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Research

Regional variation in the use of surgery in Ontario

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Abstract

Background: Regional variation in the use of surgery implies that there is uncertainty regarding appropriate use. The objectives of this study were to identify which surgical procedures are most commonly performed in the province of Ontario and measure the extent of variation in the use of surgical procedures across Ontario counties.

Methods: We used the Canadian Institute for Health Information Discharge Abstract Database, Same Day Surgery Database and National Ambulatory Care Reporting System to retrieve information on all inpatient and day surgery visits in Ontario between Apr. 1, 2002, and Mar. 31, 2011. We identified the 84 most common procedures according to Canadian Classification of Interventions codes. We calculated rates of use for each procedure throughout the 49 Ontario counties and then calculated measures of variation (quartile ratio and systematic component of variation) in use between the counties.

Results: Colonoscopy was the most commonly performed procedure during the study period, with an average adjusted rate of 2012 per 100 000 population. The procedure with the highest measure of variation was iridectomy, with a quartile ratio of 6.7, followed by colposcopy (5.2), cervical biopsy (4.2) and femoral arteriography (4.1). These procedures were less commonly performed. Common procedures such as colonoscopy, cataract extraction and vaginal delivery had lower quartile ratios. Analysis using the systematic component of variation as the measure of variation gave similar results.

Interpretation: Colonoscopy was the most commonly performed procedure in Ontario, and cataract extraction was the most common surgical procedure. Procedures with the highest measures of variation between counties tended to be those that occurred less commonly in Ontario, and common procedures were associated with less regional variation.

There is a long history of examining variations in surgical procedure rates between geographic regions, beginning with research in the 1930s focusing on tonsillectomy.[1] In that novel study, Glover observed that tonsillectomy rates for British schoolchildren varied considerably between the different counties. Unable to fully account for the source of variation on the basis of patient factors, Glover concluded that the variation stemmed from differences in providers' medical opinion. In reality, the reasons for practice variation are complex and interdependent. Nonetheless, regional variation in the use of surgery implies that there is a degree of uncertainty regarding the appropriate use of a procedure. Although differences in disease burden across populations may contribute to small-area variation, they cannot explain most of the observed variation.[2,3] Quality initiatives aimed at improving delivery of appropriate surgery should focus on procedures for which there is variation.

Much of the literature on variation comes from sources outside Canada.[4–6] In the province of Ontario, regional variation in the use of 12 common surgical procedures was reported in a practice atlas published over 2 decades ago.[7] In the interim, there have been large changes in practice, including the widespread adoption of minimally invasive procedures.

When studying surgical procedures, it is important to define exactly what constitutes a "surgical procedure." Clinical problems that once required open operations, such as common bile duct exploration for common bile duct stones, are now managed with minimally invasive or endoscopic procedures, such as endoscopic retrograde cholangiopancreatography. The scope of surgical procedures has exploded, with an increase in the Canadian Classification of Intervention codes from just under 3500 in 2000 to about 18 000 in 2012.[8]

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The objectives of this study were to identify which surgical procedures are most commonly performed in Ontario and measure the extent of variation in the use of procedures across Ontario counties.

Methods

Data sources

We used the Canadian Institute for Health Information Discharge Abstract Database, Same Day Surgery Database and National Ambulatory Care Reporting System to retrieve information on all inpatient and day surgery visits in Ontario. There is excellent agreement between these databases and physician billings. For example, rates of agreement of Ontario Health Insurance Plan physician billing data with hospital data are 94% for hysterectomy and 93% for cholecystectomy.[9] We identified procedures according to Canadian Classification of Interventions codes, including all services that occurred between Apr. 1, 2002, and Mar. 31, 2011; we included elective and emergency procedures. Non-Ontario residents and those without Ontario health card numbers were excluded. The data sets were linked by means of unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences, Toronto.

Surgical procedures

To study variation in common surgical procedures, we first had to create a list of the procedures. Unfortunately, the coding structure used in the Canadian Classification of Interventions does not necessarily correlate with commonly used categories of procedures. Furthermore, what constitutes a "surgical procedure" is not always intuitively clear. For example, there is probably consensus that transurethral resection of the prostate is a surgical procedure, whereas cystoscopy may not be widely considered to be surgery. We (D.R.U. and J.P.) first compiled a list of the Canadian Classification of Interventions codes from all inpatient and ambulatory hospital separations (discharges, transfers and deaths) in Ontario ranked in order by the most commonly occurring codes. We then recategorized the list of procedures into a framework that appropriately clustered related procedures and excluded others that did not constitute isolated interventions for the purpose of quantifying use of procedure-related health care services. For example, we labelled as "colonoscopy" all the following clinical services: "Inspection, large intestine"; "Biopsy, large intestine"; "Excision partial, large intestine, endoscopic per orifice approach"; "Biopsy, rectum"; "Excision partial, rectum, endoscopic per orifice approach"; "Inspection, rectum"; and "Destruction, rectum, endoscopic per orifice approach."

The resulting list included some services that did not involve a surgical incision but are nevertheless invasive, for example, insertion of a ureteric stent and transurethral resection of the prostate. For this study, we also included certain endoscopic procedures, such as colonoscopy and cystoscopy, because these procedures are often used as alternatives to surgical procedures and because we wanted to keep a broad perspective on what constitutes a "procedure." We excluded several invasive procedures performed in the provision of complex hospital-based care, such as insertion of a central venous line or tracheostomy for patients receiving mechanical ventilation in an intensive care unit, or placement of gastrointestinal feeding tubes, because these types of procedures are typically components of complex care plans and were not considered independent surgical procedures for our study. We initially sought to identify the 100 most common procedures; after recategorizing procedures and excluding services not considered surgical procedures, we retained a list of 84 procedures (Appendix 1, available at www.cmajopen.ca/content/3/3/E310/suppl/DC1).

For people who received 2 or more different procedures on the same day, each procedure contributed 1 count to the numerator of the respective rate. However, people who had 2 or more Canadian Classification of Interventions codes that were grouped under an identical procedure on the same day contributed only 1 event to the numerator, as did inpatients who had the same procedure performed on different days during a single admission.

Definition of geographic areas

We chose Ontario counties (Figure 1) to define the geographic regions for analysis of variation. There are 49 counties, ranging in population from about 13 000 to 2 600 000.[10] They serve as a natural division for measuring use of health care services because hospitals tend to service counties. Moreover, we chose this unit for the analysis because it provided a sufficient number of groups for analysis. For example, there are only 14 Local Health Integration Networks in Ontario,[11] a small number of groups from which to draw conclusions about regional variation.

Statistical analysis

Population-based rates were standardized to the 2006 Ontario population, according to age and sex (or age alone in the case of procedures used only among male patients or among female patients). We calculated rates based on the county where the recipient of the procedure resided and not where the procedure was performed.

We calculated 2 separate measures of variation for each surgical procedure. The quartile ratio is a descriptive statistic that compares the rates of use of individual procedures across regions. It is obtained by calculating the ratio of the 75th percentile rate to the 25th percentile rate for a specific procedure. By removing the extreme values from the calculation, the quartile ratio reduces the influence of outliers. Because use of the ratio does not allow determination of whether the variation between regions is statistically significant, we also calculated the systematic component of variation, a statistic that distinguishes variation between regions from variation within regions.[12] By eliminating random variation from the measurement, this statistic allows observation of the true systemic variation. Large values may indicate true differences between regions. However, the systematic component of variation is sensitive to the underlying procedure rate, population size of the regions and variability of population size between regions.

Ethics approval

The study protocol was approved by the research ethics board of Sunnybrook Health Sciences Centre at the University of Toronto.

Results

The average annual number of surgical procedures performed in Ontario during the 9-year study period for each of the 84 included procedures is illustrated in Figure 2. The figure presents absolute numbers of procedures; the average age- and sex-adjusted rates per 100 000 population ranged from 22 for fixation of fracture of tibia and fibula to 2012 for colonoscopy, the most commonly performed procedure (Appendix 2, available at www.cmajopen.ca/content/3/3/E310/suppl/DC1). Cataract extraction, with a rate of 984 per 100 000, was the most common procedure that could be considered "surgery," as opposed to an endoscopic intervention.

The procedure with the highest quartile ratio was iridectomy, with a value of 6.6 (Figure 3). In other words, there was a nearly sevenfold difference between the county at the 25th percentile and the county at the 75th percentile in the iridectomy rate. Other procedures with high quartile ratios included colposcopy (5.2), cervical biopsy (4.2) and femoral arteriography (4.1).

We were interested in learning whether the procedures that were performed most commonly were associated with high levels of regional variation. In Figure 4, the quartile ratio for each procedure is plotted against the annual rate per 100 000 population. Procedures with high quartile ratios, such as iridectomy and colposcopy, tended to be those that were performed less commonly. Common procedures, such as colonoscopy, cataract extraction and vaginal delivery, were associated with lower quartile ratios.

Finally, we calculated the systematic component of variation for each surgical procedure and plotted this value against the annual rate per 100 000 population (Figure 5). As with the quartile ratios, the procedures with the highest systematic component of variation, such as iridectomy and dental procedures (e.g., tooth extraction and tooth restoration) were less commonly performed.

Figure 1: Map of Ontario counties.

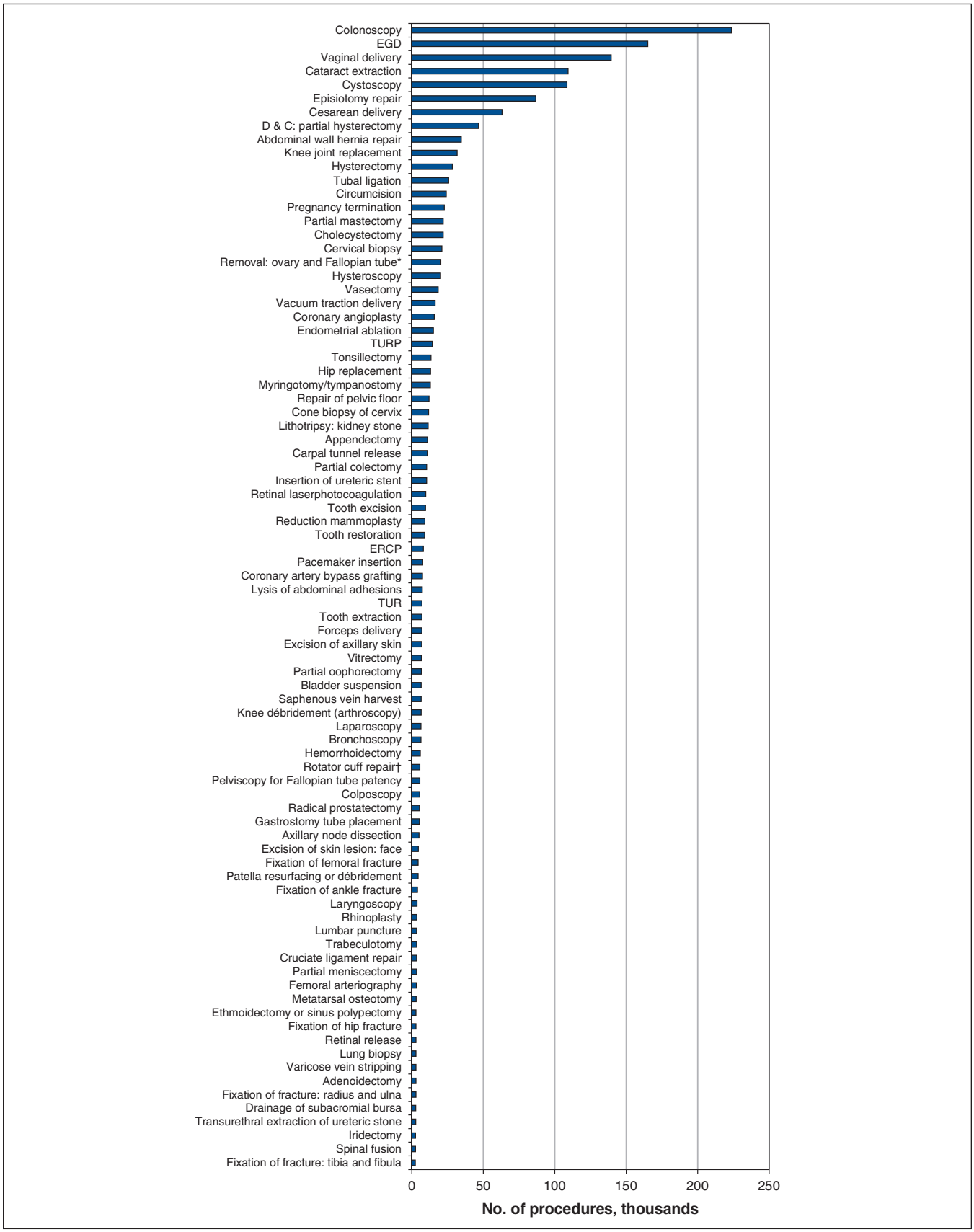

Figure 2: Average annual number of surgical procedures performed in Ontario between Apr. 1, 2002, and Mar. 31, 2011. D & C = dilation and curettage, EGD = esophagogastroduodenoscopy, ERCP = endoscopic retrograde cholangiopancreatography, TUR = transurethral or other partial resection of bladder, TURP = transurethral (partial) resection of the prostate. *With or without hysterectomy. †Acromioclavicular/sternoclavicular joint repair.

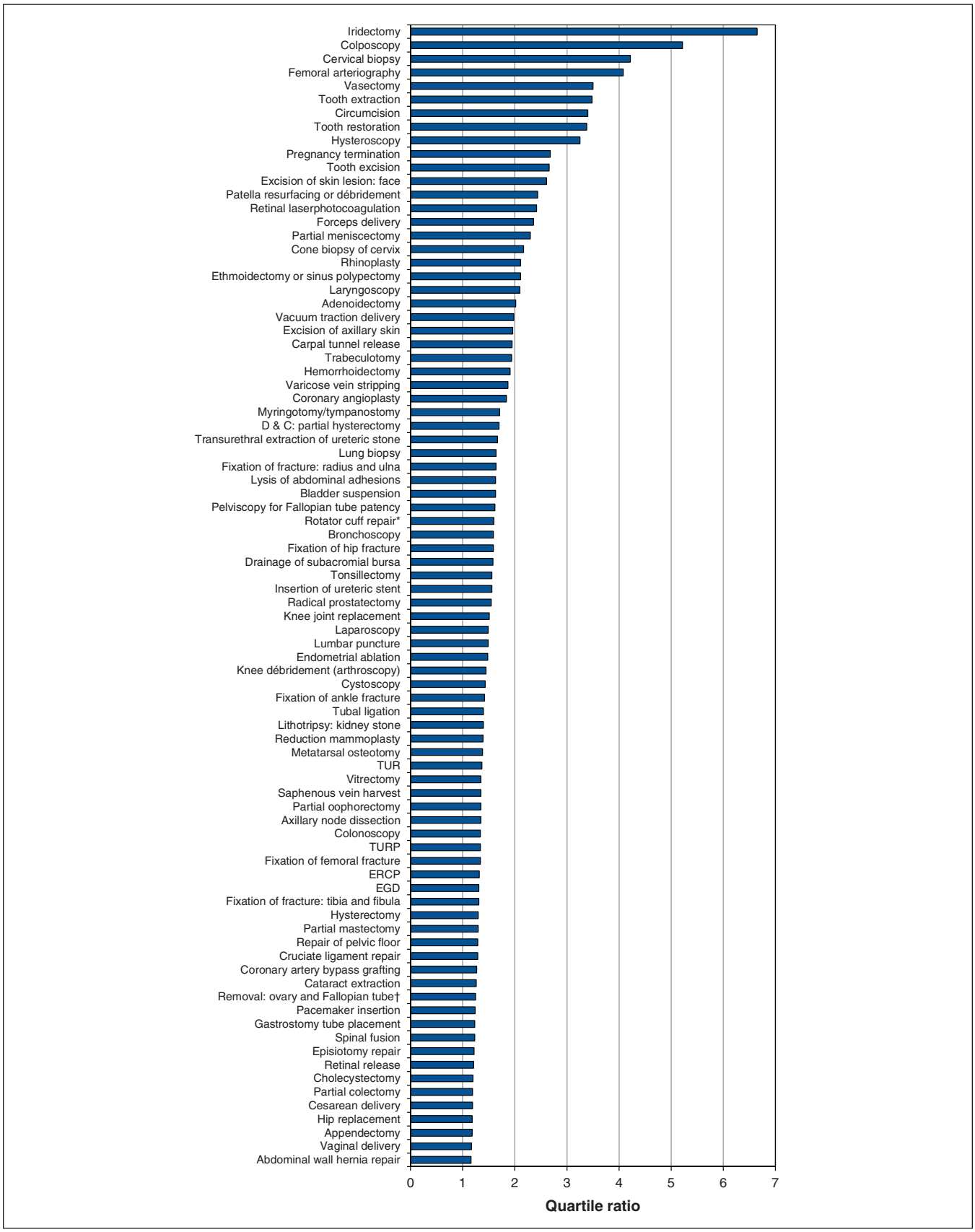

Figure 3: Quartile ratio for each surgical procedure. D & C = dilation and curettage, EGD = esophagogastroduodenoscopy, ERCP = endoscopic retrograde cholangiopancreatography, TUR = transurethral or other partial resection of bladder, TURP = transurethral (partial) resection of the prostate. *Acromioclavicular/sternoclavicular joint repair. †With or without hysterectomy.

Interpretation

Over the 9-year study period, colonoscopy was the most commonly performed procedure in Ontario, and cataract extraction was the most common surgical procedure. Procedures with the highest measures of variation between counties tended to be those that occurred less commonly in Ontario, such as iridectomy, colposcopy, capsulotomy and dental procedures. Common procedures, such as colonoscopy and vaginal delivery, were associated with less area variation. Overall, it appears that the use of surgery in Ontario is more uniform for common conditions than for uncommon ones.

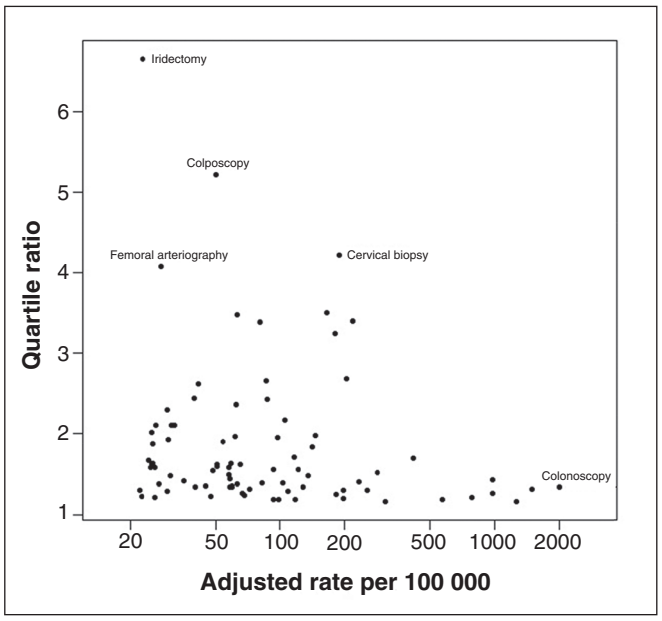

Figure 4: Quartile ratio by adjusted annual rate per 100 000 population for the 84 surgical procedures studied.

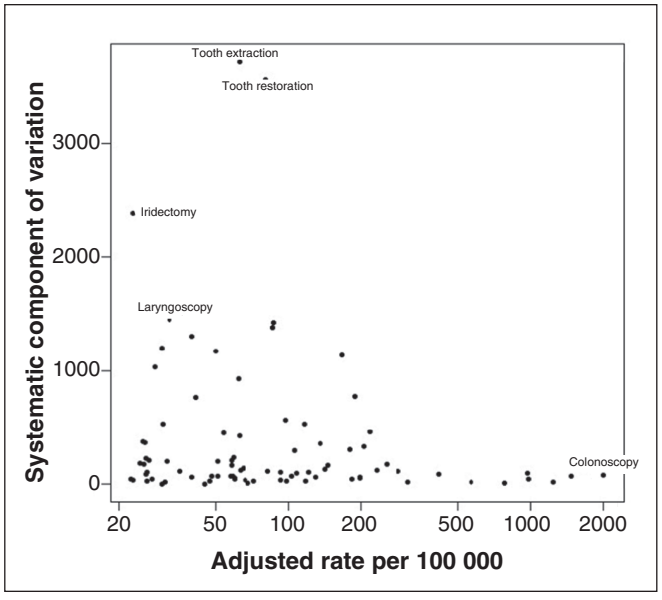

Figure 5: Systematic component of variation by adjusted annual rate per 100 000 population for the 84 surgical procedures studied.

Variations in the rate of surgical procedures across geographic areas may indicate over- or underuse of surgery.[13] Evidence of regional variation in the use of surgery implies that somewhere there may be inappropriate use of the procedure. Variations are considered unwarranted when they cannot be explained by patient need or medical evidence.[14] Given that differences in disease burden cannot explain most of the variation that we observed across different counties, variations may exist owing to physician factors or resource availability. For example, the quartile ratio for the incidence of prostate cancer across Ontario health regions is 1.1,[15] whereas the quartile ratio for prostatectomy in our study was 1.6. Similarly, the quartile ratio for the incidence of breast cancer across health regions is 1.1,[16] smaller than the ratio of 1.3 that we observed for partial mastectomy.

Wennberg and colleagues[17] proposed that the source of such variations can be divided into 3 categories: effective care, preference-sensitive care and supply-sensitive care. Effective care refers to interventions that are strongly supported by scientific evidence, such as colonoscopic screening for colon cancer.[18] Preference-sensitive care refers to treatment of conditions for which there are at least 2 valid therapeutic alternatives. Although the patient should choose the intervention in preference-sensitive care, the decisions are highly influenced by care providers' opinions. Lastly, supply-sensitive care refers to interventions that are limited only by the availability of resources. For example, the number of patients in a critical care unit typically increases as the number of available beds increases. Approaches to reducing variation in the use of surgical procedures should aim to classify the procedures within the framework of effective care, preference-sensitive care and supply-sensitive care. Variations associated with procedures that provide effective care could represent underuse; addressing this situation could involve increasing surgical capacity.[19] For variations that result from preference-sensitive or supply-sensitive care, expert panels could examine the interventions on a case-by-case basis, and practice guidelines and consensus statements could then be created to realize more uniform practice. Primary care physicians are also essential targets for reducing variation, because they most often refer the patient and do not receive financial reward for the procedures.[20] These initiatives could help direct efficient use of resources related to the procedures identified in this study.

Limitations

This study has several limitations. First, we included only procedures that were provided in a hospital or ambulatory clinic setting. It is likely that the use of procedures that can be provided in physicians' offices or private clinics, such as dental procedures, was underestimated. However, presumably their use would have been underestimated in all counties, and therefore underestimation does not likely account for the degree of variation that we observed. Second, we assigned procedures to regions using the patient's address rather than the location where the services were performed. Owing to centralization of care, there are certain specialized procedures that are performed primarily in tertiary referral centres. Analyzing the rate of use of procedures based on a patient's address and not the address where the service was rendered provides a more representative description of the approach

to the use of services by clinical care providers in a given county. This has been the approach used in other studies of this type.[21–26] Third, if a patient resided in a county with a service arrangement with another province to deliver care — such as a resident of northwestern Ontario who receives hospital care in Manitoba — procedure rates in the county of residence would be underestimated. Finally, when multiple procedures were done for the same patient on the same day, each procedure was counted separately. We found that some of the Canadian Classification of Interventions codes described components of procedures rather than individual interventions. For example, lysis of abdominal adhesions is often performed as part of other operations such as hernia repair but would rarely be done as an isolated intervention. It is difficult to determine the significance of variation for a procedure that is part of a larger operation. However, the coding of procedure components versus individual interventions may reflect differences in coding by physicians; this would be an interesting issue for future study.

Conclusion

Colonoscopy was the most commonly performed procedure in Ontario, and cataract extraction was the most common "surgical" procedure. Procedures with the highest measures of variation between counties (e.g., iridectomy, colposcopy, cervical biopsy and femoral arteriography) tended to be those that occurred less commonly in Ontario, and common procedures (e.g., colonoscopy, cataract extraction and vaginal delivery) were associated with less regional variation. Future research is required to determine the exact source of the high rates of variation. Further study could help elucidate whether there is inappropriate use of resources and could improve decision-making regarding use of surgical procedures.

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