Geographic variation of the provider of screening colonoscopy care in Canada: Rural surgeons and urban gastroenterologists?

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Background: Screening colonoscopies for detection of colorectal carcinoma (CRC) may be provided by several specialties. Few studies have assessed geographic variations in delivery of this care. Our objective was to investigate how geographic and socioeconomic factors impact the provider of colonoscopic care.

Methods: This was a population-based cohort of all screening colonoscopies performed at Canadian publicly funded health facilities between April 2008 and March 2015. The main outcome of interest was the proportion of colonoscopies performed by surgeons at the neighbourhood level. Predictors of interest included socioeconomic and geographic variables. Spatial analysis was used to analyze significant clustering of practitioner services. Multinomial logistic regression was used to model predictors.

Interpretation: From 2008-2015, we identified 658,113 screening colonoscopies by 1,886 providers, of which 53.7% were performed by surgeons. Of all neighbourhoods, 24.2% were located within clusters predominantly served by gastroenterologists and 19.5% were within surgeon clusters. Rural neighborhoods had significantly increased relative risk of being within a surgeon cluster (RRR 5.38; 95%CI 3.38-8.01 p<0.001) compared to mixed clusters and nearly 100 times higher relative risk than gastroenterology clusters (RRR 98.95; 95%CI 15.3-427.2 p<0.001). Compared to mixed clusters, highest socioeconomic status neighbourhoods were 1.74 times likelier to be in gastroenterologist clusters (95%CI 1.14-2.56 p=0.005). Surgeons provide a large proportion of colonoscopies and are essential for access to care, particularly in rural regions. Though absolute numbers may vary, similar patterns may exist in other countries due to the nature of the specialty.

INTRODUCTION

Colorectal cancer is the third most commonly diagnosed and fourth most common cause of cancer-related death in men and women worldwide, respectively.[1] In 2012, 1.4 million people were diagnosed with colorectal cancer and it was estimated that 700,000 of these individuals will die from the disease.[1] High disease incidence and mortality have led to the development of multiple screening modalities, many of which detect and remove colonic polyps that are precursors to many colorectal cancers.[2] Of these, colonoscopy is most sensitive test for detection of colorectal cancer and adenomas.[3] As a common primary screening test, colonoscopy has been shown to decrease the mortality and incidence of colorectal cancer[4,5], and was suggested to be a more effective screening tool compared to both guaiac-based fecal occult blood testing and flexible sigmoidoscopy by recent meta-analysis.[6]

Conflicting literature has emerged as to whether endoscopist specialty affects patient outcomes. Some studies have found that patients who underwent colonoscopy performed by a gastroenterologist were significantly more likely to have polyps detected[7–9]and removed[10], had lower rates of bowel perforation[11], and were less likely to later develop colorectal cancer[12], compared to those treated by general surgeons or other specialties. It is suggested that this may reflect the extensive formal training gastroenterologists undergo as part of their core training requirements.[12] However, others have found there to be no significant difference in polyp detection[13] or complication rates[14] between gastroenterologists and surgeons, with at least one study finding that gastroenterologists to have significantly higher total complication rates than surgeons.[13] Despite these findings, little is known as to whether the populations these specialties serve are the same and how important each is to the delivery of colonoscopy care, as provider delivery in urban and rural areas was found to vary.[15] Residents of rural areas have also been

shown to have lower screening rates than those in urban areas[16–18] and had a higher proportion of their colonoscopies done by general surgeons.[15] In addition, the nature of each profession differs and allows for varied roles in the delivery of endoscopy. Gastroenterologists can be more focused and have a high volume endoscopy practice but their specialty may not be as suitable to rural areas.

Few studies have investigated geographic variations in the delivery of colonoscopy care and what factors affect that variation. This information is vital to understanding and planning the delivery of colonoscopic care as well as contextualizing differences in outcomes. As such, the purpose of this study was to investigate variations in the delivery of screening colonoscopies by specialty across Canada.

MATERIALS & METHODS

Study Design and Setting

This was a national retrospective cohort study of all adult (age ≥18) patients undergoing screening colonoscopy in a publicly funded facility between April 2008 and March 2015 in Canada (excluding the province of Quebec). Screening colonoscopy guidelines are relatively similar across Canada.[3]

Data Sources and Definitions

Patient procedure, provider, distance and neighbourhood data were derived from the Canadian Institute for Health Information Discharge Abstract Database. Quebec was excluded as its data are not accessible directly from the Canadian Institute for Health Information, but only

through the Quebec Ministry of Health and Social Services. Screening colonoscopy was identified by a colonoscopy procedure clarified by a screening diagnosis code. Neighbourhoods were defined as forward sortation areas, which are denoted by the first three digits of the postal code and are a unit of area used by the Canadian postal system. There are approximately 1,200 forward sortation areas in Canada (excluding Quebec). Forward sortation area geographic data were derived from the 2013 Canadian census files.[19]Neighbourhood income data werederived from Statistics Canada and rurality was defined through the postal code.[20,21]The median individual income for each neighbourhood was the specific income measure used and was derived from Statistics Canada.[21]

Outcome measures and regression variables

The main outcome of interest in this study was the neighborhood ratio of screening colonoscopies done by surgeons versus gastroenterologists/internists. Colonoscopies done by other providers accounted for less than 2% of all colonoscopies and were excluded. The main geographic and socioeconomic factors of interest were distance to the colonoscopy facility, neighbourhood rurality and neighbourhood socioeconomic status

Statistical Analysis

The main outcome was calculated as the percent of total colonoscopies within a neighborhood that were done by surgeons. To determine the spatial relationship between neighborhoods and specialty, a geographic cluster analysis was undertaken using the Getis-Ord-Gi* statistic. This statistic determines whether the neighbourhood and all of its adjacent neighbors is significantly different from the overall mean. For this analysis, neighbourhood

connectivity was defined as having an adjacent border. Neighbourhood clusters were then classified as a surgeon cluster, a gastroenterologist cluster high use or a mixed cluster. Spatial analyses were carried out using the ArcGIS Desktop suite (Environmental Systems Research Institute ArcMap10.1, Redlands, CA). Univariable comparisons of geographic and socioeconomic factors across surgical rate groups and clusters were compared using ANOVA or chi-square where appropriate. To determine the effect of the neighbourhood and socioeconomic factors on neighbourhood cluster status, a multilevel multinomial logistic regression was used with the geographic and socioeconomic factors as fixed effects and the provinces as random effects. Importantly, this methodology allows for an unbiased evaluation of the effects by accounting for the utilization differences between provinces. Results were presented as surgeon and gastroenterologist neighborhoods compared to mixed neighborhoods, respectively, as well as surgeon neighborhoods compared directly to gastroenterologist neighborhoods. Due to the use of multinomial regression, relative risk ratios (RRRs) with 95% confidence intervals (CI) were reported. Statistical significance was set at $p<0.05$. Stata software (StataCorp. 2013. *Stata Statistical Software: Release 12.1*. College Station, TX: StataCorp LP) and MLwiN (Version 2.26; Centre for Multilevel Modeling, University of Bristol) were was used for data analysis.

RESULTS

Table 1 presents the associations between and the covariates of interest. Overall, 658,113 were performed over the time period with 53.7% being performed by surgeons (n=353,165). In relation to geographic variables, surgeons performed 100,195 colonoscopies in rural areas comprising 28.4% of their total colonoscopies compared to 37,893 (12.4%) for gastroenterologists. More than 32.9% of colonoscopies done by gastroenterologists were done in

neighborhoods with a higher socioeconomic status compared to 17.7% for surgeons. People undergoing colonoscopy by surgeons travelled further compared to those treated by gastroenterologists (27.0 vs 21.3km).

Figure 1 and Table 2 present the results of the cluster analysis.There were 1,114 neighborhoods analyzed in the cluster analysis found that 270 were within a cluster that had significantly higher rates of gastroenterologist care, while 217 were within a surgeon cluster. In gastroenterology clusters, surgeons performed 22.7% of colonoscopies, whereas in mixed clusters and surgeon clusters that performed 53.5% and 83.0% respectively. Of the gastroenterology clusters, only 2 (0.7%) of the gastroenterologist cluster neighborhoods where rural areas compared to 75 (34.6%) for surgeon cluster neighborhoods. Additionally, 63.0% of gastroenterologist neighborhoods were in the two highest categories as economic status neighborhoods compared to 31.8% for surgeons. Surgeon cluster neighborhoods were also nearly 42 km further from the hospital that provided colonoscopy care compared to gastroenterologist clusters (59.4 vs 17.7km).When considering Figure 1, the red areas are surgeon clusters while blue are gastroenterologist clusters. This clearly shows the role predominance of the surgeon clusters, while major urban areas tend to be served by gastroenterologists with suburban areas as well a smaller cities generally of mixed delivery between surgeons and gastroenterologists.

Table 3 presents the results of the multinomial analysis, which looked at the differences between the surgeon and gastroenterologist predominant neighborhoods compared to the mixed neighborhoods. Compared to a mixed cluster, the relative risk of having a rural neighbourhood be within a gastroenterologist clusterwas 0.12 times lower (95%CI 0.01-0.35 $p<0.001$) while the relative risk of a rural neighborhood being in a surgeon cluster was 5.38 times higher (95%CI 3.48-8.01 $p<0.001$).Furthermore, the relative risk of the highest economic status neighborhood

being within a gastroenterology cluster was 1.74 times higher (95%CI 1.14-2.56 p=0.005) while the relative risk of a surgeon cluster being of the highest socioeconomic status was 0.60 times lower (95%CI 0.33-1.00 p=0.026). Distance was only significant for gastroenterology clustering as for every 50 km, the relative risk of being a gastroenterology cluster compared to mixed cluster was 0.76 times lower (95%CI 0.58-0.93 p=0.001).

Table 4 presents the comparison of surgeon clusters directly to gastroenterology clusters. Compared to gastroenterology clusters, rural neighborhood were 98.95 higher (95%CI 15.3-427.2 p<0.001) as likely to be in a surgeon cluster. In addition, neighborhoods in the highest as economic status had relative risk of being in a surgeon cluster that were 0.35 times lower than being in a gastroenterology cluster. Lastly, for each 50 km further from the hospital a neighborhood was, it was was 1.37 times likelier to be in a surgeon cluster than a gastroenterology cluster (95%CI 1.10-1.77 p<0.001).

INTERPRETATION

This study identified significant patterns in the geographic variation of the delivery of screening colonoscopy care in Canada that were consistent across provinces. Overall, there was a clear rural/urban divide between surgeon delivered care and gastroenterologist delivered care. Surgeons performed 53.7% of all screening colonoscopies and more than 73% of screening colonoscopies in rural areas. Accordingly, rural neighborhoods were nearly 100 more times likely to be in a surgeon cluster than a gastroenterology cluster (RRR 98.95 95%CI 15.3-427.2 p<0.001) and more than five times as likely to be in a surgeon cluster than a mixed cluster (RRR 5.38 95%CI 3.48-8.01 p<0.001). In non-rural areas, surgeons provided 48.7 % of the overall screening colonoscopy care, though this was spread around suburban areas and smaller cities

while gastroenterologists clustered within major cities such as Toronto, Vancouver, Edmonton, Calgary and Ottawa. This division of the delivery of care additionally manifested itself in the fact that gastroenterologists tended to treat patients of the highest economic status, as well as those with shorter distances to the public health care facility.

Our findings related to the distribution of colonoscopy care in Canada are consistent with the finding of Baxter et al that surgeons performed 53% of colonoscopies in Ontario[22]; Schultz et al also found gastroenterologists and surgeons to perform almost the same total number of procedures, although gastroenterologists tended to perform more procedures per physician.[23] Variations in provider distribution between urban and rural areas have also been identified in the literature. Hilsden et al. identified gastroenterologists to primarily provide colonoscopies in large urban areas, whereas surgeons tended to dominate provision of care in smaller urban and rural areas in Canada.[15] This study could only look at total numbers and not determine whether significant clustering exists. This is consistent with our finding that rural neighborhoods had significantly increased odds of being predominantly served by surgeons compared to mixed neighborhoods. However, a recent systematic review by Evans et al identified a notable lack of studies assessing who provides colonoscopy care in rural areas.[16] Lower colorectal cancer screening rates in rural areas[17,18]suggest a need for increased provision of colonoscopy care in these regions. Currently, there is evidence that colonoscopies performed by surgeons have similar morbidity and mortality rates to those performed by gastroenterologists.[14,24,25] In a study of Ontario residents, Rabeneck et al found that patients who underwent colonoscopy by a non-gastroenterologist were at significantly increased risk of developing colorectal cancer later.[12] Ko et al also found that gastroenterologists were significantly more likely to detect and remove polyps during outpatient colonoscopy compared to other specialties, including general surgery

and colorectal surgery.[7] However, Kozbial et al found no significant differences in polyp detection rate or carcinoma detection rate between general surgeons and internists.[13] Schultz et al found that gastroenterologists across Canada tended to have higher procedure volume,[23] which was found to be associated with significant improvement in completion rate.[24] However, other studies did not find a significant association between endoscopist volume and patient important outcomes such as later development of colorectal cancer.[22]

The findings of this paper have several important applications to healthcare delivery. Previous work has demonstrated that endoscopy comprises are larger percentage of a surgeon's practice in rural areas within the United States and surgeons may play a more important role in these areas for the provision of endoscopic care.[26] This may be due to their respective spectrums of care as surgeons and gastroenterologists fill distinct but important roles in healthcare system. These roles seem quite complementary as they allow each to provide colonoscopy care in areas where the other would not be able. Specifically, in lower density rural areas, where the density may not allow for many gastroenterologists to have a steady practice, surgeons fill the gaps in care due to their ubiquity and ability to supplement their endoscopy practice with a surgical practice. Meanwhile in high density urban areas, gastroenterologists can fill gaps in coverage where surgeons would likely not be able to meet demand. Recognizing this phenomenom may be a key for health systems in the effort to ensure access to colonoscopy for all patients and ensure that inappropriate screening is kept to a minimum due to an efficient delivery of care.[27,28] This division of care also helps to contextualize findings related to volume and outcomes, as it may not be possible for all surgeons to have high-volume endoscopy practices. Therefore, in effort to provide access to colonoscopy care, it may be necessary to recognize this fact when creating national credentialing guidelines with regards to yearly endoscopy volumes. Guidelines based on

the practice of high-volume urban practitioners may have the effect of limiting access to colonoscopy care for residents and not giving these residents an equitable choice in their colonoscopy screening modality. Lastly, when pursuing research in colonoscopy screening outcomes, it may not be relevant to include all practitioners within the same analysis as lower volume practitioners, serving mainly rural or low income patients, may not have outcomes that are generalizable to high-volume urban endoscopists. Therefore, this study is instrumental in better contextualizing these analyses to ensure generalizable results.

This study has several limitations. It only covered colonoscopies that were done in publicly funded health facilities, and therefore did not include private endoscopy centers. Considering that most private endoscopy centers would be in urban centers and run by gastroenterologists, it is unlikely that they would change the overall message of this study, but rather would likely increase the disparity already found. The study also did not cover all colonoscopy care, but rather just focused on screening. Therefore, our findings may not be generalizable to all colonoscopy care. However, the purpose of including only screening colonoscopies was to encompass an overlapping area and indication for both specialties as many other indications for colonoscopy would not overlap. Accordingly, we do feel that the findings of this study are relatively generalizable to all colonoscopy care.

This study focused on screening colonoscopy care and clearly demonstrated the division in delivery of screening colonoscopy care between rural and urban areas. In rural areas, surgeons were the predominant specialty providing colonoscopy care whereas gastroenterologists provided much of the care in high density urban areas. This clearly underscores the importance of both specialties in achieving ubiquitous access to colonoscopy care and help to contextualize future research on specialty specific outcomes.

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Figure Legends

Figure 1: Geographic Clustering of Screening Colonoscopy in Canada

Table 1: Associations between colonoscopy provider and regression covariates

	Gastroenterology	Surgeon	*P* value
Number of providers	717	1,169	
Average annual volume	79.4 (±99.8)	54.5 (±77.9)	
Number of colonoscopies	304,948 (46.3)	353,165 (53.7)	
Rural	37,893 (12.4)	100,195 (28.4)	<0.001
Socioeconomic quartile			
1	50,010 (16.4)	64,145 (18.2)	<0.001
2	73,181 (24.0)	129,133 (36.6)	
3	81,330 (26.7)	97,383 (27.6)	
4	100,427 (32.93)	62,504 (17.7)	
Distance to hospital (in km)	21.3 (±52.6)	27.0 (±65.5)	

* Values represent n, (%) unless otherwise specified

Table 2: Hotspots by neighbourhood

	Gastroenterology	Mixed	Surgeon	Total	*P* value
Number of neighbourhoods	270	627	217	1,114	
Number of colonoscopies	148,253	350,970	158,890	658,113	
Number surgeon performed	33,643 (22.7)	187,604 (53.5)	131,918 (83.0)	353,165 (53.7)	<0.001
Rural	2 (0.7)	52 (8.3)	75 (34.6)	129 (11.6)	<0.001
Socioeconomic quartile					
1	58 (21.5)	153 (24.4)	64 (24.5)	275 (24.7)	<0.001
2	42 (15.6)	153 (24.4)	84 (38.7)	279 (25.0)	
3	61 (22.6)	175 (27.9)	45 (20.7)	281 (25.2)	
4	109 (40.4)	146 (23.3)	24 (11.1)	279 (25.0)	
Mean distance (±SD in km)	17.74 (±38.2)	36.75 (±122.5)	59.44 (±152.0)	36.56 (±116.0)	<0.001

SD, standard deviation; km, kilometre;

* Values represent n, (%) unless otherwise specified

Table 3: Comparison of specialist clusters vs. mixed

	RRR (95% CI)	*P* value
Gastroenterology clusters vs. mixed		
Rural	0.12 (0.01-0.35)	<0.001
Socioeconomic quartile		
1	Reference	
2	0.68 (0.42-1.05)	0.040
3	0.85 (0.55-1.28)	0.197
4	1.74 (1.14-2.56)	0.005
Distance per 50 km	0.76 (0.58-0.93)	0.001
Surgical clusters vs. mixed		
Rural	5.38 (3.48-8.01)	<0.001
Socioeconomic quartile		
1	Reference	
2	1.57 (1.00-2.38)	0.025
3	0.78 (0.47-1.21)	0.120
4	0.60 (0.33-1.00)	0.026
Distance per 50 km	1.02 (0.96-1.08)	0.236

RRR, relative risk ratio; CI, confidence interval; km, kilometer;

Table 4: Comparison of Surgical vs. Gastroenterology Clusters

	RRR (95% CI)	*P* value
Surgical vs. gastroenterology clusters		
Rural	98.95 (15.3-427.2)	<0.001
Socioeconomic quartile		
1	Reference	
2	2.39 (1.32-3.99)	0.001
3	0.94 (0.51-1.57)	0.360
4	0.35 (0.18-0.61)	<0.001
Distance per 50km	1.37 (1.10-1.77)	<0.001

RRR, relative risk ratio; CI, confidence interval; km, kilometer;

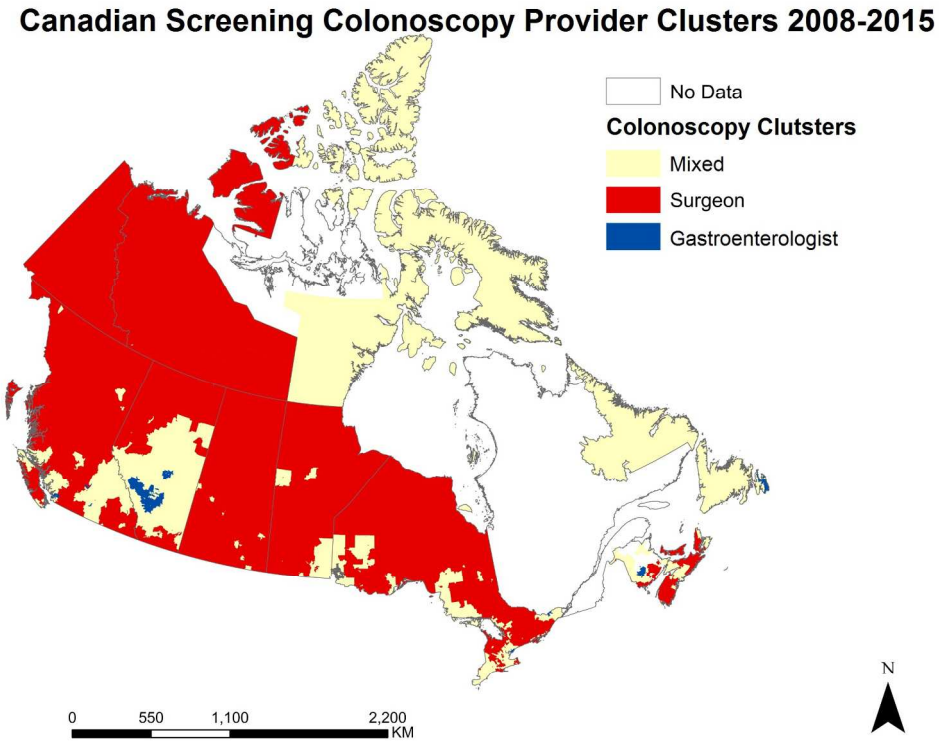

Figure 1: Geographic Clustering of Screening Colonoscopy in Canada

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