SUPPLEMENT

Suboptimal Performance of Microscopic Colitis Diagnosis Codes: A Bottleneck for Epidemiologic Insights

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Supplemental methods

Data source

The VHA consists of 171 medical centers and 1112 outpatient clinics that annually serve 9 million veterans of the United States military services and a portion of their eligible dependents. VHA CDW contains electronic health record data from 1999 – present, including demographics, diagnosis codes, procedures, laboratory results, prescription information, and free-text documents. To form the cohorts described below, we identified individuals who had at least two VHA appointments per calendar year for at least 365 continuous days.

Individuals with a microscopic colitis ICD code

To calculate the positive predictive value of microscopic colitis ICD codes, we identified individuals with an inpatient or outpatient encounter coded with an ICD code in any diagnostic coding position for microscopic colitis (subheading K52.83). The date of the first microscopic colitis diagnostic code was designated the index date. Because ICD codes for microscopic colitis were not introduced in the United States until October 1, 2016, potential index dates were no earlier than October 1, 2016. The latest potential index date was April 24, 2023.

Individuals with an ICD code for a diarrheal condition

To calculate the negative predictive value of microscopic colitis ICD codes, we also identified individuals with an inpatient or outpatient encounter coded with an ICD code in any diagnostic coding position for a diarrheal condition in the differential diagnosis of microscopic colitis (**Supplemental table 1**). Individuals potentially eligible for this diarrheal condition code sample were excluded if they also had an ICD code for microscopic colitis at any time during enrollment. The date of the first diarrheal condition ICD code was designated the index date. To ensure temporal overlap with the microscopic colitis code sample, individuals with ICD codes for diarrheal conditions before October 1, 2016 were excluded. The overall study design is depicted in **Supplemental figure 1.**

ICD code validation

We randomly selected a sample of 200 individuals with a microscopic colitis ICD code and 200 individuals with a diarrheal condition ICD code. We chose 200 charts because at the minimum clinically acceptable positive predictive value of 0.80, the 95% CI would have a width of approximately 0.10. We then manually reviewed the text of all surgical pathology reports and all clinical notes containing “colitis” within one word of “microscopic,” “lymphocytic,” or “collagenous.” We classified individuals in each cohort as having microscopic colitis if a surgical pathology report or a clinical note no later than 60 days after the index date indicated an

incident or historical diagnosis of microscopic colitis. All surgical pathology reports prior to the index date were reviewed, but clinical notes were restricted to the 365 days before the index date.

Calculation of positive predictive value

The positive predictive value of a microscopic colitis ICD code was calculated as the proportion of individuals in the microscopic colitis sample who were identified to have microscopic colitis by the validation procedure described above. The positive predictive value represents the probability that an individual with an ICD code for microscopic colitis has microscopic colitis by chart review.

Calculation of negative predictive value

The negative predictive value of a microscopic colitis ICD was calculated as the proportion of individuals from the diarrheal condition sample who did not have microscopic colitis by the validation procedure described above. The negative predictive value represents the probability that an individual without an ICD code for microscopic colitis does not have microscopic colitis by chart review.

Calculation of sensitivity and specificity

Sensitivity is the proportion of individuals with microscopic colitis who have an ICD code for microscopic colitis recorded in their medical record. Specificity is that the proportion of individuals without microscopic colitis who do not have an ICD code for microscopic colitis recorded in their medical record. To estimate the sensitivity and specificity of microscopic colitis ICD codes, we applied the positive predictive value and negative predictive value estimates to two clinically relevant cohorts. The first cohort consisted of individuals with any of the diarrheal condition codes listed in **Supplemental table 1** or microscopic colitis ICD codes (subheading K52.83). The second cohort consisted of individuals with these codes and a colonoscopy within 60 days of the first code (procedure codes for colonoscopy are listed in **Supplemental table 2**). For both cohorts, we identified the number of individuals with a microscopic colitis ICD code within 30 days of the first code. We assumed that these cohorts captured all individuals with microscopic colitis in the general population and that the positive predictive value and negative predictive value were identical to those estimated in the microscopic colitis and diarrhea condition samples described above. We then calculated the sensitivity and specificity of microscopic colitis ICD codes in each cohort based on the following derivation:

Abbreviations:

- TP = True positive (an individual with microscopic colitis and a microscopic colitis ICD code)
- FN = False negative (an individual with microscopic colitis but without a microscopic colitis ICD code)
- FP = False positive (an individual without microscopic colitis but with a microscopic colitis ICD code)
- TN = True negative (an individual without microscopic colitis and without a microscopic colitis ICD code)
- PPV = Positive predictive value
- NPV = Negative predictive value

- MC = Microscopic colitis

$$Sensitivity = \frac{TP}{TP + FN} \quad (1)$$

$$Specificity = \frac{TN}{TN + FP} \quad (2)$$

$$PPV = \frac{TP}{TP + FP} = \frac{MC\ with\ MC\ code}{MC\ code} \quad (3)$$

$$NPV = \frac{TN}{TN + FN} = \frac{No\ MC\ and\ no\ MC\ code}{No\ MC\ code} \quad (4)$$

$From\ (3)$:

$$TP = PPV * (TP + FP) = PPV * MC\ code \quad (5)$$

AND

$$PPV * (TP + FP) = TP$$

$$TP + FP = \frac{TP}{PPV}$$

$$FP = \frac{TP}{PPV} - TP$$

$Substitute\ (5)\ for\ TP$:

$$FP = \frac{(PPV * MC\ code)}{PPV} - (PPV * MC\ code)$$

$$= (PPV * MC\ code) * \left(\frac{1}{PPV} - 1\right) \quad (6)$$

$From\ (4)$:

$$TN = NPV * (TN + FN) = NPV * No\ MC\ code \quad (7)$$

AND

$$NPV * (TN + FN) = TN$$

$$TN + FN = \frac{TN}{NPV}$$

$$FN = \frac{TN}{NPV} - TN$$

$Substitute\ (7)\ for\ TN$:

$$FN = \frac{NPV * No\ MC\ code}{NPV} - NPV * No\ MC\ code$$

$$= (NPV * No\ MC\ code) * \left(\frac{1}{NPV} - 1\right) \quad (8)$$

$Therefore$:

$$Sensitivity = \frac{TP}{TP + FN}$$

$$= \frac{PPV * MC\ code}{PPV * MC\ code + \left((NPV * No\ MC\ code) * \left(\frac{1}{NPV} - 1\right)\right)} \quad (9)$$

AND

$$Specificity = \frac{TN}{TN + FP}$$

$$= \frac{NPV * No\ MC\ code}{NPV * No\ MC\ code\ + \left((PPV * MC\ code) * \left(\frac{1}{PPV} - 1\right)\right)} \quad (10)$$

95% confidence intervals for the sensitivity and specificity were calculated assuming that the calculated positive predictive value and negative predictive value are binomially distributed.

Supplemental results

A flowchart illustrating the application of inclusion and exclusion criteria to the microscopic colitis and diarrheal condition in the differential diagnosis of microscopic colitis cohorts is presented in **Supplemental figure 2**.

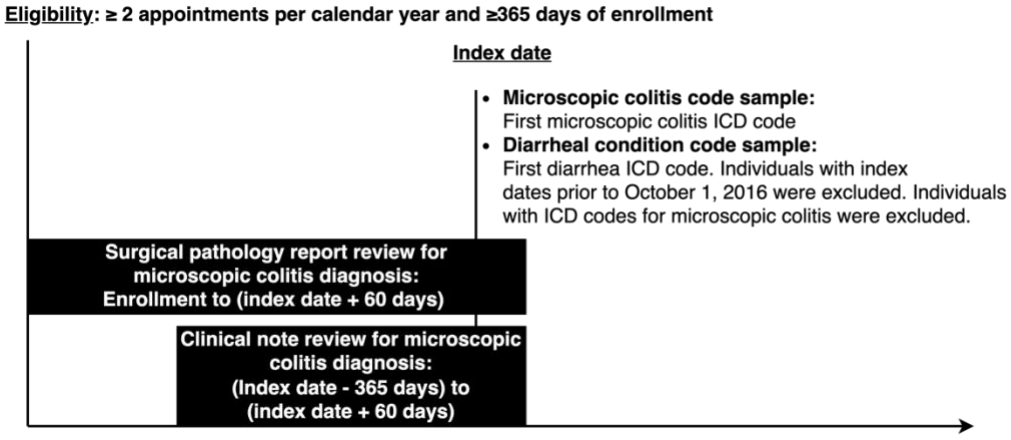
Subgroup analysis of male veterans

The positive predictive value was 134/171 = 0.784. The negative predictive value was 181/182 = 0.995. The sensitivity in the diarrhea cohort and the diarrhea and colonoscopy cohort was 0.889 (95% CI 0.715 – 1.000) and 0.710 (95% CI 0.433 – 1.000), respectively. The specificity in the diarrhea cohort and the diarrhea and colonoscopy cohort was 0.988 (95% CI 0.984 – 0.991) and 0.996 (95% CI 0.995 – 0.997), respectively.

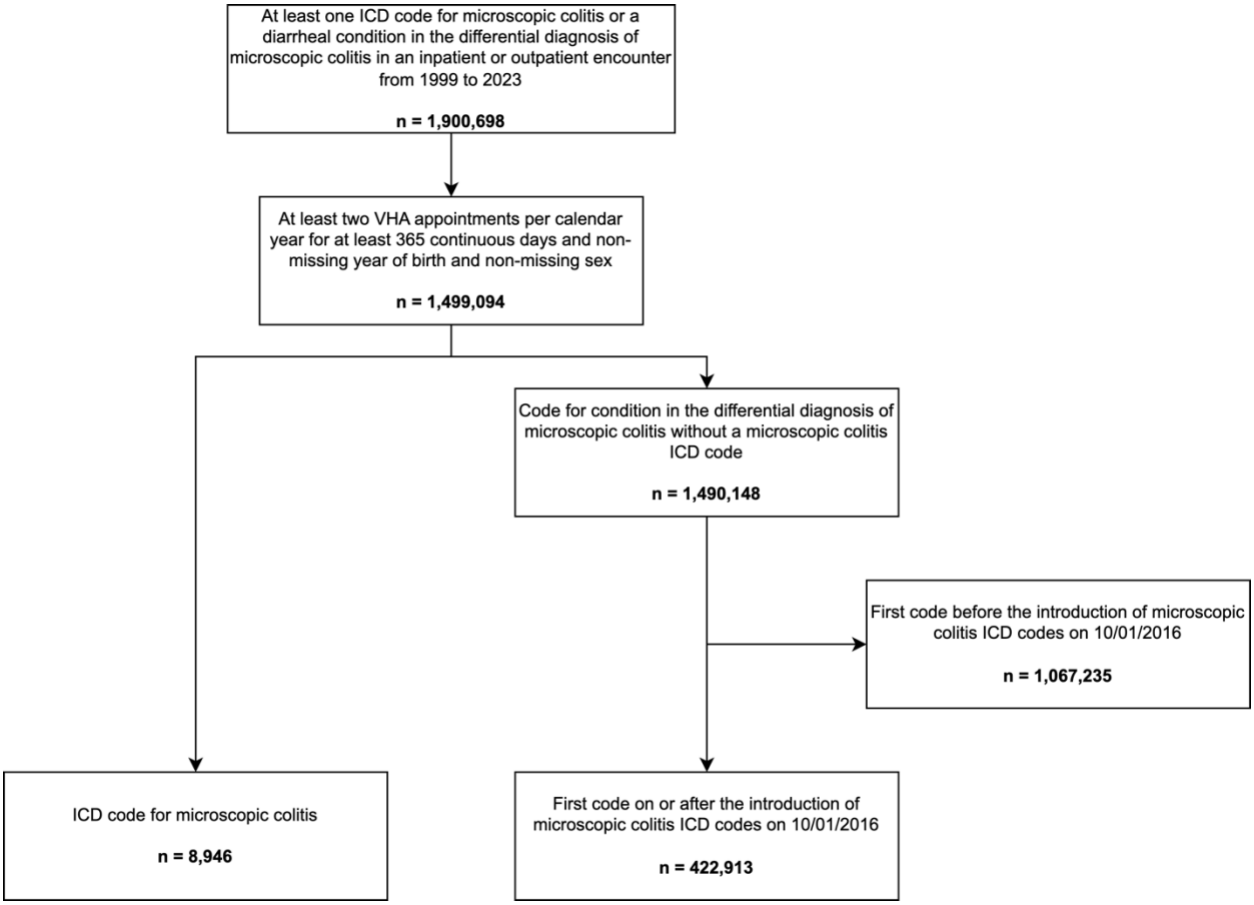
Subgroup analysis of female veterans

The positive predictive value was 24/29 = 0.828. The negative predictive value was 18/18 = 1.000. The sensitivity in the diarrhea cohort and the diarrhea and colonoscopy cohort was 1.000 (95% CI 1.000 – 1.000) and 1.000 (95% CI 1.000 – 1.000), respectively. These sensitivity values are unreliable due to the low number of female veterans reviewed in the diarrheal condition in the differential diagnosis of microscopic colitis sample. The specificity in the diarrhea cohort and the diarrhea and colonoscopy cohort was 0.999 (95% CI 0.998 – 0.999) and 0.996 (95% CI 0.993 – 0.998), respectively.

Supplemental figure 1. Study design illustrating eligibility criteria and validation strategy



Supplemental figure 2. Flow diagram of inclusion/exclusion criteria



Supplemental table 1. ICD-10 codes to identify diarrheal condition code sample

Code	Description
A04.71	Enterocolitis due to Clostridium difficile, recurrent
A04.72	Enterocolitis due to Clostridium difficile, not specified as recurrent
A04.8	Other specified bacterial intestinal infections
A04.9	Bacterial intestinal infection, unspecified
A09	Infectious gastroenteritis and colitis, unspecified
K50.00	Crohn's disease of small intestine without complications
K50.011	Crohn's disease of small intestine with rectal bleeding
K50.012	Crohn's disease of small intestine with intestinal obstruction
K50.013	Crohn's disease of small intestine with abscess
K50.014	Crohn's disease of small intestine with fistula
K50.018	Crohn's disease of small intestine with other complication
K50.019	Crohn's disease of small intestine with unspecified complications
K50.10	Crohn's disease of large intestine without complications
K50.111	Crohn's disease of large intestine with rectal bleeding
K50.112	Crohn's disease of large intestine with intestinal obstruction
K50.113	Crohn's disease of large intestine with fistula
K50.114	Crohn's disease of large intestine with abscess
K50.118	Crohn's disease of large intestine with other complication
K50.119	Crohn's disease of large intestine with unspecified complication
K50.80	Crohn's disease of both small and large intestine without complications
K50.811	Crohn's disease of both small and large intestine with rectal bleeding
K50.812	Crohn's disease of both small and large intestine with intestinal obstruction
K50.813	Crohn's disease of both small and large intestine with fistula
K50.814	Crohn's disease of both small and large intestine with abscess
K50.818	Crohn's disease of both small and large intestine with other complication
K50.819	Crohn's disease with unspecified complications
K50.90	Crohn's disease, unspecified without complications
K50.911	Crohn's disease, unspecified, with rectal bleeding
K50.912	Crohn's disease, unspecified, with intestinal obstruction
K50.913	Crohn's disease, unspecified, with fistula
K50.914	Crohn's disease, unspecified, with abscess
K50.918	Crohn's disease, unspecified, with other complication
K50.919	Crohn's disease, unspecified, with unspecified complications
K51.00	Ulcerative (chronic) pancolitis without complications
K51.011	Ulcerative (chronic) pancolitis with rectal bleeding
K51.012	Ulcerative (chronic) pancolitis with intestinal obstruction

K51.013	Ulcerative (chronic) pancolitis with fistula
K51.014	Ulcerative (chronic) pancolitis with abscess
K51.018	Ulcerative (chronic) pancolitis with other complication
K51.019	Ulcerative (chronic) pancolitis with unspecified complications
K51.20	Ulcerative (chronic) proctitis without complications
K51.211	Ulcerative (chronic) proctitis with rectal bleeding
K51.212	Ulcerative (chronic) proctitis with intestinal obstruction
K51.213	Ulcerative (chronic) proctitis with fistula
K51.214	Ulcerative (chronic) proctitis with abscess
K51.218	Ulcerative (chronic) proctitis with other complication
K51.219	Ulcerative (chronic) proctitis with unspecified complications
K51.30	Ulcerative (chronic) rectosigmoiditis without complications
K51.311	Ulcerative (chronic) rectosigmoiditis with rectal bleeding
K51.312	Ulcerative (chronic) rectosigmoiditis with intestinal obstruction
K51.313	Ulcerative (chronic) rectosigmoiditis with fistula
K51.314	Ulcerative (chronic) rectosigmoiditis with abscess
K51.318	Ulcerative (chronic) rectosigmoiditis with other complication
K51.319	Ulcerative (chronic) rectosigmoiditis with unspecified complications
K51.50	Left sided without complications
K51.511	Left sided with rectal bleeding
K51.512	Left sided with intestinal obstruction
K51.513	Left sided with fistula
K51.514	Left sided with abscess
K51.518	Left sided with other complication
K51.519	Left sided with unspecified complications
K51.80	Other ulcerative colitis without complications
K51.811	Other ulcerative colitis with rectal bleeding
K51.812	Other ulcerative colitis with intestinal obstruction
K51.813	Other ulcerative colitis with fistula
K51.814	Other ulcerative colitis with abscess
K51.818	Other ulcerative colitis with other complication
K51.819	Other ulcerative colitis with unspecified complications
K51.90	Ulcerative colitis, unspecified without complications
K51.911	Ulcerative colitis, unspecified, with rectal bleeding
K51.912	Ulcerative colitis, unspecified, with intestinal obstruction
K51.913	Ulcerative colitis, unspecified, with fistula
K51.914	Ulcerative colitis, unspecified, with abscess
K51.918	Ulcerative colitis, unspecified, with other complication
K51.919	Ulcerative colitis, unspecified, with unspecified complications
K52.3	Indeterminate colitis

K52.89	Other specified noninfective gastroenteritis and colitis
K52.9	Noninfective gastroenteritis and colitis, unspecified
K90.0	Celiac disease
K90.89	Other intestinal malabsorption
K90.9	Intestinal malabsorption, unspecified
R19.7	Diarrhea, unspecified

Supplemental table 3. Colonoscopy procedure codes

Code	Description	Type
45378	Colonoscopy, flexible; diagnostic, including collection of specimen(s) by brushing or washing, when performed (separate procedure)	CPT
45379	Colonoscopy, flexible; with removal of foreign body(s)	CPT
45380	Colonoscopy, flexible; with biopsy, single or multiple	CPT
45381	Colonoscopy, flexible; with directed submucosal injection(s), any substance	CPT
45382	Colonoscopy, flexible; with control of bleeding, any method	CPT
45384	Colonoscopy, flexible; with removal of tumor(s), polyp(s), or other lesion(s) by hot biopsy forceps	CPT
45385	Colonoscopy, flexible; with removal of tumor(s), polyp(s), or other lesion(s) by snare technique	CPT
45386	Colonoscopy, flexible; with transendoscopic balloon dilation	CPT
45388	Colonoscopy, flexible; with ablation of tumor(s), polyp(s), or other lesion(s) (includes pre- and postdilation and guide wire passage, when performed)	CPT
45389	Colonoscopy, flexible; with endoscopic stent placement (includes pre- and postdilation and guide wire passage, when performed)	CPT
45390	Colonoscopy, flexible; with endoscopic mucosal resection	CPT
45391	Colonoscopy, flexible; with endoscopic ultrasound examination limited to the rectum, sigmoid, descending, transverse, or ascending colon and cecum, and adjacent structures	CPT
45392	Colonoscopy, flexible; with transendoscopic ultrasound guided intramural or transmural fine needle aspiration/biopsy(s), includes endoscopic ultrasound examination limited to the rectum, sigmoid, descending, transverse, or ascending colon and cecum, and adjacent structures	CPT
45393	Colonoscopy, flexible; with decompression (for pathologic distention) (eg, volvulus, megacolon), including placement of decompression tube, when performed	CPT
45398	Colonoscopy, flexible; with band ligation(s) (eg, hemorrhoids	CPT