

Original Article

## Variation in care of patients with elderly-onset inflammatory bowel disease in Ontario, Canada: A population-based cohort study

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### Abstract

**Background:** Variation in health care, when not based on patient preference, may result in poorer care. We determined whether variation in health services utilization, gastroenterologist care and outcomes existed among patients with elderly-onset inflammatory bowel disease (IBD).

**Methods:** Patients with IBD (diagnosed  $\geq 65$  years) were identified from population-based health administrative data from Ontario, Canada (1999 to 2014). We assessed variation across multispecialty physician networks in gastroenterologist care and outcomes using multilevel logistic regression. Median odds ratios (MOR) described variation. We evaluated the association between gastroenterologist supply, specialist care and outcomes.

**Results:** In 4806 patients, there was significant variation in having ever seen a gastroenterologist (MOR 3.35,  $P < 0.0001$ ), having a gastroenterologist as the primary IBD care provider (MOR 4.16,  $P < 0.0001$ ), 5-year colectomy risk in ulcerative colitis (MOR 1.38,  $P = 0.01$ ), immunomodulator use (MOR 1.47,  $P = 0.001$ ), and corticosteroid use (MOR 1.26,  $P = 0.006$ ). No variation in emergency department visits, hospitalizations or intestinal resection (Crohn's) was noted. Patients in networks with fewer gastroenterologists were less likely to see a gastroenterologist (odds ratio [OR] 0.29, 95% confidence interval [CI] 0.15 to 0.56), have a gastroenterologist as their primary care provider (OR 0.27, 95% CI 0.12 to 0.59), be hospitalized within 5 years (OR 0.82, 95% CI 0.69 to 0.98), and be prescribed biologics within 1 year (OR 0.50, 95% CI 0.28 to 0.89).

**Conclusions:** Utilization of gastroenterology care in patients with elderly-onset IBD varies greatly. Patients treated by gastroenterologists and in networks with more gastroenterologists have better outcomes. There is a need to ensure all individuals with IBD have equal access to and utilization of specialist care to ensure the best possible outcomes.

**Keywords:** *Elderly; Health services utilization; Inflammatory bowel disease; Specialist care; Variation in care*

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## Background

Elderly people  $\geq 65$  years represent the fastest growing group living with inflammatory bowel disease (IBD). Prevalence among Ontario seniors increased by 5.2% per year between 1999 and 2008 (1) and is expected to reach 1370 per 100,000 by 2030 (2). Elderly-onset IBD presents a challenge due to age-related comorbidities (e.g., diabetes, cardiovascular disease) (3,4), increased risk of malignant and infectious complications (5–7), and postoperative complications and mortality following surgery (8,9).

Despite a universal health care system in Ontario, Canada, disparities in access to gastroenterologist care exists for patients with IBD (10). Rural dwelling IBD patients, especially elderly people, are less likely to be cared for by gastroenterologists (11)—which is known to lower surgery rates (10,12), in-hospital mortality (13) and emergency department (ED) utilization (14). Variation in IBD-related outcomes have also been observed across tertiary-care centers (14,15). While some variation is ubiquitous in health care, it may act as a marker of quality of care when not based on disease characteristics or patient preference (16–18). Therefore, the identification of variation in care is the first step toward a structured, large-scale quality improvement program.

In this population-based study, we determined whether variation in care exists among patients with elderly-onset IBD, and whether variation in access to specialist care was associated with worse outcomes. We also evaluated the impact of being treated by a gastroenterologist and gastroenterologist supply on these outcomes.

## MATERIALS AND METHODS

### Study Design and Data Sources

This study was approved by the Research Ethics Board at the Children's Hospital of Eastern Ontario. We conducted a retrospective cohort study including all patients newly diagnosed with IBD at  $\geq 65$  years between April 1, 1999 and March 31, 2014 using health administrative data in Ontario, Canada. These data include all legal residents of Ontario eligible for universal health care ( $>99\%$  of the population). Data are collected on all outpatient physician contacts (Ontario Health Insurance Plan [OHIP] physician claims), hospitalizations (Canadian Institute for Health Information (CIHI) Discharge Abstract Database), and ED visits (CIHI National Ambulatory Care Reporting System). The Registered Persons Database was used to confirm OHIP eligibility. The ICES Physician Database was used to obtain certification and billing practice information to classify specialty of physician care providers. The Ontario Drug Benefit database includes all information on prescriptions filled for

patients  $\geq 65$  years, including the type of medication, dose and number of days supplied. A unique encrypted identifier derived from Ontario health card number was used to deterministically link patient records across databases. Participants were followed for 5 years, until death, or migration out of Ontario. All databases were maintained by ICES according to an agreement with the Ontario Ministry of Health and Long-Term Care. Full uncleaned databases were available to researchers (19).

Cases of IBD were identified with the Ontario Crohn's and Colitis Cohort using a previously validated algorithm based on International Classification of Diseases (ICD)-9 and ICD-10 codes for Crohn's disease (CD) and ulcerative colitis (UC; ICD-9: 555, 556; ICD-10: K50, K51). The algorithm required  $\geq 5$  physician contacts or hospitalizations for IBD and  $\geq 1$  prescription for an IBD medication within 4 years (sensitivity 78.3%, specificity 98.2%; positive predictive value: 71.1%; negative predictive value: 98.3%) (20). Incident cases were eligible for OHIP for  $\geq 8$  years prior to their first IBD diagnostic code (95.7% accuracy for distinguishing incident from prevalent cases) (20). Type of IBD was based on the most recent five of nine outpatient diagnostic codes for IBD (91.1% accuracy); patients had IBD type unclassifiable (IBDU) if they could not be identified as CD or UC. The first health care encounter with a code for CD or UC was the date of IBD diagnosis.

### Outcomes

We included the following outcomes (Table 1): (i) Utilization of specialist gastroenterology care; (ii) IBD-related hospitalization within the month before or after IBD diagnosis; (iii) IBD-related ED visit within the month before or after IBD diagnosis; (iv) IBD-specific hospitalization within 1 and 5 years of IBD diagnosis; (v) IBD-specific ED visit within 1 and 5 years of IBD diagnosis; (vi) intestinal resection (CD) or colectomy (UC); (vii) utilization of an immunomodulator, biologic or systemic corticosteroids within 1 and 5 years of IBD diagnosis; and (viii) chronic opioid use within 1 and 5 years of IBD diagnosis.

### Multispecialty Physician Networks

Multispecialty physician networks are informal networks derived from Ontario health administrative data based on clusters of care, designed to evaluate quality and cost of health care (21). Specialists were assigned to the hospital at which they provided the majority of their inpatient care. Specialists without inpatient service and primary care physicians were assigned to the hospital where the majority of their ambulatory patients were admitted. Small clusters in close proximity were combined into a single network, with at least one medium or large hospital per

**Table 1.** Definitions of outcomes (utilization of specialist gastroenterology care, health services utilization, surgery and medication utilization) and selected covariates

	<b>Outcome</b>	<b>Definition</b>
Utilization of specialist gastroenterology care	<ol style="list-style-type: none"> <li>1. Having ever seen a gastroenterologist within 1 year of IBD diagnosis</li> <li>2. Having a gastroenterologist as the primary provider of IBD-specific care (i.e., the majority of IBD-specific outpatient visits were to a gastroenterologist).</li> </ol>	<p><b>Gastroenterologist:</b> Board-certified gastroenterologist or general internists who performed more than 50 endoscopies per year (11,30,31). Physicians without sufficient endoscopy codes in a single year but had sufficient endoscopy codes either in the year prior or the year after were also considered gastroenterologists.</p> <p><b>IBD-specific outpatient visits:</b> Outpatient visits with an OHIP code for either CD (555) or UC (556)</p>
Health services utilization	<ol style="list-style-type: none"> <li>1. IBD-related hospitalization in the month before or after IBD diagnosis</li> <li>2. IBD-related ED visit in the month before or after IBD diagnosis</li> <li>3. IBD-specific hospitalization within 1 and 5 years of IBD diagnosis (excluding the first month following IBD diagnosis)</li> <li>4. IBD-specific ED visit within 1 and 5 years of IBD diagnosis (excluding the first month following IBD diagnosis)</li> </ol>	<p><b>IBD-specific ED visit or hospitalization:</b> ED visit or hospitalization with a most responsible diagnosis of CD (ICD-9: 555; ICD-10: K50) or UC (ICD-9: 556; ICD-10: K51)</p> <p><b>IBD-related ED visit or hospitalization:</b> IBD-specific hospitalization or ED visit; hospitalization or ED visit with a most responsible diagnosis of any sign, symptom or extra-intestinal manifestation of IBD (Supplementary Table S1)</p>
Surgery	<ol style="list-style-type: none"> <li>1. Intestinal resection within 1 and 5 years of IBD diagnosis (CD only)</li> <li>2. Colectomy within 1 and 5 years of IBD diagnosis (UC only)</li> </ol>	See Supplementary Table S2 for a previously validated list of procedure codes (28,32)
Utilization of IBD medications	<ol style="list-style-type: none"> <li>1. ≥1 prescription for an immunomodulator within 1 and 5 years of IBD diagnosis</li> <li>2. ≥1 prescription for a biologic within 1 and 5 years of IBD diagnosis</li> <li>3. ≥1 prescription for systemic corticosteroids within 1 and 5 years of IBD diagnosis</li> </ol>	<p><b>Immunomodulator:</b> Azathioprine, 6-mercaptopurine, methotrexate, cyclosporin or tacrolimus</p> <p><b>Biologic:</b> Infliximab, adalimumab, certolizumab, golimumab, ustekinumab, vedolizumab or natalizumab</p> <p>See Supplementary Table S3 for a list of DINs associated with immunomodulators, biologics and systemic corticosteroids</p>
Opioid use	<ol style="list-style-type: none"> <li>1. Chronic opioid use within 1 and 5 years of IBD diagnosis</li> </ol>	≥1 opioid prescription at least 91 days after the first opioid prescription, with no interval ≥120 days between successive opioid prescriptions (33)
	<b>Covariate</b>	<b>Definition</b>
Comorbidities	<ol style="list-style-type: none"> <li>1. Tertile of comorbidity score</li> </ol>	Johns Hopkins ACG System Version 10
Time to IBD Diagnosis	<ol style="list-style-type: none"> <li>1. Time from first diagnostic code deemed to be ‘most likely IBD’ to the first IBD diagnostic code, categorized as &lt;1 month, 1 month to &lt;6 months, 6 months to &lt;12 months, and ≥12 months</li> </ol>	<p><b>Most likely IBD:</b> Codes identified in a survey of gastroenterologists in which they were asked to rank potential codes as being indicative of a future diagnosis of IBD (12). Those with a mean score ≥4 on a 5-point Likert scale were included in the list of most likely IBD codes. Codes include signs, symptoms and common extra-intestinal manifestations of IBD (Supplementary Table S5).</p>

CD, Crohn's disease; DIN, drug identification number; ED, emergency department; IBD, inflammatory bowel disease; ICD, International Classification of Diseases; OHIP, Ontario Health Insurance Plan; UC, ulcerative colitis.

network. Satellite networks were clusters of small institutions referring to a single outside center for tertiary care.

IBD patients were assigned to a multispecialty physician network based on the physician providing the majority of IBD-specific outpatient care in the first year after diagnosis to identify the location where they received their IBD care since they may have travelled for specialist care. We evaluated variation in specialist care and outcomes among patients within each physician network, allowing us to examine variation based on where gastroenterology care was provided. We excluded patients who could not be linked with a physician network or patients linked to a children's hospital hub ( $n = 264$ ), patients with a postal code in the Census Metropolitan Area of Kingston or assigned to the Kingston General Hospital network due to incomplete shadow billing ( $n = 111$ ), and patients missing rural/urban classification or neighbourhood income ( $n = 7$ ).

### Gastroenterologist Supply

In order to determine whether variation in care was reduced by network-level supply of gastroenterologists, we conducted models with and without the number of gastroenterologists per 100,000 adults ( $\geq 18$  years) assigned to each physician network, categorized as 0–2.4, 2.5–4.9 and  $\geq 5$ .

### Covariates

A summary of covariates included in each model is provided in [Supplementary Table S4](#). All models were adjusted for age at IBD diagnosis, sex, mean neighbourhood income quintile (a validated proxy for individual-level income (22)), rural/urban residence and comorbidities ([Table 1](#)).

Models evaluating variation in 1- and 5-year risk of ED visit, hospitalization, surgery and medication use additionally accounted for individual measures of utilization (having a gastroenterologist as the primary provider of IBD-specific care) and access to specialist gastroenterology care (distance to primary provider of IBD-specific care, having an IBD-specific ED visit or hospitalization in the month before or after diagnosis, and time to diagnosis; [Table 1](#)). Models evaluating the variation in the risk of ED visit, hospitalization and surgery were additionally adjusted for biologic and immunomodulator use.

### Statistical Analysis

Descriptive characteristics were reported as means and standard deviations (SD), medians and quartiles or proportions, where appropriate. We used a mixed effects multilevel logistic regression, clustered based on multispecialty physician networks. Models had a random intercept, meaning the intercepts of regression models (i.e., log-odds of the outcome) were unique to each physician network. All variables in the model were fixed effects, meaning they were assumed to be consistent across all physician networks. This allowed us to estimate variation in outcomes between networks and account for similarities

between patients in the same network. All models combined patients with CD, UC and IBDU, except models involving surgical outcomes which reported CD and UC separately.

Between network variability was quantified using the median odds ratio (MOR) and interclass correlation coefficient (ICC) (23). The MOR measures between-network variability, computed using the variation of the random intercept and represents the median of all possible odds ratios that would be observed when comparing two similar people, one in a cluster with a higher overall risk of the outcome and the other in a cluster with a lower risk of the outcome. The MOR is always greater than 1, with larger values indicating a higher degree of variation between clusters. The ICC is the proportion of the total variation in an outcome that can be attributed to differences between networks, with values near 1 indicating between-network differences were important in determining an individual's outcome, whereas values near 0 suggested differences were driven by individual differences.

## RESULTS

### Patient Characteristics

We included 4806 incident cases of elderly-onset IBD. Descriptive characteristics are reported in [Table 2](#).

### Utilization of Gastroenterology Care and Health Services

Within a year of diagnosis, 80.1% of patients had seen a gastroenterologist and 72.5% had a gastroenterologist as the primary IBD care provider ([Table 2](#)). There was significant variation across physician networks in having ever seen a gastroenterologist (MOR 3.35, ICC 0.3277,  $P < 0.0001$ ) and having a gastroenterologist as the primary care provider (MOR 4.16, ICC 0.4044,  $P < 0.0001$ ). Variation in access to specialist care (based on both definitions) decreased in magnitude but remained significant when accounting for the number of gastroenterologists within a network ([Table 3](#)). Patients in networks with 0 to 2.4 gastroenterologists per 100,000 were significantly less likely to use specialist care compared to those with  $\geq 5$  gastroenterologists per 100,000 ([Table 3](#)).

Both IBD-related ED visits and hospitalizations in the month before or after IBD diagnosis varied across networks ([Table 3](#)). The number of gastroenterologists per network was not associated with hospitalization or ED visit at diagnosis and its inclusion in the model did not impact between-network variation ([Table 3](#)).

Across physician networks, there was no significant variation in 1- or 5-year risk of ED visit or hospitalization ([Table 4](#)). Networks with 0 to 2.4 gastroenterologists per 100,000 had decreased 5-year risk of hospitalization compared to those with  $\geq 5$  gastroenterologists (odds ratio [OR] 0.82, 95% confidence interval [CI] 0.69 to 0.89).



**Table 2.** Characteristics of study participants

Characteristics	CD (n = 1535)	UC (n = 2919)	IBD (N = 4806)
<b>Age at IBD diagnosis</b>			
65–74 years, n (%)	1013 (66.0%)	1833 (62.8%)	3056 (63.6%)
75–84 years, n (%)	450 (29.3%)	942 (32.3%)	1517 (31.6%)
≥85 years, n (%)	72 (4.7%)	144 (4.9%)	233 (4.8%)
<b>Female sex, n (%)</b>	916 (59.7%)	1576 (54.0%)	2702 (56.2%)
<b>Mean neighbourhood income quintile, n (%)</b>			
Q1 (lowest)	254 (16.5%)	556 (19.0%)	874 (18.2%)
Q2	327 (21.3%)	603 (20.7%)	1004 (20.9%)
Q3	313 (20.4%)	583 (20.0%)	973 (20.2%)
Q4	313 (20.4%)	526 (18.0%)	901 (18.7%)
Q5 (highest)	328 (21.4%)	651 (22.3%)	1054 (21.9%)
<b>Urban household, n (%)</b>	1320 (86.0%)	2473 (84.7%)	4088 (85.1%)
<b>ADG tertile, n (%)</b>			
Q1 (lowest)	558 (36.4%)	1096 (37.5%)	1773 (36.9%)
Q2	499 (32.5%)	946 (32.4%)	1573 (32.7%)
Q3 (highest)	478 (31.1%)	877 (30.0%)	1460 (30.4%)
<b>Having ever seen a gastroenterologist within 1 year of diagnosis, n (%)</b>	1243 (81.0%)	2341 (80.2%)	3848 (80.1%)
<b>Having a gastroenterologist as the primary provider of care in the first year after diagnosis, n (%)</b>	1104 (71.9%)	2138 (73.2%)	3483 (72.5%)
<b>IBD-related ED visit ± 1 month from diagnosis, n (%)</b>	432 (28.1%)	652 (22.3%)	1149 (23.9%)
<b>IBD-related hospitalization ± 1 month from diagnosis, n (%)</b>	415 (27.0%)	527 (18.1%)	994 (20.7%)
<b>Distance to primary provider of IBD-specific outpatient care</b>			
Mean (SD)	16.59 (44.20)	18.52 (51.17)	18.28 (50.58)
Median (Q1-Q3)	6 (3–13)	6 (3–16)	6 (3–15)
<b>Time to IBD diagnosis, n (%)*</b>			
<1 month	159 (10.4%)	85 (2.9%)	273 (5.7%)
1 month to <6 months	102 (6.6%)	71 (2.4%)	199 (4.1%)
6 months to <12 months	662 (43.1%)	1859 (63.7%)	2699 (56.2%)
≥12 months	608 (39.6%)	903 (30.9%)	1629 (33.9%)
<b>IBD-specific health services utilization, n (%)</b>			
ED visit within 1 year of diagnosis	240 (15.6%)	365 (12.5%)	629 (13.1%)
ED visit within 5 years of diagnosis	427 (27.8%)	624 (21.4%)	1092 (22.7%)
Hospitalization within 1 year of diagnosis	504 (32.8%)	632 (21.7%)	1194 (24.8%)
Hospitalization within 5 years of diagnosis	692 (45.1%)	900 (30.8%)	1674 (34.8%)
<b>IBD-related surgery, n (%)</b>			
Intestinal resection or colectomy within 1 year of diagnosis	312 (20.3%)		
Intestinal resection or colectomy within 5 years of diagnosis	529 (34.5%)		
Colectomy within 1 year of diagnosis		320 (11.0%)	
Colectomy within 5 years of diagnosis		543 (18.6%)	

ADG, Ambulatory Diagnostics Group; CD, Crohn's disease; ED, emergency department; IBD, inflammatory bowel disease; SD, standard deviation; UC, ulcerative colitis.

\*Time to diagnosis was missing for six patients.

## Surgery

There was no significant variation across physician networks in terms of the 1- or 5-year risk of surgery in patients with

CD (Table 5). In patients with CD, surgery was not associated with access to specialist care or the availability of gastroenterologists.

**Table 3.** Results of multilevel regression analyses assessing health services utilization within  $\pm 1$  month of inflammatory bowel disease (IBD) diagnosis and access to specialist gastroenterology care in the first year following diagnosis among elderly patients with IBD

Outcome	Model	Number of gastroenterologists per 100,000 population (Reference: $\geq 5$ )		Variance of random effects			
		0–2.4	2.5–4.9	Variance ( $\tau^2$ )	P-value	MOR	ICC
Having ever seen a gastroenterologist	A			<b>1.60</b>	<b>&lt;0.0001</b>	<b>3.35</b>	<b>0.328</b>
	B	<b>0.29 (0.15, 0.56)</b>	0.79 (0.33, 1.88)	<b>1.29</b>	<b>&lt;0.0001</b>	<b>2.95</b>	<b>0.281</b>
Having a gastroenterologist as the primary provider of IBD care	A			<b>2.23</b>	<b>&lt;0.0001</b>	<b>4.16</b>	<b>0.404</b>
	B	<b>0.27 (0.12, 0.59)</b>	0.89 (0.32, 2.45)	<b>1.85</b>	<b>&lt;0.0001</b>	<b>3.66</b>	<b>0.36</b>
Emergency department visits	A			<b>0.08</b>	<b>0.0066</b>	<b>1.30</b>	<b>0.023</b>
	B	1.02 (0.81, 1.28)	1.01 (0.76, 1.33)	<b>0.08</b>	<b>0.0065</b>	<b>1.30</b>	<b>0.023</b>
Hospitalizations	A			<b>0.11</b>	<b>0.0017</b>	<b>1.38</b>	<b>0.033</b>
	B	0.93 (0.72, 1.21)	0.92 (0.67, 1.26)	<b>0.11</b>	<b>0.0019</b>	<b>1.37</b>	<b>0.033</b>

Significant findings are indicated in bold font.

IBD, inflammatory bowel disease; ICC, intraclass correlation coefficient; MOR, median odds ratio Model A includes patient-level variables only. Model B includes patient-level variables and network-level gastroenterologist supply. Both models are adjusted for age at IBD diagnosis, sex, mean neighbourhood income quintile, rural/urban residence and comorbidity index. Significant findings are indicated in bold font.

There was no variation noted in 1-year risk of colectomy in UC patients (MOR 1.26, ICC 0.0173,  $P = 0.15$ ), however, there was significant variation in the 5-year risk of colectomy among patients with UC (MOR 1.38, ICC 0.0339,  $P = 0.01$ ; Table 5). Network-level gastroenterologist supply was not associated with the risk of colectomy but having a gastroenterologist as the primary provider of care in the first year following diagnosis decreased the risk of colectomy (Table 5).

### Medication Use

There was significant variation in the use of immunomodulators but not biologics (Table 6). Gastroenterologist supply was not associated with immunomodulator use and did not decrease variation across networks, but patients with a gastroenterologist as their primary provider of care had a higher odds of immunomodulator use within 1 and 5 years of diagnosis relative to patients whose primary provider of care was not a gastroenterologist (1 year: OR 1.99, 95% CI 1.58 to 2.51; 5 years: OR 1.69, 95% CI 1.41 to 2.02). Patients with a gastroenterologist as their primary provider of care had increased odds of using biologics within 5 years (OR 1.59, 95% CI 1.12 to 2.26) but not within 1 year (OR 1.36, 95% CI 0.79 to 2.34). Decreased gastroenterologist supply within a network was associated with lower odds of biologic use within 1 year (0–2.4 versus  $\geq 5$  per 100,000: OR 0.50, 95% CI 0.28 to 0.89) but not within 5 years (0–2.4 versus  $\geq 5$  per 100,000: OR 0.78, 95% CI 0.55 to 1.10).

There was significant variation across networks in terms of the likelihood of being prescribed a systemic corticosteroid (1 year: MOR 1.21, ICC 0.0210,  $P = 0.0095$ ; 5 years: MOR 1.26, ICC 0.0174,  $P = 0.0061$ ; Table 6). The odds of receiving steroids was

not associated with network-level gastroenterologist supply but patients with a gastroenterologist as their primary provider of care were more likely to receive systemic steroids (1 year: OR 1.26, 95% CI 1.09 to 1.46; 5 years: 1.18, 95% CI 1.01 to 1.39).

Chronic opioid use did not vary across physician networks and was not associated with network-level gastroenterologist supply (1 year: MOR 1.18, ICC 0.0092,  $P = 0.21$ ; 5 years: MOR 1.24, ICC 0.0153,  $P = 0.15$ ; Table 6). However, patients with a gastroenterologist as their primary care provider were less likely to be prescribed opioids (1 year: OR 0.70, 95% CI 0.56 to 0.86; 5 years OR 0.70, 95% CI 0.55 to 0.89).

### DISCUSSION

Utilization of gastroenterology care among individuals diagnosed with IBD at an elderly age varies greatly within Ontario, despite a universal health system. Systematic differences between multispecialty physician networks were responsible for one-third of the variation in ever having seen a gastroenterologist and 40% of variation in having a gastroenterologist as the primary provider of IBD care. Despite high variation in specialist care, ED visits and hospitalizations in patients with IBD and intestinal resection in patients with CD did not vary across physician networks. In contrast, the 5-year risk of colectomy among patients with UC varied by physician network and decreased among patients who received IBD care from gastroenterologists.

Disparities in gastroenterologist care exist among patients with IBD living in rural households, compared to urban-dwellers, and elderly patients were much less likely to be treated by gastroenterologists than younger patients (11). In addition,

**Table 4.** Results of multilevel regression analyses assessing IBD-specific emergency department visits and hospitalizations within 1 and 5 years of IBD diagnosis

	Emergency department Visits <sup>a</sup>						Hospitalizations <sup>a</sup>					
	Within 1 year of diagnosis		Within 5 years of diagnosis		Within 1 year of diagnosis		Within 5 years of diagnosis		Within 1 year of diagnosis		Within 5 years of diagnosis	
	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B
<b>Utilization of and access to specialist care, OR (95% CI)</b>												
Gastroenterologist as the primary provider of IBD care at diagnosis	1.01 (0.81, 1.28)	1.02 (0.81, 1.28)	1.04 (0.87, 1.24)	1.05 (0.88, 1.26)	0.92 (0.76, 1.12)	0.91 (0.75, 1.11)	1.03 (0.87, 1.22)	1.01 (0.85, 1.2)				
Distance to primary provider of IBD care (per 10 km)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.98, 1.01)	1.00 (0.98, 1.01)	1.00 (0.98, 1.02)	1.00 (0.98, 1.02)	1.00 (0.99, 1.02)	1.00 (0.99, 1.02)				
Emergency department visit at diagnosis	<b>2.26</b> ( <b>1.77, 2.89</b> )	<b>2.26</b> ( <b>1.77, 2.89</b> )	<b>1.60</b> ( <b>1.30, 1.97</b> )	<b>1.60</b> ( <b>1.30, 1.96</b> )	0.93 (0.75, 1.17)	0.93 (0.75, 1.17)	1.05 (0.86, 1.29)	1.06 (0.86, 1.29)				
Hospitalization at diagnosis	<b>2.18</b> ( <b>1.70, 2.79</b> )	<b>2.17</b> ( <b>1.70, 2.79</b> )	<b>1.93</b> ( <b>1.57, 2.39</b> )	<b>1.94</b> ( <b>1.57, 2.40</b> )	<b>10.36</b> ( <b>8.33, 12.9</b> )	<b>10.35</b> ( <b>8.32, 12.89</b> )	<b>3.97</b> ( <b>3.24, 4.86</b> )	<b>3.94</b> ( <b>3.22, 4.83</b> )				
<b>Medication utilization, OR (95% CI)</b>												
Biologic use	0.69 (0.27, 1.81)	0.69 (0.26, 1.80)	<b>2.99</b> ( <b>1.01, 8.85</b> )	<b>2.97</b> ( <b>1.004, 8.81</b> )	1.30 (0.81, 2.07)	1.29 (0.81, 2.05)	<b>3.73</b> ( <b>1.98, 7.04</b> )	<b>3.67</b> ( <b>1.95, 6.94</b> )				
Immunomodulator use	<b>3.56</b> ( <b>2.52, 5.03</b> )	<b>3.56</b> ( <b>2.52, 5.03</b> )	<b>14.74</b> ( <b>10.51, 20.67</b> )	<b>14.68</b> ( <b>10.46, 20.59</b> )	<b>6.77</b> ( <b>5.28, 8.68</b> )	<b>6.79</b> ( <b>5.30, 8.70</b> )	<b>12.84</b> ( <b>9.82, 16.78</b> )	<b>12.9</b> ( <b>9.86, 16.86</b> )				
<b>Time to diagnosis, OR (95% CI)</b>												
<1 month (reference)												
1 to <6 months	1.25 (0.81, 1.92)	1.25 (0.81, 1.92)	1.33 (0.96, 1.85)	1.33 (0.96, 1.85)	1.11 (0.76, 1.62)	1.11 (0.76, 1.62)	0.90 (0.65, 1.25)	0.90 (0.65, 1.25)				
6 to <12 months	<b>1.66</b> ( <b>1.05, 2.61</b> )	<b>1.66</b> ( <b>1.05, 2.61</b> )	1.11 (0.75, 1.65)	1.11 (0.75, 1.65)	1.16 (0.74, 1.82)	1.16 (0.74, 1.81)	0.84 (0.56, 1.25)	0.84 (0.56, 1.25)				
≥12 months	1.07 (0.85, 1.35)	1.07 (0.85, 1.35)	1.11 (0.92, 1.33)	1.11 (0.93, 1.33)	1.06 (0.87, 1.29)	1.06 (0.87, 1.28)	1.03 (0.87, 1.22)	1.02 (0.86, 1.21)				

Table 4. Continued

	Emergency department Visits <sup>a</sup>				Hospitalizations <sup>a</sup>			
	Within 1 year of diagnosis		Within 5 years of diagnosis		Within 1 year of diagnosis		Within 5 years of diagnosis	
	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B
<b>Number of gastroenterologists per 100,000, OR (95% CI)</b>								
0–2.4	1.01 (0.76, 1.33)	1.09 (0.90, 1.32)			0.89 (0.72, 1.09)			<b>0.82</b> ( <b>0.69, 0.98</b> )
2.5–4.9	0.95 (0.68, 1.32)	0.92 (0.73, 1.15)			1.03 (0.81, 1.31)			0.97 (0.79, 1.20)
≥5 (reference)								
<b>Variance of random effects</b>								
Variance ( $\tau^2$ )	0.0500	0.0500	0.004	0.0005	0	0	0	0
P-value	0.1123	0.1110	0.4221	0.49	-	-	-	-
MOR (95% CI)	1.24	1.24	1.06	1.02	1.0	1.0	1.0	1.0
ICC	0.0153	0.0153	0.0013	0.0001	0	0	0	0

<sup>a</sup>Emergency department visits and hospitalizations occurring within 1 month of diagnosis were excluded from the 1- and 5-year outcomes.

CI, confidence interval; IBD, inflammatory bowel disease; ICC, intraclass correlation coefficient; MOR, median odds ratio; OR, odds ratio Model A includes patient-level variables only. Model B includes patient-level variables and network-level gastroenterologist supply. Both models are adjusted for age at IBD diagnosis, sex, mean neighbourhood income quintile, rural/urban residence and comorbidity index. Significant findings are indicated in bold font.



**Table 5.** Results of multilevel regression analyses assessing the risk of intestinal resection and colectomy in patients with Crohn's disease and ulcerative colitis, respectively, within 1 and 5 years of IBD diagnosis

	Crohn's disease						Ulcerative colitis					
	Within 1 year of diagnosis		Within 5 years of diagnosis		Within 1 year of diagnosis		Within 5 years of diagnosis		Within 1 year of diagnosis		Within 5 years of diagnosis	
	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B
<b>Utilization of and access to specialist care, OR (95% CI)</b>												
Gastroenterologist as the primary provider of IBD care at diagnosis	0.76 (0.57, 1.03)	0.77 (0.57, 1.03)	0.79 (0.60, 1.05)	0.79 (0.60, 1.05)	<b>0.64 (0.49, 0.83)</b>	<b>0.64 (0.49, 0.83)</b>	0.99 (0.96, 1.02)	0.99 (0.96, 1.02)	<b>0.78 (0.63, 0.97)</b>	<b>0.77 (0.62, 0.95)</b>	0.99 (0.97, 1.01)	0.99 (0.97, 1.01)
Distance to primary provider of IBD care (per 10 km)	1.00 (0.97, 1.03)	1 (0.97, 1.03)	1.01 (0.98, 1.03)	1.01 (0.98, 1.03)	1.06 (0.77, 1.45)	1.06 (0.77, 1.45)	1.06 (0.77, 1.45)	1.06 (0.77, 1.45)	1.01 (0.78, 1.31)	1.01 (0.78, 1.31)	1.01 (0.78, 1.31)	1.01 (0.78, 1.31)
Emergency department visit at diagnosis	1.37 (0.98, 1.92)	1.37 (0.98, 1.92)	1.27 (0.92, 1.76)	1.27 (0.92, 1.76)	<b>3.24 (2.32, 4.51)</b>	<b>3.24 (2.33, 4.5)</b>	<b>2.05 (1.49, 2.83)</b>	<b>2.05 (1.49, 2.83)</b>	<b>2.04 (1.48, 2.83)</b>	<b>2.04 (1.47, 2.81)</b>	<b>1.52 (1.15, 2.00)</b>	<b>1.51 (1.15, 1.99)</b>
<b>Medication utilization, OR (95% CI)</b>												
Biologic use	0.23 (0.05, 1.05)	0.23 (0.05, 1.04)	1.08 (0.41, 2.83)	1.07 (0.41, 2.81)	0.89 (0.28, 2.81)	0.86 (0.27, 2.70)	1.48 (0.67, 3.25)	1.43 (0.65, 3.16)	0.91 (0.51, 1.64)	0.93 (0.52, 1.67)	<b>4.40 (2.98, 6.5)</b>	<b>4.46 (3.02, 6.59)</b>
Immunomodulator use	0.97 (0.57, 1.64)	0.97 (0.57, 1.65)	<b>8.90 (5.24, 15.10)</b>	<b>8.94 (5.26, 15.19)</b>	0.85 (0.56, 1.29)	0.85 (0.56, 1.30)	1.34 (0.71, 2.52)	1.37 (0.73, 2.58)	0.77 (0.58, 1.02)	0.76 (0.57, 1.01)	0.88 (0.71, 1.10)	0.87 (0.70, 1.08)
<b>Time to diagnosis, OR (95% CI)</b>												
<1 month (reference)												
1 to <6 months	0.87 (0.54, 1.40)	0.87 (0.54, 1.40)	0.85 (0.56, 1.29)	0.85 (0.56, 1.30)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.68 (0.38, 1.22)	0.68 (0.38, 1.22)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)
6 to <12 months	0.68 (0.38, 1.22)	0.68 (0.38, 1.22)	0.90 (0.55, 1.47)	0.9 (0.55, 1.47)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)
≥12 months	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)	0.84 (0.63, 1.11)	0.82 (0.61, 1.11)	0.82 (0.61, 1.11)

Table 5. Continued

	Ulcerative colitis					
	Crohn's disease		Within 5 years of diagnosis		Within 1 year of diagnosis	
	Model A	Model B	Model A	Model B	Model A	Model B
<b>Number of gastro-enterologists per 100,000, OR (95% CI)</b>						
0-2.4		1.07 (0.78, 1.47)		0.99 (0.70, 1.39)		0.76 (0.56, 1.04)
2.5-4.9		1.18 (0.83, 1.68)		1.09 (0.74, 1.61)		0.90 (0.63, 1.31)
≥5 (reference)						
<b>Variance of random effects</b>						
Variance ( $\tau^2$ )	0.002	0	0.08	0.08	0.06	0.05
P-value	0.48	-	0.08	0.08	0.15	0.19
MOR	1.05	1.00	1.32	1.32	1.26	1.23
ICC	0.0007	0	0.0247	0.0248	0.0173	0.0143
					<b>0.0339</b>	<b>0.0316</b>

CI, confidence interval; IBD, inflammatory bowel disease; ICC, intraclass correlation coefficient; MOR, median odds ratio; OR, odds ratio Model A includes patient-level variables only. Model B includes patient-level variables and network-level gastroenterologist supply. Both models are adjusted for age at IBD diagnosis, sex, mean neighbourhood income quintile, rural/urban residence and comorbidity index. Significant findings are indicated in bold font.

**Table 6.** Results of multilevel regression analyses assessing medication utilization in patients with IBD within 1 and 5 years of IBD diagnosis

	Immunomodulators		Biologics		Systemic steroids		Chronic opioid use									
	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis								
	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B								
<b>Utilization of and access to specialist care, OR (95% CI)</b>																
Gastroenterologist as the primary provider of IBD care at diagnosis	<b>1.99</b> (1.58, 2.51)	<b>1.69</b> (1.41, 2.02)	<b>1.70</b> (1.42, 2.04)	<b>1.36</b> (0.79, 2.34)	<b>1.29</b> (0.75, 2.21)	<b>1.59</b> (1.12, 2.26)	<b>1.56</b> (1.10, 2.22)	<b>1.26</b> (1.09, 1.46)	<b>1.27</b> (1.10, 1.47)	<b>1.18</b> (1.01, 1.37)	<b>1.19</b> (1.02, 1.39)	<b>1.19</b> (1.01, 1.41)	<b>0.70</b> (0.56, 0.86)	<b>0.70</b> (0.57, 0.89)	<b>0.70</b> (0.55, 0.90)	
Distance to primary provider of IBD care (per 10 km)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.01 (0.98, 1.04)	1.01 (0.97, 1.04)	1.02 (0.997, 1.03)	1.01 (0.996, 1.03)	1.00 (0.99, 1.01)	1.00 (0.99, 1.01)	1.01 (0.99, 1.02)	1.01 (0.99, 1.02)	1.00 (0.99, 1.02)	1.00 (0.98, 1.02)	1.00 (0.97, 1.02)	1.00 (0.97, 1.02)	
Emergency department visit at diagnosis	<b>1.39</b> (1.10, 1.75)	<b>1.34</b> (1.10, 1.64)	<b>1.34</b> (1.10, 1.64)	1.38 (0.79, 2.4)	1.37 (0.79, 2.39)	<b>1.52</b> (1.06, 2.19)	<b>1.52</b> (1.06, 2.19)	<b>1.46</b> (1.24, 1.71)	<b>1.45</b> (1.23, 1.71)	<b>1.29</b> (1.07, 1.55)	<b>1.29</b> (1.07, 1.55)	<b>1.29</b> (1.07, 1.55)	<b>0.86</b> (0.66, 1.12)	<b>0.99</b> (0.73, 1.33)	<b>0.99</b> (0.73, 1.33)	
Hospitalization at diagnosis	<b>1.55</b> (1.22, 1.97)	<b>1.31</b> (1.07, 1.62)	<b>1.31</b> (1.07, 1.62)	3.47 (2.00, 6.02)	3.47 (2.00, 6.01)	<b>1.54</b> (1.06, 2.23)	<b>1.53</b> (1.05, 2.22)	<b>2.75</b> (2.31, 3.27)	<b>2.76</b> (2.32, 3.28)	<b>1.99</b> (1.62, 2.44)	<b>2.00</b> (1.63, 2.45)	<b>2.00</b> (1.63, 2.45)	<b>1.32</b> (1.02, 1.73)	<b>1.33</b> (1.02, 1.73)	<b>1.19</b> (0.87, 1.61)	<b>1.19</b> (0.88, 1.62)
<b>Time to diagnosis, OR (95% CI)</b>																
<1 month (reference)																
1 to <6 months	1.18 (0.81, 1.72)	0.98 (0.72, 1.34)	0.98 (0.72, 1.34)	1.31 (0.54, 3.15)	1.33 (0.55, 3.21)	0.96 (0.53, 1.75)	0.96 (0.53, 1.75)	0.91 (0.70, 1.19)	0.91 (0.70, 1.19)	<b>0.63</b> (0.48, 0.82)	<b>0.63</b> (0.48, 0.82)	<b>0.63</b> (0.48, 0.82)	0.99 (0.63, 1.55)	0.99 (0.63, 1.55)	1.34 (0.86, 2.07)	1.34 (0.86, 2.07)
6 to <12 months	1.31 (0.86, 1.98)	1.06 (0.74, 1.51)	1.06 (0.74, 1.51)	0.59 (0.14, 2.5)	0.59 (0.14, 2.5)	1.2 (0.62, 2.3)	1.2 (0.62, 2.3)	1.09 (0.81, 1.49)	1.09 (0.81, 1.49)	0.84 (0.61, 1.16)	0.84 (0.61, 1.16)	0.84 (0.61, 1.16)	1.08 (0.66, 1.77)	1.08 (0.66, 1.77)	0.78 (0.42, 1.45)	0.78 (0.42, 1.45)
>12 months	1.01 (0.91, 1.35)	1.13 (0.96, 1.33)	1.13 (0.96, 1.33)	1.01 (0.61, 1.67)	0.98 (0.59, 1.63)	1.03 (0.75, 1.42)	1.02 (0.74, 1.41)	0.99 (0.87, 1.14)	1.00 (0.87, 1.14)	1.06 (0.91, 1.22)	1.06 (0.91, 1.22)	1.06 (0.91, 1.22)	1.19 (0.96, 1.48)	1.19 (0.96, 1.48)	1.21 (0.94, 1.55)	1.21 (0.94, 1.55)

Table 6. Continued

	Immunomodulators		Biologics		Systemic steroids		Chronic opioid use	
	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis	Within 1 year of diagnosis	Within 5 years of diagnosis
	Model A	Model B	Model A	Model B	Model A	Model B	Model A	Model B
Number of gastroenterologists per 100,000, OR (95% CI)								
0-2.4	1.07 (0.76, 1.51)	1.11 (0.83, 1.49)	<b>0.50</b> ( <b>0.28</b> , <b>0.89</b> )	0.78 (0.55, 1.10)	1.20 (0.99, 1.45)	1.2 (0.97, 1.48)	1.06 (0.82, 1.37)	1.12 (0.82, 1.51)
2.5-4.9	0.9 (0.59, 1.39)	1.00 (0.70, 1.44)	0.64 (0.33, 1.24)	0.88 (0.59, 1.30)	1.18 (0.94, 1.47)	1.1 (0.85, 1.41)	0.94 (0.69, 1.28)	1.04 (0.73, 1.49)
≥5 (reference)								
Variance of Random Effects								
Variance ( $\tau^2$ )	<b>0.21</b>	<b>0.16</b>	0.12	0.04	<b>0.04</b>	<b>0.06</b>	0.03	0.05
p-value	<b>0.001</b>	<b>0.0011</b>	0.2185	0.2511	<b>0.0095</b>	<b>0.0061</b>	0.2064	0.1505
MOR	<b>1.55</b>	<b>1.47</b>	1.40	1.20	<b>1.21</b>	<b>1.26</b>	1.18	1.24
ICC	<b>0.0610</b>	<b>0.0474</b>	0.0362	0.0107	<b>0.0120</b>	<b>0.0174</b>	0.0092	0.0153

CI, confidence interval; IBD, inflammatory bowel disease; ICC, intraclass correlation coefficient; MOR, median odds ratio; OR, odds ratio.

Model A includes patient-level variables only. Model B includes patient-level variables and network-level gastroenterologist supply. Both models are adjusted for age at IBD diagnosis, sex, mean neighbourhood income quintile, rural/urban residence and comorbidity index. Significant findings are indicated in bold font.

patients of any age living in rural areas were more likely to be hospitalized for IBD (11). Even after adjusting for rural/urban residence, we observed a high level of variation in utilization of specialist gastroenterology care suggesting that rurality is not an independent predictor of access to care. Instead, variation is best reported as the combination of region of residence and location of care.

We observed variation in the use of immunomodulators and systemic corticosteroids across physician networks, while biologic prescriptions and chronic opioid use did not vary. Within 1 year of diagnosis, 6.1% of variation in immunomodulator use and 1.2% of variation in systemic steroids resulted from systematic differences in networks. Due to the small numbers of patients with a prescription for a biologic medication, we may have been underpowered to detect variability in this outcome. This is particularly true for the use of biologic medications within the first year, when 6.6% of variation in biologic prescriptions resulting from systematic differences between networks. Previous studies have reported similarly high variation in the use of IBD medications. An international comparison of elderly IBD patients in Canada, Denmark, the United Kingdom and the United States demonstrated significant variability in prescription rates for steroids, mesalamine, immunomodulators and biologics (24). Further, variation in medication was reported across IBD tertiary care centers in the United States (14) suggesting that there are inherent differences in how patients are treated, even by specialists. Alternatively, patients with more severe disease may be more likely to be referred to gastroenterologists and receive corticosteroids—a difference which may have been overemphasized by evaluating variation based on where care was received. Elderly patients with both CD and UC use fewer immunomodulators and biologics than younger patients; some studies report decreased use of steroids among elderly patients, while others report higher steroid use (25–27).

Interestingly, there was significant variation in the need for IBD-related surgery across networks for patients with UC but not CD. However, the magnitude of variation (MOR 1.32 in CD versus 1.38 in UC) was similar suggesting we may have been underpowered to detect significant variability in the risk of intestinal resection for CD. Systematic differences between networks were responsible for 3.4% of variation in the 5-year risk of colectomy in patients with UC and 2.5% of variation in the 5-year risk of intestinal resection in patients with CD. Elderly-onset CD is typically associated with a milder phenotype of disease (e.g., decreased stricturing or penetrating disease behaviour) (25,26). Nonetheless, elderly patients with multiple comorbidities requiring surgery may experience more complications (28). The risk of intestinal resection was previously shown to be similar in patients with CD across all ages (25,26,29). In contrast, elderly patients with UC may undergo

colectomy more frequently than younger patients despite having less extensive disease (26,27,29).

Patients in multispecialty physician networks with small numbers of gastroenterologists were less likely to receive gastroenterology care and less likely to be treated with a biologic within the first year of diagnosis, but were less likely to be hospitalized within 5 years of diagnosis independent of biologic utilization. Further, patients with a gastroenterologist as their primary IBD care provider were more likely to be treated with an immunomodulator, biologic or steroids, less likely to receive chronic opioid therapy, and were at lower risk of colectomy for UC. This suggests that gastroenterologist care is critical for ensuring the best possible outcomes among seniors with IBD.

Our study was limited by the potential for misclassification of IBD in health administrative data. Although the algorithm for elderly-onset IBD has been validated (20), its performance is worse compared to younger people. As a result, we may have included some patients with non-IBD gastrointestinal disorders such as microscopic or ischemic colitis which may have impacted our findings. However, we have no reason to believe there was differential misclassification of patients amongst physician networks. Further, measures of disease severity, phenotype, disease extent and location, or factors which may influence disease severity (e.g., smoking) were not available in health administrative data. Failure to account for disease characteristics may have resulted in residual confounding. That is, patients with severe disease at the time of IBD diagnosis may have been more likely to visit gastroenterologists compared to patients with mild disease. This may have impacted their likelihood of being assigned to a multispecialty network with a higher number of gastroenterologists than someone with mild disease who had a general practitioner as their primary provider of IBD care. In addition, patients may be prescribed IBD medications (e.g., biologics) by other specialties (e.g., rheumatology) due to the presence of extraintestinal manifestations of IBD. We did not examine health care utilization for extraintestinal manifestations, which may have increased observed variation.

## Conclusions

In patients with elderly-onset IBD, utilization of specialty gastroenterology care was highly variable, with lower risk of colectomy and hospitalization associated with increased specialist care. Variation in medical treatment, notably with immunomodulators and systemic corticosteroids, was also noted. There is a need to ensure all individuals living with IBD receive high-quality evidence-based care for their IBD. Health services researchers in other regions should similarly examine the assumption that health care is being provided equally to their IBD patients, no matter their socioeconomic status, region of residence or age.



## SUPPLEMENTARY DATA

Supplementary data are available at *Journal of the Canadian Association of Gastroenterology* online.

## DATA SHARING STATEMENT

The data from this study is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet prespecified criteria for confidential access, available at [www.ices.on.ca/DAS](http://www.ices.on.ca/DAS). The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

## CONFLICTS OF INTEREST

G.G.K. has received honoraria for speaking or consultancy from Abbvie, Janssen, Pfizer and Takeda. He has received research support from Janssen, Abbvie, GlaxoSmithKline, Merck and Shire. He shares ownership of a patent: TREATMENT OF INFLAMMATORY DISORDERS, AUTOIMMUNE DISEASE, AND PBC. UTI Limited Partnership, assignee. Patent 62/555,397. 7 Sept. 2017. The remaining authors have no relevant conflicts of interest.

## AUTHOR CONTRIBUTIONS

Study concept and design: M.E.K. and E.I.B.; Data acquisition: M.E.K., T.A.S., R.T., and E.I.B. Statistical analysis: R.T.; Interpretation of the data: M.E.K., T.A.S., G.G.K., S.K.M., G.C.N., and E.I.B.; Drafting of the manuscript: M.E.K.; Critical revision of the manuscript for intellectual content: M.E.K., T.A.S., G.G.K., S.K.M., G.C.N., R.T., and E.I.B. Final approval of the manuscript: M.E.K., T.A.S., G.G.K., S.K.M., G.C.N., R.T., and E.I.B.

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## References

1. Benchimol EI, Manuel DG, Guttman A, et al. Changing age demographics of inflammatory bowel disease in Ontario, Canada: A population-based cohort study of epidemiology trends. *Inflamm Bowel Dis*. 2014;20(10):1761–9. doi:10.1097/MIB.000000000000103.
2. Coward S, Clement F, Benchimol EI, et al. Past and future burden of inflammatory bowel diseases based on modeling of population-based data. *Gastroenterology* 2019;156(5):1345–53.e4.
3. Juneja M, Baidoo L, Schwartz MB, et al. Geriatric inflammatory bowel disease: Phenotypic presentation, treatment patterns, nutritional status, outcomes, and comorbidity. *Dig Dis Sci* 2012;57(9):2408–15.
4. Kaplan GG. The global burden of IBD: From 2015 to 2025. *Nat Rev Gastroenterol Hepatol* 2015;12(12):720–7.
5. Brassard P, Bitton A, Suissa A, et al. Oral corticosteroids and the risk of serious infections in patients with elderly-onset inflammatory bowel diseases. *Am J Gastroenterol* 2014;109(11):1795–802; quiz 1803.
6. Cottone M, Kohn A, Daperno M, et al. Advanced age is an independent risk factor for severe infections and mortality in patients given anti-tumor necrosis factor therapy for inflammatory bowel disease. *Clin Gastroenterol Hepatol* 2011;9(1):30–5.
7. Lobatón T, Ferrante M, Rutgeerts P, et al. Efficacy and safety of anti-TNF therapy in elderly patients with inflammatory bowel disease. *Aliment Pharmacol Ther* 2015;42(4):441–51.
8. Bollegala N, Jackson TD, Nguyen GC. Increased postoperative mortality and complications among elderly patients with inflammatory bowel diseases: An analysis of the National Surgical Quality Improvement Program Cohort. *Clin Gastroenterol Hepatol* 2016;14(9):1274–81.
9. Nordenvall C, Ekblom A, Bottai M, et al. Mortality after total colectomy in 3084 patients with inflammatory bowel disease: A population-based cohort study. *Aliment Pharmacol Ther* 2014;40(3):280–7.
10. Nguyen GC, Nugent Z, Shaw S, Bernstein CN. Outcomes of patients with Crohn's disease improved from 1988 to 2008 and were associated with increased specialist care. *Gastroenterology*. 2011;141(1):90–97. doi:10.1053/j.gastro.2011.03.050.
11. Benchimol EI, Kuenzig ME, Bernstein CN, et al. Rural and urban disparities in the care of Canadian patients with inflammatory bowel disease: A population-based study. *Clin Epidemiol*. 2018;10:1613–1626. doi:10.2147/CLEP.S178056.
12. Benchimol EI, Manuel DG, Mojaverian N, et al. Health services utilization, specialist care, and time to diagnosis with inflammatory bowel disease in immigrants to Ontario, Canada: A population-based cohort study. *Inflamm Bowel Dis* 2016;22(10):2482–90.
13. Murthy SK, Steinhart AH, Tinmouth J, et al. Impact of gastroenterologist care on health outcomes of hospitalised ulcerative colitis patients. *Gut* 2012;61(10):1410–6.
14. Nguyen G, Bouchard S, Diong C, Network P. Access to specialists and emergency department visits in inflammatory bowel disease: a population-based study. *Journal of Crohn's and Colitis* 2018;13(3):330–6. doi:10.1093/ecco-jcc/jjy161.
15. Nguyen GC, Murthy SK, Bressler B, et al. Quality of care and outcomes among hospitalised inflammatory bowel disease patients. *Inflamm Bowel Dis*. 2017;23(5):695–701. doi:10.1097/MIB.0000000000001068.
16. Chassin MR, Galvin RW. The urgent need to improve health care quality. Institute of Medicine National Roundtable on Health Care Quality. *JAMA* 1998;280(11):1000–5.
17. Institute of Medicine (US) Committee on Quality of Health Care in America. *Crossing the Quality Chasm: a New Health System for the 21st Century*. Washington, DC: National Academies Press, 2001.
18. Berwick DM. *As Good as It Should Get: Making Health Care Better in the New Millennium*. Washington, DC: The National Coalition on Health Care, 1988.
19. ICES Data Dictionary. <https://datadictionary.ices.on.ca>. Published 2018. Accessed August 28, 2018.
20. Benchimol EI, Guttman A, Mack DR, et al. Validation of international algorithms to identify adults with inflammatory bowel disease in health administrative data from Ontario, Canada. *J Clin Epidemiol* 2014;67(8):887–96.
21. Stukel TA, Glazier RH, Schultz SE, et al. Multispecialty physician networks in Ontario. *Open Med* 2013;7(2):e40–55.

22. Glazier RH, Creatore MI, Agha MM, et al.; Inner City Toronto Time Trends Working Group. Socioeconomic misclassification in Ontario's Health Care Registry. *Can J Public Health* 2003;94(2):140-3.
23. Austin PC, Merlo J. Intermediate and advanced topics in multilevel logistic regression analysis. *Stat Med*. 2017;1(6):223-21. doi:10.1002/sim.7336.
24. Benchimol EI, Cook SF, Erichsen R, et al. International variation in medication prescription rates among elderly patients with inflammatory bowel disease. *J Crohns Colitis* 2013;7(11):878-89.
25. Ananthakrishnan AN, Shi HY, Tang W, et al. Systematic review and meta-analysis: Phenotype and clinical outcomes of older-onset inflammatory bowel disease. *J Crohns Colitis* 2016;10(10):1224-36.
26. Fumery M, Pariente B, Sarter H, et al.; EPIMAD group. Natural history of Crohn's disease in elderly patients diagnosed over the age of 70 years: A population-based study. *Inflamm Bowel Dis* 2016;22(7):1698-707.
27. Komoto S, Higashiyama M, Watanabe C, et al. Clinical differences between elderly-onset ulcerative colitis and non-elderly-onset ulcerative colitis: A nationwide survey data in Japan. *J Gastroenterol Hepatol* 2018;33(11):1839-43.
28. Ma C, Crespin M, Proulx MC, et al. Postoperative complications following colectomy for ulcerative colitis: A validation study. *BMC Gastroenterol* 2012;12:39.
29. Nguyen GC, Bernstein CN, Benchimol EI. Risk of surgery and mortality in elderly-onset inflammatory bowel disease: A population-based cohort study. *Inflamm Bowel Dis*. 2017;23(2):218-23. doi:10.1097/MIB.0000000000000993.
30. Benchimol EI, Guttman A, To T, Rabeneck L, Griffiths AM. Changes to surgical and hospitalization rates of pediatric inflammatory bowel disease in Ontario, Canada (1994-2007). *Inflamm Bowel Dis*. 2011;17(10):2153-61. doi:10.1002/ibd.21591.
31. Benchimol EI, To T, Griffiths AM, et al. Outcomes of pediatric inflammatory bowel disease: Socioeconomic status disparity in a universal-access healthcare system. *J Pediatr* 2011;158(6):960-7.e1-4.
32. Ma C, Moran GW, Benchimol EI, et al. Surgical rates for Crohn's disease are decreasing: A population-based time trend analysis and validation study. *Am J Gastroenterol*. 2017;148:344. doi:10.1038/ajg.2017.394.
33. Kaplovitch E, Gomes T, Camacho X, et al. Sex differences in dose escalation and overdose death during chronic opioid therapy: A population-based cohort study. *PLoS One* 2015;10(8):e0134550.