CIHI on issues related to health services in rural and remote areas.

ii. A health indicator is "a single measure (usually expressed in quantitative terms) that captures a key dimension of health, the health care system or other related factors. They can further our understanding of the health of Canadians, how the health care system works and what needs improvement. Health indicators can be used to inform health policy, manage the health care system, enhance our understanding of the broader determinants of health, as well as to identify gaps in health status and outcomes for specific populations."[6]

Box 1: Selected CIHI Health Indicators

Health Status
Well-being
Health conditions
1. Injury hospitalization
2. Hospitalized acute myocardial infarction event rate
3. Hospitalized stroke event rate

Human function
Death

Non-Medical Determinants of Health
Health behaviours
Living and working conditions
Personal resources
Environmental factors

Health System Performance
Acceptability
Accessibility
4. Wait time for hip fracture surgery

Appropriateness
5. Caesarean section

Competence
Continuity
Effectiveness
6. Ambulatory care sensitive conditions
7. 30-day acute myocardial infarction in-hospital mortality
8. 30-day stroke in-hospital mortality
9. Acute myocardial infarction readmission
10. Asthma readmission
11. Hysterectomy readmission
12. Prostatectomy readmission

Efficiency
Safety
13. Hospitalized hip fracture event rate
14. In-hospital hip fracture

Community and Health System Characteristics
Community
Health System
15. Coronary artery bypass graft
16. Percutaneous coronary intervention
17. Cardiac revascularization
18. Knee replacement
19. Hip replacement
20. Hysterectomy
21. Inflow/outflow ratios

Resources

Source
Canadian Institute for Health Information, *Health Indicators 2010* (Ottawa, Ont.:CIHI, 2010).

Interpreting Indicators

While on the surface the meaning and interpretation of health indicators may seem straightforward, it is most informative to use them in conjunction with other sources of information. To take an example, the 30-day acute myocardial infarction (AMI) in-hospital mortality rate may reflect quality of care and the underlying effectiveness of treatment in the hospital, as well as care provided in the community (for example, the effectiveness of transfers from community hospitals). The rate for Canada (without Quebec data) was 8.9% in the period 2006–2007 to 2008–2009.[1] For this indicator, three years of data were pooled to provide reliable estimates. During this three-year period, there were variations in 30-day AMI in-hospital mortality rates across Canada, with the rate in British Columbia (9.4%) being significantly above the national rate and the rates in Manitoba (7.8%) and Alberta (7.3%) being significantly below the national rate. By health region, the rates ranged from 5.2% for Annapolis Valley, Nova Scotia, to 14.7% for Northeast, B.C.

Most of the health indicators are reported according to the patient's place of residence.[iii] For example, only residents of the Winnipeg Health Region are included in the AMI in-hospital mortality rate mentioned above, regardless of whether they were treated in Winnipeg's hospitals or not. Similarly, any death occurring in a Winnipeg hospital to a resident of another health region would be included in the rate for the patient's place of residence. Indicators based on patient's place of residence may be of particular interest to those involved in the governance of medical service plans on a regional, provincial or territorial level. A hospital administrator would likely prefer to have data limited to those cared for within his or her facility when making operational decisions. A regional health manager, when faced with a relatively high 30-day AMI in-hospital mortality rate for his or her jurisdiction, would want to further explore factors that may account for higher mortality rates. For example, a high rate of deaths occurring within hours of hospitalization may indicate problems in transportation or emergency services, whereas later deaths secondary to sepsis occurring one to two weeks following the hospital admission may point to a need to investigate hospital infection control practices.

Data Sources

Information from administrative health databases is often the primary data source for health indicators. As many as 811 facilities across Canada report information on acute inpatient stays and day surgery procedures to CIHI's Discharge Abstract Database (DAD).[7] In 2008–2009, more than 3.2 million abstracts were submitted to the DAD, representing 75% of all acute inpatient separations in Canada. The remaining 25% of discharges occurred in Quebec, where data is reported to the Hospital Morbidity Database and then combined with that in the DAD. For information on day surgery procedures, CIHI supplements the DAD with reports from the National Ambulatory Care Reporting System and selected provincial data (from the Alberta Ambulatory Care Database).

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iii. One indicator, in-hospital hip fracture, is reported according to where the hospitalization occurred rather than where the patient resides.

Data and Measures

A first step to understanding how statistics apply to health indicators is distinguishing the types of data and measures used to express their values. Statisticians describe three types of data: categorical, continuous and rank ordered.[iv] Different statistical tests are appropriate for each of these types of data.

Most of the CIHI indicators represent events or conditions represented by two states, which may be described as “present” versus “absent” or “yes” versus “no.” Because each individual is in one of two states, the variables are referred to as binary categorical variables. These binary categorical variables are used to calculate a variety of summary statistics, such as rates (for example, cardiac revascularization rate), percentages (for example, patients within the wait time target for hip fracture surgery) and ratios (for example, inflow/outflow ratio). Although these terms are used interchangeably, understanding the distinguishing features of these measures is important, because they are often treated differently when statistical tests are applied.

Ratio: An expression of the relationship between two numbers in the form of x to y (x / y), for example, the ratio of the number of males to the number of females in a population. (In this example x is the numerator and y the denominator.)

Rate: A special case of a ratio, where the numerator represents a quantity that is in some sense contained in the units of the denominator; it is expressed as z numerator units per denominator unit. Examples are z miles per hour and z gallons per minute. In health care statistics we often look at the number of events of interest in a specified period per 100,000 persons in the population (the population subject to these events in the specified period).

Proportion: Another special case of a ratio, this time where the denominator is the size of a group and the numerator the size of a subgroup, so every case that contributes to the numerator also contributes to the denominator; thus it always has a value that falls between 0 and 1. Making inference is easier when it is based on proportions that lie in the middle of the range between 0 and 1 (central proportions, such as between 0.2 and 0.8) than when they lie very close to 0 or 1 (extreme proportions), as these must be treated differently when applying statistical tests.

Percentage: Obtained by multiplying a proportion by 100.

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iv. Variables are often considered to be in one of three groups: categorical, ordinal or continuous. As the name would suggest, categorical data is based on categories, for example, male or female, death associated with a procedure that either happens or does not happen, or province of birth. Categorical variables are often summarized using rates, proportions or percentages. Ordinal variables are much like categorical ones, but the categories involved have a natural order. An example would be highest level of education, with the categories *elementary school*, *high school*, *undergraduate college or university* and *post-graduate university*. The inherent ordering of the categories introduces additional analytic possibilities. Continuous variables are measured in small increments. Examples of continuous data are age, height and weight. We are often interested in the mean or median of a continuous variable.

Some indicators pertain to the general population, while others are limited to a specific population subgroup (such as women delivering babies in the case of Caesarean section or persons older than age 65 in the case of hip fracture).

Across the indicators, the unit of measurement varies. Some of them measure events (such as deaths or readmissions) in a specific patient cohort (for example, deaths among patients admitted to hospital for a heart attack), and others measure health encounters occurring in the general population (for example, persons admitted for an injury per 100,000 persons in the population).

As mentioned above, all of the indicators in the *Heath Indicators* report, except one, refer geographically to where patients reside and not to where they are hospitalized. For example, if residents of one region are injured and hospitalized in another region, their hospitalization would be attributed to their health region of residence. The only indicator that reflects the location of the hospital is the in-hospital hip fracture rate, because this indicator is a measure of patient safety in hospitals.

Some indicators measure a specific health condition or procedure, while others are composite in nature. For example, the indicator that measures hospitalizations for ambulatory care sensitive conditions identifies potentially avoidable hospitalizations. These are hospitalizations for conditions for which appropriate ambulatory care can often avoid a hospitalization (such as diabetes and asthma).

Summary

CIHI, in collaboration with Statistics Canada, developed a set of indicators to measure health status, non-medical determinants of health, health system performance and community and health system characteristics. The administrative data upon which the CIHI health indicators (Box 1) are based includes information on acute care hospitalizations and day surgery procedures. The indicators themselves are considered binary variables, representing conditions or events that have occurred or not occurred (such as death and hospitalization). The indicators are expressed as ratios, rates or proportions. In *Health Indicators*, most of the indicators refer geographically to where patients reside and not to where they are hospitalized. The indicators can therefore be interpreted as generally reflecting the overall functioning of the health system, rather than the performance of particular hospitals in the region. Given the complexity of health and health care, health care decision-makers are advised not to interpret indicator values for their jurisdiction in isolation but to instead consider them in conjunction with other sources of information.

Answering Frequently Asked Questions About CIHI Health Indicators

When comparing indicators across jurisdictions, what assurance is there that it is a fair comparison, that apples are being compared to apples?

Introduction

When interpreting the results of a comparison between two jurisdictions, one concern that often arises is whether any significant finding is an artefact of underlying differences in the populations being compared. For example, an analyst may ask, "How can I be sure that my region's significantly higher rate of 30-day stroke in-hospital mortality is not due to the fact that in my region there are a disproportionate number of difficult-to-treat, high-risk patients, placing them at increased risk of complications and death during a hospitalization?" Or a regional planner may legitimately point out that very elderly people who have multiple comorbid conditions and are more prone to hip fractures tend to be seen in his region's hospitals, which could well explain his region's high rate of in-hospital hip fractures.

To address these types of concerns, CIHI performs adjustments on most of its health indicators. A common statistical procedure for these types of adjustments is called standardization. A direct or indirect method of standardization can be used. The direct method is applied when the study population is large and age-specific rates within the population are stable. When the population is small, the outcome is rare or many factors need to be taken into account, indirect methods are used.[8] Appendix A shows the indicators and what age and risk adjustments are made. This section of the paper describes why age standardization and risk adjustment are performed and how these procedures improve the comparability of published indicators.

Age Standardization

The distribution of young people and the elderly is uneven across the provinces and health regions of Canada. For example, in 2008, the proportion of the population that was age 65 and older varied from 2.8% in Nunavut to 10.4% in Alberta to 15.3% in New Brunswick.[1] The average across Canada was 13.8%.

Age standardization is important when indicators are compared across the country. If this variation in the age structure of the provinces, territories and health regions is not taken into account, the crude unadjusted rates could be quite misleading for conditions or events that are associated with age.

Age standardization is also important when there are changes in a region's age structure and time trends are of interest. For example, from 1992 to 2009, Newfoundland and Labrador lost 12% of its population, largely due to out-migration among young people for job opportunities in Western Canada. With a concomitant declining birth rate, the population of Newfoundland and Labrador has aged considerably. In 1971, the median age was 20.9, indicating that roughly

half of the population was younger than 20 and the remaining population older than 20.[9] By 2008, the effects of out-migration and the birth dearth were evident, with the median age having increased to 42.0. Without adjustments for these changes in age structure, making sense of changes over time in rates of disease, death and unfavourable hospital events would be difficult. For example, increasing crude unadjusted rates over time could reflect the effects of population aging alone and would not necessarily be attributable to community health status or hospital system practices.

With direct age standardization, age-specific rates of disease, death or hospital events in each jurisdiction are applied to an agreed-upon standard population. This standardization procedure removes the effects of a non-homogeneous age structure. Table 1 illustrates the effects of differences in population age distributions and why corrections must be made to adjust crude rates. In the example shown, population A has an older age distribution, with 30% of its population age 45 and older, compared to population B, with only 10% of its population in this age group. Despite having the same mortality rates within age groups (that is, the age-specific mortality rates are the same), the crude mortality rate of population A is considerably higher than that of population B (9.0 versus 5.8 per 1,000, respectively).

Table 1: Example of the Effects of Age Distribution on Crude Mortality Rates

	Age (Years)	Population		Age-Specific Mortality Rate (per 1,000 Population)	Annual Number of Deaths	Crude Mortality Rate (per 1,000 Population)
		Number	Percentage Distribution			
Population A	<15	15,000	30%	2	30	
	15–44	20,000	40%	6	120	
	≥45	15,000	30%	20	300	
	All Ages	50,000	100%		450	
						450 / 50,000 = 9.0
Population B	<15	20,000	40%	2	40	
	15–44	25,000	50%	6	150	
	≥45	5,000	10%	20	100	
	All Ages	50,000	100%		290	
						290 / 50,000 = 5.8

Source
Adapted from J. S. Mausner and S. Kramer, *Mausner & Bahn Epidemiology: An Introductory Text* (Philadelphia, Pennsylvania: WB Saunder Co., 1985).

Table 2 illustrates how the direct standardization technique is used to adjust for the effects of different population age distributions. In the example, the age-specific rates of populations A and B are applied to the same standard population, in this case, a combination of the populations of A and B. By doing so, the expected number of deaths is calculated; this number reflects the number of deaths that would occur if the age structure of populations A and B were the same. The resulting age-standardized mortality rate is now the same for the two populations, at 7.40 per 1,000.

Table 2: Example of Standardization to Correct for Effects of Age Distribution

Age (Years)	Standard Population (A and B Combined)	Population A Age-Specific Mortality Rate	Expected Deaths	Population B Age-Specific Mortality Rate	Expected Deaths
<15	35,000	2	70	2	70
15–44	45,000	6	270	6	270
≥45	20,000	20	400	20	400
All Ages	100,000		740		740
Age-Standardized Mortality Rate			**7.40 / 1,000**		**7.40 / 1,000**

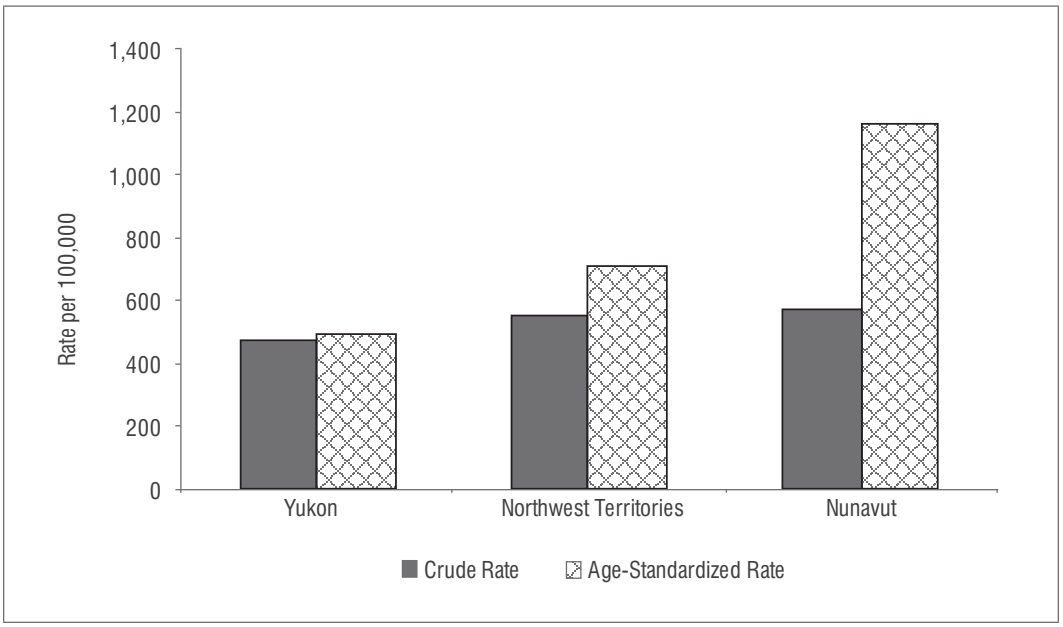
For *Health Indicators*, the direct method[v] of standardization is used for indicators that are reported per 100,000 population. To ensure that indicators are comparable over time the same standard population is used (specifically, the July 1, 1991, Canadian population). Adjustments are made within five-year age groups.[10]

Figure 1 illustrates how age standardization can influence health indicators. In the example, the crude ambulatory care sensitive condition (ACSC) hospitalization rate for Nunavut is substantially lower than the age-standardized rate. This is attributable to the relatively young age distribution in this jurisdiction. However, age standardization has a smaller effect on the ACSC rate for the Northwest Territories and almost no effect on the Yukon rate because the age structures are similar to the standard population.

While age-standardized rates are needed when making comparisons between jurisdictions or when tracking progress over time, crude rates are valuable for health planning purposes. In this example, a regional health manager would want to examine the crude rate and the number of patients who reside in the region and who are hospitalized for conditions that may have been preventable with improved access to primary care. This information could help determine the need for additional ambulatory clinics or personnel.

v. The indirect method can also be used to age-standardize rates.

Figure 1: ACSC Hospitalization Rate per 100,000 Population Younger Than Age 75, 2007–2008



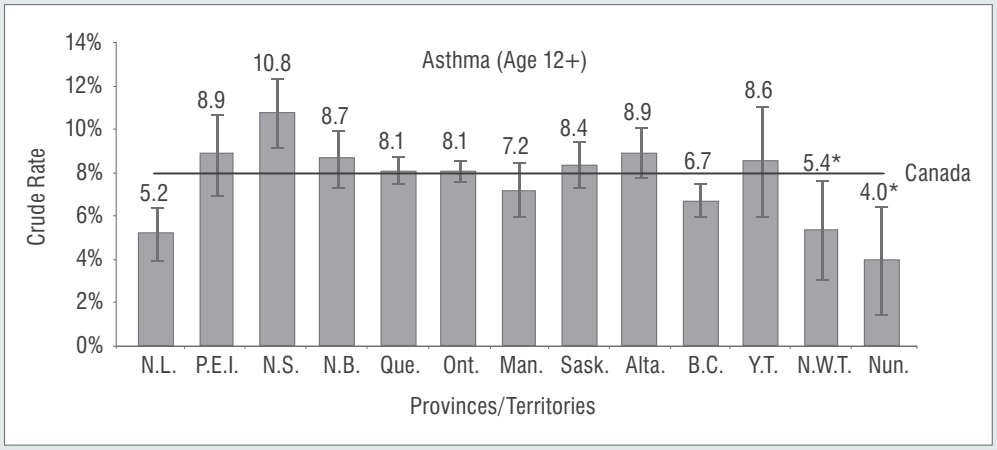
Source
Discharge Abstract Database, 2007–2008, Canadian Institute for Health Information.

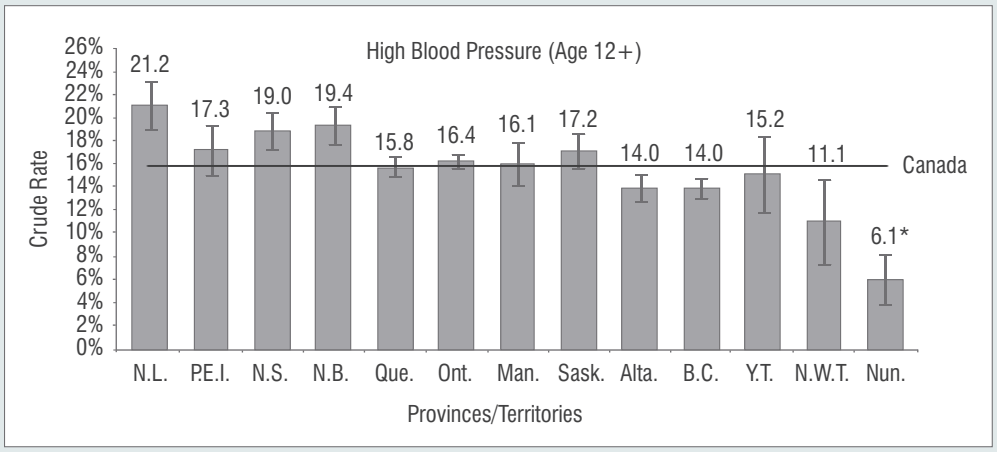
Risk Adjustment

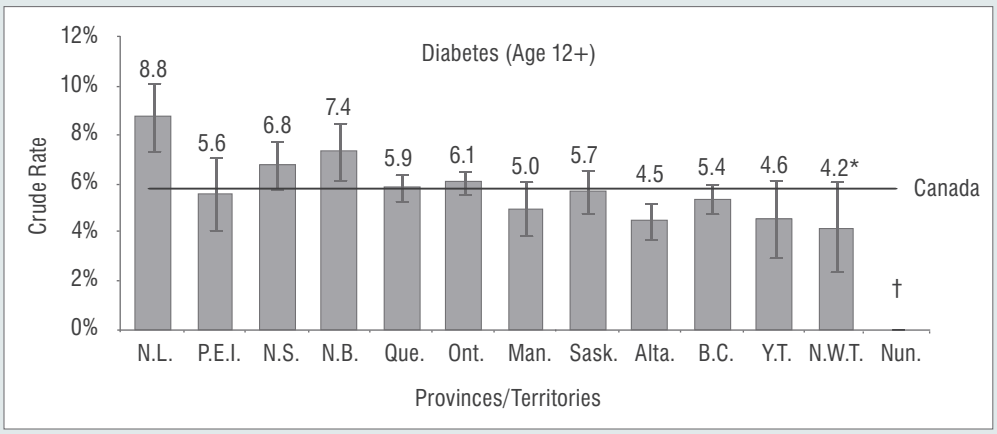
Just as communities across Canada vary in their age distribution, variation also occurs in terms of other socio-demographic and health characteristics that can greatly influence health status and the need for and use of health services. Smoking rates across Canada in 2008, for example, varied from a low of 18.6% in British Columbia to a high of 54.2% in Nunavut.[1] Box 2 shows three figures depicting how the prevalence of high blood pressure, asthma and diabetes varies across Canada. These figures illustrate how the occurrence of underlying chronic conditions can vary by as much as twofold. Often, these and other chronic conditions exist in combination with the index condition that leads to a hospitalization. Sometimes referred to as comorbid conditions, these risk factors, along with age and sex, must often be taken into account to make fair comparisons.

Risk adjustment, using the indirect method of standardization, is a set of techniques used to take such underlying variation into account. It is especially important to adjust for factors that cannot be altered, such as age and sex. Differences that can be explained by factors that can be altered, for example, health care providers' adherence to clinical practice guidelines, can potentially be reduced by implementing quality improvement programs.

Box 2: Prevalence of Self-Reported Selected Chronic Conditions Among Those Age 12 and Older, by Province/Territory, 2007







Notes
* Interpret with caution.
† Figure suppressed due to small numbers or incomplete data.
I indicates the length of the 95% confidence interval.
These rates are not age adjusted.
Populations on Indian reserves, Canadian Forces bases and some remote areas are excluded from the Canadian Community Health Survey, the source of these estimates.
Source
Canadian Community Health Survey, Statistics Canada.

In making its risk adjustments, CIHI uses statistical models that can take into account a number of factors that may affect an outcome of interest. All of the indicators that are risk adjusted are binary outcomes, because they refer to events that either occur or do not occur. For example, deaths, readmissions and hip fractures either happen or they do not. To simultaneously examine the many factors that can affect these binary outcomes, a technique called logistic regression is often used. Appendix A shows the eight health indicators that are risk adjusted and the factors that are considered in the adjustments. Details on the logistic models and their calculation can be found in the *Health Indicators* Technical Notes.[10]

While attempts are made by CIHI to adjust for underlying factors that could compromise making apples-to-apples comparisons, there is a general recognition that inferences about health outcomes based on risk-adjusted measures must be interpreted very carefully.[11] CIHI is attempting to measure health system effectiveness and safety with the indicators that are risk adjusted. To isolate the health system's performance, one would ideally like to have a comprehensive set of relevant demographic, clinical, socio-economic and behavioural risk factors. For its indicators, CIHI has only the information recorded on the hospital discharge abstract. Many important risk factors are available on the abstract, such as the patient's age, sex and some comorbid conditions, but other important risk factors that could potentially further refine outcome analyses are not available (for example, an individual's smoking status and body mass index). Despite their limitations, the risk adjustments that are carried out strengthen the conclusions that can be drawn when interpreting CIHI health indicators.

Summary

An assurance that apples are being compared to apples is difficult to make when comparing jurisdictions' health indicators. That said, attempts are made with available data to take into account differences in the age and risk profile of residents of jurisdictions before health indicators are published. In recognition of the variation in age distribution across Canada, CIHI age standardizes several of the health indicators. For a set of indicators, CIHI performs risk adjustment by using statistical models to take into account age, sex and selected comorbid conditions that may vary across jurisdictions and affect the comparability of indicator values. Recognized are the limits of age and risk adjustment as many factors, not captured in data systems, can affect health outcomes and indicators of health system performance.

How can I tell if my jurisdiction's health status or health system performance is different from that of another jurisdiction?

Introduction

The purpose of *Health Indicators* is to "further understanding of the health of Canadians, how the health care system works and what needs improvement."[6] A first step in using the indicators to meet these objectives is to see how the values of indicators vary across regions, provinces and territories and how they compare to the national rate. Health care consumers may want to know if their region's health care system performance indicators are comparable to the Canadian average. A health care administrator may want to know if the health outcomes of hospitalized residents in his or her region are more or less favourable than those in

the neighbouring jurisdiction. Appropriate use of health indicators to answer such questions requires a basic understanding of the statistics that are used to analyze variation and assess the significance of observed differences.

This section of the paper reviews how statistical measures of uncertainty are applied to health indicators, highlights some cautions when making comparisons across jurisdictions and to the national average, and discusses certain limitations of statistics in understanding health status and health system performance with health indicators.

Measuring Uncertainty With Confidence Intervals

Statistics and the uncertainty associated with statistical estimates have become familiar in our daily life. During the election season, for example, news reports of the level of support for one candidate relative to another are couched in terms of percentage approval ratings with a margin of error of plus or minus three to five percentage points. In the case of a survey, it is common knowledge that the figures that are reported are subject to error and uncertainty because these estimates are based on a sample of the population. *Health Indicators* includes estimates of health behaviours and the prevalence of health conditions (such as self-reported diabetes and asthma) based on large population-based surveys conducted by Statistics Canada. These estimates have to account for the uncertainty associated with basing an estimate for an entire population on a sample of that population.

Other health indicators are based on administrative databases that attempt to capture records of the entire universe of health care events, such as acute hospital discharges. As a result, some believe that the so-called sampling error associated with a survey is not an issue. However, the hospital administrative data, even if completely ascertained, is subject to random variation—that is, the number of events or deaths that actually occur may be viewed as one of a large number of possible results that could have arisen under similar circumstances.[12] It is this naturally occurring random variation that must be taken into account when interpreting the values associated with the health indicators based on administrative data. The indicator values are considered estimates, with the associated uncertainty that is measured with statistics.

Uncertainty is of particular concern in the case of indicators measuring a relatively rare event. For example, in-hospital hip fractures do not occur frequently—the rate is 0.8 per 1,000 discharges of patients age 65 and older over a three-year period.[vi] Table 3 shows two hypothetical regions, each with the same number of discharges and each with the same underlying actual rate of in-hospital hip fractures (on average 0.8 per 1,000). We can imagine a hypothetical case in which region 1, by chance, experiences two additional cases one year and region 2 experiences two fewer cases of in-hospital hip fracture that same year. This chance occurrence in the number of cases, two more in one region and two fewer in the other, affects the rate to a considerable extent. Region 1 now has a hypothetical rate of 1.0 per 1,000, and region 2 has a rate of 0.6 per 1,000. Even though the change in rates seems to be large, the difference between the actual and the hypothetical rate is not statistically significant. This random variation has to be taken into consideration, and special attention needs to be paid to rates representing rare events, especially in small populations. It is often difficult to distinguish relatively small but significant differences from random variation when comparing two or more sparsely populated regions.

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vi. Six other indicators use a three-year average to stabilize rates of relatively rare events: 30-day AMI and stroke in-hospital mortality and readmission indicators.

Table 3: Example of Effects of Random Variation on In-Hospital Hip Fractures

	Number of In-Hospital Hip Fractures		Number of Hospitalizations (65 and Older)	Rate	
	Actual	Hypothetical		Actual	Hypothetical
Region 1	8	+2 = 10	10,000	0.8	1.0
Region 2	8	-2 = 6	10,000	0.8	0.6

When reviewing the values of CIHI indicators for a particular region, we may first want to assess the confidence or precision with which the estimate is made. This is usually done with the help of confidence intervals (CIs). CIs are measures of the variability in the data and the number of cases that contribute to the estimate. *Health Indicators* usually includes two columns for each indicator. The first column provides an estimate for the indicator in question, and the second column provides a 95% CI. The 95% CI represents our degree of certainty that the true indicator value falls within that interval. Another way of thinking about this measure of precision is that if we made a large number of estimates of the value of the indicator, the true value for the indicator would fall within this interval 95% of the time. It is a common convention to use a 95% CI, but other levels of confidence, such as a 99% CI, can be calculated.

An example from *Health Indicators 2010* will help illustrate the interpretation of the 95% CI. According to the report, there were 534 injury-related hospitalizations per 100,000 population in Canada in 2008–2009.[1] The 95% CI associated with this estimate was 531 to 536, meaning that 95% of the time the true value for this indicator will fall within this relatively tight range. During this same period, the rate of injury-related hospitalizations was similar for Newfoundland and Labrador, at 539 per 100,000 population. The 95% CI associated with this estimate was 519 to 559, a wider range than for the pan-Canadian estimate. As a general rule, the CI associated with an estimate narrows as the size of the population increases and the degree of variation for the estimate diminishes. CIs can be wide, reflecting uncertainty, when dealing with a small population with a large degree of variability for the particular estimate. This is in keeping with our intuition that we have confidence when we benefit from many observations. For very sparsely populated areas, the 95% CI can become so wide that the indicator values are hard to interpret. Therefore, certain health indicators for smaller jurisdictions are not reported.

CIs do not account for all sources of uncertainty. Estimates could be skewed due to missing or incomplete data, miscoded data or biases arising from a lack of reporting or underreporting from certain hospitals.

Detecting Statistically Significant Differences

CIs for estimates presented in *Health Indicators* provide the reader with information about the uncertainty associated with each of the published estimates. However, CIs are not sufficient to judge whether two rates are statistically significantly different. For example, when comparing a result for a province or region with the national estimate, one cannot assume that if the CI surrounding the estimate for a particular jurisdiction overlaps with those surrounding the pan-Canadian estimate that there is no statistically significant difference. As an illustration, according to *Health Indicators 2010*, the rate of hip replacement performed per 100,000 population age 20 and older in 2008–2009 was 91 in New Brunswick (95% CI 84 to 98). This CI refers to the uncertainty surrounding the provincial

estimate. The rate per 100,000 for Canada in 2008–2009 was 99 (95% CI 98 to 101). This CI refers to the uncertainty surrounding the Canadian estimate. To test the difference between the provincial and pan-Canadian values, statistical tests are performed to compare the two estimates and take into account the lack of independence of the estimates. This lack of independence arises because in this case New Brunswick data is included in the pan-Canadian estimate. Even though the provincial and pan-Canadian CIs overlap (both include 98), there is a statistically significant difference between these estimates as indicated by the red symbol (the report indicates with a red symbol any jurisdictional estimate that is statistically significantly different from the pan-Canadian estimate). As this example illustrates, making a judgment about statistical differences by simply comparing the CIs can be inconclusive.

Can the published CIs be used to test the significance of differences between the indicator values of two provinces, territories or regions?

In short, the answer is "it depends." First, the method of standardization needs to be considered. As a general rule, rates that are calculated using the indirect method of standardization, such as risk-adjusted rates, can be compared to the standard population only, which is the national average in the case of *Health Indicators*. Conversely, rates calculated by the direct method, such as age-standardized rates, can be used to compare across jurisdictions.

The second consideration is statistical significance. When two jurisdictional CIs for the age-standardized rates do not overlap, we can conclude that there is a statistically significant difference. For example, when using CIs constructed separately for the provinces of Saskatchewan and Nova Scotia when examining hip replacement rates in 2008–2009, we see that the CIs do not overlap; therefore, we can confidently conclude that there is a statistically significant difference in the age-standardized rate of hip replacement (Table 4). However, when CIs overlap, we cannot conclude that there is not a statistically significant difference between the two values. For example, the hip replacement rate seems to be similar for residents of Alberta relative to those living in British Columbia (109 versus 115 per 100,000) and the respective confidence intervals overlap (Table 4). In situations where province-to-province or region-to-region comparisons are being made and the CIs barely overlap, additional statistical testing is needed.

Table 4: Age-Standardized Rate of Hip Replacement, 2008–2009

	Age-Standardized Rate per 100,000 Population	95% CI
Saskatchewan	127	(120–135)
Nova Scotia	104	(98–111)
Alberta	109	(105–113)
British Columbia	115	(112–118)

Source
Canadian Institute for Health Information, *Health Indicators 2010* (Ottawa, Ont.: CIHI, 2010).

Factors to Consider When Interpreting Indicators

Health indicators are published to support evidence-based decision-making for regional, provincial, territorial and national stakeholders. The expectation is that stakeholders will examine deviations in their jurisdiction's indicator values, explore possible reasons for underperformance and subsequently, where possible, take actions to improve population health and health care. This paper has described some of the issues essential to interpreting methods used to identify statistically significant differences in health and health care performance. It is as important to appreciate the limits of what the indicators can tell us as it is to understand the basic elements of these methods. This section of the paper will discuss several factors that must be considered when evaluating health indicator values, including information gaps, the distinction between statistical and clinical significance, problems associated with making multiple comparisons and consideration of unaccounted-for sources of bias.

Information Gaps

The set of CIHI indicators included in the Health Indicator framework (Box 1) represents measurements that have been judged most useful and for which data is available for pan-Canadian comparisons. However, there are still many obvious gaps in coverage of important aspects of health and health care. For example, measuring the appropriateness of care is currently limited to one indicator of obstetrical care: the rate of Caesarean section. Safety indicators are limited to two measures: the hospitalized hip fracture event rate and the rate of in-hospital hip fracture. The same indicator may reflect several categories in the framework. For example, the rate of potentially avoidable hospitalization for conditions amenable to primary care intervention may, in some instances, reflect a lack of effectiveness on the part of the communities' primary care providers; in another it may reflect a lack of resource capacity and limited access to primary care. In many cases, the indicators should be considered crude measures of the framework constructs. Any significant deficits in indicator values observed need to be further explored to understand factors influencing the indicator. For example, one jurisdiction's high proportion of patients with prolonged wait times for surgery for hip fracture could be easily explained by clinicians' adherence to a protocol that delayed surgery for patients who had certain comorbidities or complications.

Organizations that develop indicators recognize the lack of relevant data to adequately populate the framework. Acknowledged also are the challenges of developing indicators that are relevant to residents of rural and sparsely populated areas. Efforts are under way to improve data systems and the availability of meaningful indicators of Canadian health and health care.[13] As information and reporting systems improve across Canada, additional indicators will be developed across health sectors and for various population subgroups.[13]

Distinguishing Statistical and Clinical Significance

There is often the misunderstanding that a statistically significant finding is also significant in a clinical or public health sense. It is important to recognize that a statistically significant effect is determined not only by the size of the effect but also by both the size of the sample and the amount of variation observed within it.[14] As the size of the population increases, the variability of the estimate of the size of the effect is reduced, and the associated CI narrows. No matter how small a difference is, there is a sample large enough to find it statistically significant. Consequently, if the sample used for a study is very large, even a very small difference may be found to be statistically significant, even though it is too

small to have real meaning in a clinical or public health sense. In such cases, decision-makers are advised to not over-interpret or make too much of very small but statistically significant differences. Conversely, what could be a clinically significant difference between groups may not be statistically significant if the population size is small, as is often the case in sparsely populated areas.

Problems Associated With Making Multiple Comparisons

When analyzing several indicators or comparing multiple regions or provinces to a pan-Canadian estimate, the results of many statistical tests come under consideration. If, with *Health Indicators* in hand, an analyst compares indicator values for 20 jurisdictions to the pan-Canadian estimate using a 95% significance level, it is expected that, on average, one statistically significant difference would be found when, in fact, there was no difference between the jurisdiction's value and the pan-Canadian value. The observed difference would be due to chance alone but would be big enough to appear statistically significant. When making a conclusion that depends on the results of many tests of statistical significance, the significance level of each test may need to be adjusted so the overall significance level is of the desired size.

Consideration of Unaccounted-for Sources of Bias

The prudent reviewer of *Health Indicators* would not be confident of any judgments regarding his or her jurisdiction's health status or health system performance relative to others if just the results of statistical tests were considered. There are a host of issues beyond statistical concerns that must be taken into account when interpreting health indicator values. Cautious readers should consider when the data upon which the indicator is based was collected to see if it represents the current environment and medical practices. Second, the potential impact of under-reporting or misreporting data must be examined. CIHI manages data quality for reporting through standard setting, training programs and audits. However, changes in coding standards, reporting practices or staffing may contribute to errors. Another source of potential bias in estimates relates to the limits of risk adjustments. A host of factors is considered in attempts to make comparisons of jurisdictions fair, but data may be unavailable to fully account for all of the factors one would like to include in these adjustments.

While these and other potential pitfalls are important to consider in the interpretation of health indicators, examining regional variation in health indicators is a good place to start for those interested in improving population health and health care.

Summary

Examining the extent of health indicator variation across jurisdictions is an important step that can be taken to meet the objective of improving the health of Canadians and the functioning of the health care system. Critical to meeting this objective is an understanding of statistical measures of uncertainty that are applied to health indicators. CIs are used to measure the uncertainty associated with indicator estimates. Rare events, such as in-hospital hip fractures, and sparse populations can both contribute to wide CIs that may indicate a high level of uncertainty associated with indicator estimates. Readers of *Health Indicators* should be aware of how jurisdictional comparisons are made. Statistically significant differences highlighted in the reports pertain to comparisons between provinces, territories and regions and the pan-Canadian average. While there is considerable interest in how comparisons are made, well recognized is the screening nature of the indicators themselves. When statistically significant differences are found, they should be further explored to identify the underpinnings of the differences before changing policies or practices.

How can I tell if my jurisdiction's health status or health system performance is improving or getting worse?

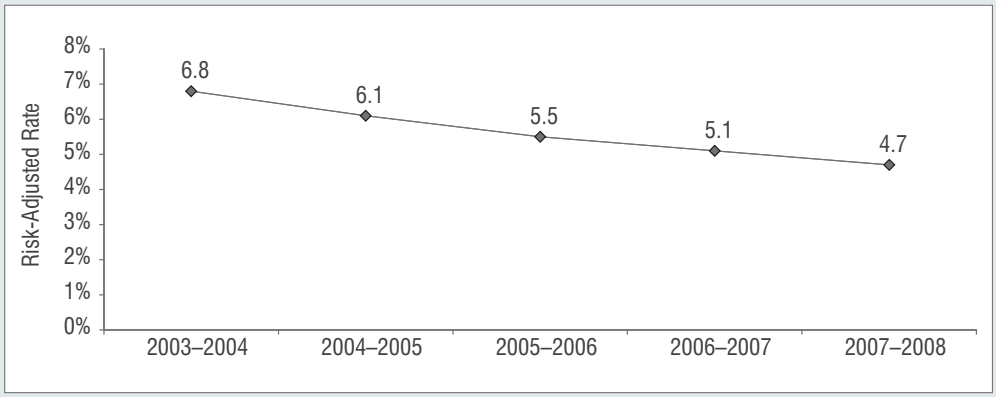
Introduction

Health Indicators includes In Focus sections that highlight key findings for particular indicators. For example, *Health Indicators 2009* featured an in-depth look at rates of readmission after a heart attack showing trends over five years (Box 3).

The first figure shows a 31% drop (to 4.7%, from 6.8%) in unplanned readmissions following discharge for a heart attack from 2003–2004 to 2007–2008. The second figure shows readmission rates diminishing in all provinces from 2003–2004 to 2007–2008. Behaviours of physicians and patients and the capacity of the system itself could all account for these positive trends, either singly or in concert. Over this period, knowledge on how to manage heart attacks may have improved and providers may have adhered more closely to evolving clinical practice guidelines. At the same time patients may have been more likely to receive counselling during their hospital stay and increased their compliance with post-discharge therapy. Augmented health system capacity could also be at play. For example, investments may have been made in diagnostic and therapeutic technologies (angiograms or angioplasties) or in health personnel to supplement the number of providers able to provide comprehensive care in and out of hospital. These trends in AMI readmission rates also need to be interpreted in the context of AMI deaths that are occurring in the community. AMI readmission rates could be declining, but this could be explained by a trend toward lower-risk patients being admitted to hospital. In theory, this could also occur if, over time, a greater proportion of higher-risk patients were dying prior to ever being hospitalized. Likewise, the decline in AMI readmissions could be explained if, over time, a greater proportion of AMI patients die following their initial hospitalization, foregoing any opportunity for readmission.

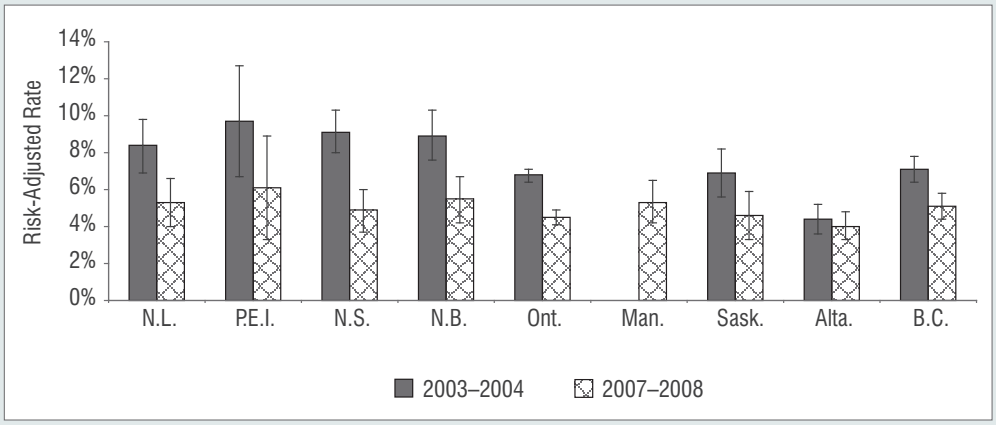
Box 3: Trends in Rates of Readmission After a Heart Attack

Figure 1: Annual Rates of Readmission After a Heart Attack, Canada



Notes
Rates do not include Quebec due to differences in data collection. The rate for 2003–2004 does not include Manitoba due to differences in data collection. To obtain annual results the rates were risk-adjusted using data from 2003–2004 to 2007–2008. The trend is statistically significant ($p<0.05$).
Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, Canadian Institute for Health Information; Alberta Ambulatory Care Database, Alberta Health and Wellness.

Figure 2: Rates of Readmission After a Heart Attack by Province, Canada



Notes
Rates do not include Quebec due to differences in data collection. The rate for 2003–2004 for Manitoba is not presented due to differences in data collection. Rates for the territories are not shown due to small numbers. To obtain annual results the rates were risk-adjusted using data from 2003–2004 to 2007–2008. I represents 95% confidence intervals.
Sources
Discharge Abstract Database and National Ambulatory Care Reporting System, Canadian Institute for Health Information; Alberta Ambulatory Care Database, Alberta Health and Wellness.

As this example illustrates, analyzing health indicator trends commands our attention and provokes the generation of hypotheses to explain the uptick or downturn in the indicator of interest. The health care analyst is interested in examining whether there is a trend and if there is a significant increase or decrease in the indicator of interest—the rate of change over the period. Seeing a consistent trend across jurisdictions is also of interest as it bolsters the confidence in the existence of a trend. In this example, the pan-Canadian trend is observed in all of the provinces examined (Figure 2 in Box 3). The health care administrator is interested in trends because he or she might want to evaluate the impact of programs or policies that may have occurred during the period of interest.[15] He or she may also want to assess progress toward an objective or project the potential number of future cases for planning purposes. Clinicians may be interested in trends because they may be useful in gauging the success of innovations in technology, procedural interventions or medical management.

Factors to Consider When Interpreting Trends

While assessing trends is potentially very rewarding, their interpretation may be stymied by several factors if not taken into account.

- **Coding or reporting practices**: Coding and reporting practices are constantly evolving in response to changes in clinical practice and the demand for clinical information. Updates to the indicator methodology must be taken into consideration when interpreting time trends. The calculation of the Caesarean section rate, for example, changed as of 2002–2003 estimates to include stillbirths. Case selection for AMI and stroke patients was altered to address changes in coding practices as of 2003–2004 to 2005–2006 estimates. These changes affect comparability of readmission and mortality rates for these conditions to the rates of previous years.[10] Appendix B enumerates a timeline for the introduction of indicators and for selected changes in coding or calculation that occurred over the years and that need to be considered when analyzing trends. Changes in the definition and coding of comorbidities used in risk adjustment must also be considered before conducting trend analyses. Users should be aware of these and other changes in definitions of indicators and adjustment factors by carefully reviewing documentation. Trend analyses can often be conducted with confidence by applying definitional and coding changes retrospectively to make each year of data comparable.
- **Population dynamics**: Migration patterns may shift the socio-demographic profile of a region so that the racial/ethnic composition or income level changes over time. These factors, if not controlled for in the risk adjustment, may be associated with the indicator of interest and affect the results of the analysis of a trend. The aging of the population may also affect how hospitals are used. Beds that were formerly available for acute care are increasingly being dedicated to the long-term care (LTC) needs of the community. The DAD distinguishes acute from LTC discharges, but the availability of LTC beds may alter the health profile of the acute care patient population over time. These and other population dynamics (rather than changes in the performance of the health care system) can lead to changes in the values of the indicators and explain the trends.
- **Unaccounted-for temporal events**: As the CIHI–Statistics Canada conceptual framework (Box 1) illustrates, health outcomes are determined by a host of factors. In particular, non-medical determinants of health, including living and working conditions, personal resources and environmental factors, play key

roles in our health but may not be well accounted for in health administrative data systems. Factors such as epidemics of flu, extreme weather or global financial or political events may affect health outcomes but usually remain unaccounted for as trends are examined. Again, these temporal events can lead to changes in the values of the indicators, but these changes are not due to changes in the performance of the health care system.

Statistical Issues in Analyzing Trends

When point estimates are available over several years for which there have been stable coding and calculation methods, statistical tests are available to identify whether a trend exists and, if one does exist, to gauge the magnitude of the change. However, there are some statistical issues to consider first. When analyzing trend data, health administrators generally like to see a consistent decline over time for a mortality rate and a steady increase in an indicator that measures excellence in health system performance. A graph of a trend can reveal its direction and shape. The shape that a trend takes is instrumental in judging what kind of statistical test is needed to see if the data shows a statistically significant improvement, decline in performance or no change. The simplest tests of trend make an assumption of linearity, that is, that the indicator changes with time, either increasing or decreasing in a consistent, linear fashion. Sometimes, however, the trend is not linear. It may be jagged or change in shape or direction with time.

Non-linearity in trends can be caused by a variety of reasons. For example, sometimes an outlier value can cause discontinuity in the shape of a trend; if so, statistical approaches can be used to smooth the data. Using more than one year of data or moving averages of multiple years of data are examples of techniques that can smooth out irregularities in the data and provide more stable estimates. These so-called rolling averages can, however, mask recent dramatic changes that may have occurred. Another technique involves transforming the data to avoid misleading conclusions. For example, sometimes data is put on a logarithmic scale. This transformation does not affect the overall direction of the trend, but it does flatten the curve. If no transformation is made, an indicator that was decreasing with time would be projected to reach zero, which is often an unlikely outcome.

It is important to examine the shape of the trend line so the appropriate analytic technique can be selected to capture this information. Regression techniques can be used to examine non-linear components of trends. Regression techniques are also often used to model trend data to calculate average annual percent change, to make projections and to consider other factors that may influence a time trend (such as changes in an area's socio-demographic characteristics). These procedures are beyond the scope of this paper, but resources are available to assist analysts who wish to pursue this area of research.[15–17]

Summary

Analysts, administrators and clinicians all want to know if progress has been made, if programs implemented have succeeded and what may be anticipated in the future. In responding to these questions several factors need to be considered. First, changes in coding or methods of calculating indicator values are often made that may affect trend analysis. Second, statistical analysis of trends can be complex, demanding users of the data consider the shape of the trend, deal with

outlier values, transform data and use regression techniques. Finally, contextual information, such as changes in the socio-demographic profile of an area or temporal events, needs to be examined to make sense of observed trends.

Summary and Conclusions

The purpose of this methodology paper was to provide guidance in interpreting statistical issues pertinent to health indicators, especially when comparisons are being made between jurisdictions or over time. Three questions provided the framework for the paper:

- ## When comparing health indicators across jurisdictions, what assurance is there that it is a fair comparison, that apples are being compared to apples?

Steps are taken to ensure that published indicator estimates are as robust as possible with available data. Very important adjustments are made to take into account differences in the age and risk profile of residents of jurisdictions before health indicators are published. However, a guarantee cannot be made of complete apples-to-apples comparability across jurisdictions. Comparability will likely improve as information systems improve and data on factors that influence health and health care performance becomes available.

- ## How can I tell if my jurisdiction's health status or health system performance is different from that of another jurisdiction?

Assessments of a jurisdiction's health status or health system performance can be made if one is familiar with 1) the statistical measures of uncertainty that are applied to health indicators and 2) the reporting of statistically significant findings. Readers should be aware that statistically significant differences highlighted in the *Health Indicators* reports pertain to comparisons between provinces, territories and regions and the pan-Canadian average. Just because a statistically significant difference for a jurisdiction is or is not identified in *Health Indicators*, findings must be further explored to identify the underpinnings of the differences (or lack of difference) before actions can be directed to improve the outcomes captured by the indicator. Information gaps exist which may impede these investigations. Many areas of interest, such as continuity of care and the competence of providers and systems, cannot yet be assessed, as indicators of these dimensions of care have not yet been developed. Efforts are under way to improve information systems and the availability of policy-relevant indicators. Other factors to consider when

interpreting health indicators are 1) the importance of distinguishing statistical and clinical significance, 2) the need for caution when making multiple comparisons and 3) considerations of unaccounted-for sources of bias.

- ## How can I tell if my jurisdiction's health status or health system performance is improving or getting worse?

The interpretation of health indicators can be challenging when decision-makers try to answer pressing questions about the progress or lack thereof that their jurisdiction is making in improving health and health care. Although identifying trends in health indicators is of great interest, at least three factors need to be considered. First, changes in coding or methods of calculating indicator values are often made that may affect trend analysis and therefore must be taken into account. Second, statistical analysis of trends can be complex, demanding the application of sophisticated statistical techniques. Finally, contextual information, such as changes in the socio-demographic profile of an area or temporal events, needs to be examined to make sense of observed trends.

Appendix A: Age Standardization and Risk Adjustments Applied to Health Indicators (in Order of Presentation in *Health Indicators 2010*)

Indicator	Reference Population	Age Standardization	Risk Adjustment	Risk Adjustment: Adjustment Variables
Injury Hospitalization	Total population	✓		
Hospitalized AMI Event	Population age 20 and older	✓		
Hospitalized Stroke Event	Population age 20 and older	✓		
Hospitalized Hip Fracture Event	Population age 65 and older	✓		
In-Hospital Hip Fracture	Discharges for inpatients age 65 and older (reported according to where hospitalization occurred rather than where patient resides)		✓	Age, sex, whether a surgical procedure was provided and pre-admission comorbid conditions (cancer, seizure, stroke, delirium and other psychosis, and trauma)
Wait Time for Hip Fracture Surgery	Hip fracture inpatients age 65 and older who received hip fracture surgery		✓	Age, sex and selected pre-admission comorbid conditions (heart failure or pulmonary edema, ischemic heart disease, hypertension, COPD, diabetes with complications and cardiac dysrhythmias)
Ambulatory Care Sensitive Conditions	Population younger than age 75	✓		
Caesarean Section	Deliveries in acute care hospitals			
30-Day AMI In-Hospital Mortality	Patients hospitalized for AMI		✓	Age, sex and select pre-admission comorbid conditions (shock, diabetes with complications, heart failure, cancer, cerebrovascular disease, pulmonary edema, renal failure and cardiac dysrhythmias)
30-Day Stroke In-Hospital Mortality	Patients hospitalized for stroke		✓	Age, sex, type of stroke and select pre-admission comorbid conditions (shock, heart failure, cancer, pulmonary edema, renal failure, cardiac dysrhythmias, ischemic heart disease and liver disease)
AMI Readmission (Within 28 Days)	Patients previously discharged for AMI		✓	Age, sex and multiple previous AMI admissions (two or more)
Asthma Readmission (Within 28 Days)	Patients previously discharged for asthma		✓	Age, sex and multiple previous asthma admissions (two or more)
Prostatectomy Readmission (Within 28 Days)	Patients previously discharged for prostatectomy		✓	Age and select pre-admission comorbid condition (heart failure)
Hysterectomy Readmission (Within 28 Days)	Patients previously discharged for hysterectomy		✓	Age
Hip Replacement	Population age 20 and older	✓		
Knee Replacement	Population age 20 and older	✓		
PCI	Population age 20 and older	✓		
CABG Surgery	Population age 20 and older	✓		
Cardiac Revascularization	Population age 20 and older	✓		
Hysterectomy	Women age 20 and older	✓		
Inflow/Outflow Ratio	Region's facility discharges/region's residents' discharges			

Appendix B: Timeline for Introduction of Indicators and Selected Significant Revisions to Indicators, 1997–1998 to 2008–2009

Indicator	Year of Data in Report											
	1997–1998	1998–1999	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	2008–2009
Hospitalized AMI Event											New	
Hospitalized Stroke Event											New	
Injury Hospitalization			New									
Hospitalized Hip Fracture Event											New	
In-Hospital Hip Fracture*					New				Revised***			
Wait Time for Hip Fracture Surgery									New			
Caesarean Section	New					Revised‡						
Ambulatory Care Sensitive Conditions	New					Revised§				Revised‡‡‡		
AMI Readmission (Within 28 Days)*		New				Revised**		Revised‡‡				
Asthma Readmission (Within 28 Days)*		New				Revised††						
Prostatectomy Readmission (Within 28 Days)*		New										
Hysterectomy Readmission (Within 28 Days)*		New		Revised†							Revised§§§	
30-Day AMI In-Hospital Mortality*		New						Revised‡‡				
30-Day Stroke In-Hospital Mortality*		New						Revised§§				
Hip Replacement	New								Revised†††			
Knee Replacement	New								Revised†††			
Hysterectomy	New				Revised†					Revised§§§		
PCI							New					
CABG Surgery	New											
Cardiac Revascularization										New		
Inflow/Outflow Ratio		New										

* This indicator is calculated based on three years of pooled data; the reference year in this table reflects the mid-point of the three-year period.

† The definition of hysterectomy changed. Subtotal hysterectomy could not be uniquely identified in the Canadian Classification of Health Interventions (CCI) versions 2001 and 2003; therefore, hysterectomy rates reported for 2001–2002 to 2005–2006 include only total hysterectomies.

‡ Beginning with 2002–2003 data, stillbirths are included in the Caesarean section rate. In previous years stillbirths were excluded. Indicator values may not be comparable with earlier years.

§ Beginning with 2002–2003 data, the definition for ACSC changed; therefore, rates are not comparable to previous years.

** Beginning with 2002 rates (2001–2002 to 2003–2004 data), the methodology for the AMI readmission indicator no longer excludes readmissions associated with a transfer for catheterization, angiography, angioplasty, insertion of pacemaker or coronary artery bypass graft surgery. Comparison with rates reported for previous years should be made with caution.

†† Beginning with 2002 rates (2001–2002 to 2003–2004 data), the methodology for the asthma readmission rate was revised to make case selection comparable with ICD-10-CA coding standards. Records coded in ICD-9 or ICD-9-CM indicating asthma in combination with chronic obstructive pulmonary disease were excluded. Comparison with rates reported for previous years should be made with caution.

‡‡ Beginning with 2004 rates (2003–2004 to 2005–2006 data), AMI case selection criteria were revised to account for the fact that an increasing number of AMI patients undergo revascularization procedures (PCI or CABG) at their index admission. In the case of revascularization procedures, AMI diagnosis may not be coded as most responsible; these cases were previously excluded from the indicator. In addition, exclusion criteria were revised and patients with lengths of stay of less than three days who were discharged alive are no longer excluded. Comparison with rates reported for previous years should be made with caution.

§§ Beginning with 2004 rates (2003–2004 to 2005–2006 data), case selection criteria for stroke were revised to include patients transferred to rehabilitation during their index admission. In this case, stroke may not be coded as the most responsible diagnosis; these cases were previously excluded from the indicator. In addition, stroke resulting from occlusion of pre-cerebral arteries is now included in the indicator. These cases were previously excluded since their identification was not possible in the ICD-9 coding system. Comparison with rates reported for previous years should be made with caution.

*** Beginning with 2005 rates (2004–2005 to 2006–2007 data), the in-hospital hip fracture rate is reported by the jurisdiction where hospitalization occurred rather than by the jurisdiction of patient residence. With this change the indicator will better reflect the concept of patient safety in hospitals. Comparison with rates reported for previous years should be made with caution.

††† Beginning with 2005–2006 data, this indicator is calculated for the population age 20 and older and therefore is not comparable with rates reported for previous years. Rates back to data year 2001–2002 were calculated using the new definition to enable comparisons over time.

‡‡‡ Beginning with 2006–2007 data, the definition for ACSC was revised. The diabetes component includes only diabetes with short-term complications or diabetes without mention of complication; the angina, hypertension and heart failure components exclude records where cardiac procedures were also coded. Rates back to data year 2001–2002 were calculated using the new definition (see ACSC 2006 revision) to enable comparisons over time.

§§§ Beginning with 2006–2007 data, the definition of hysterectomy changed to include both total and subtotal hysterectomies, similar to the reporting prior to 2001–2002 data. Subtotal hysterectomy could not be uniquely identified in the Canadian Classification of Health Interventions (CCI) versions 2001 and 2003; therefore, rates reported for 2001–2002 to 2005–2006 data years included only total hysterectomies.

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