

# Practice and documentation of performance of colonoscopy in a central Canadian health region

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**OBJECTIVE:** To evaluate the reporting and performance of colonoscopy in a large urban centre.

**METHODS:** Colonoscopies performed between January and April 2008 in community hospitals and academic centres in the Winnipeg Regional Health Authority (Manitoba) were identified from hospital discharge databases and retrospective review of a random sample of identified charts. Information regarding reporting of colonoscopies (including bowel preparation, photodocumentation of cecum/ileum, size, site, characteristics and method of polyp removal), colonoscopy completion rates and follow-up recommendations was extracted. Colonoscopy completion rates were compared among different groups of physicians.

**RESULTS:** A total of 797 colonoscopies were evaluated. Several deficiencies in reporting were identified. For example, bowel preparation quality was reported in only 20%, the agent used for bowel preparation was recorded in 50%, photodocumentation of colonoscopy completion in 6% and polyp appearance (ie, pedunculated or not) in 34%, and polyp size in 66%. Although the overall colonoscopy completion rate was 92%, there was a significant difference among physicians with varying medical specialty training and volume of procedures performed. Recommendations for follow-up procedures (barium enema, computed tomography colonography or repeat colonoscopy) were recorded for a minority of individuals with reported poor bowel preparation or incomplete colonoscopy.

**CONCLUSIONS:** The present study found many deficiencies in reporting of colonoscopy in typical, city-wide clinical practices. Colonoscopy completion rates varied among different physician specialties. There is an urgent need to adopt standardized colonoscopy reporting systems in everyday practice and to provide feedback to physicians regarding deficiencies so they can be rectified.

**Key Words:** Colonoscopy; Colonoscopy completion; Documentation

Colonoscopy has become the most commonly performed endoscopic procedure (1). The annual number of colonoscopies performed for both diagnostic and screening indications has increased rapidly as the population has grown older; the procedure has become preferred over radiology contrast imaging, and with increasing uptake of colorectal cancer (CRC) screening and surveillance (2). Irrespective of the initial test used for CRC screening, colonoscopy remains the essential final step in the screening and diagnosis of most CRCs and colon polyps.

Several studies, however, have reported that colonoscopy is much less effective in detecting proximal colon (ie, right-sided) CRCs than distal (ie, left-sided) CRCs (3-5). Several studies have also suggested

## L'exercice et la consignation de la coloscopie dans une région sanitaire du centre du Canada

**OBJECTIF :** Évaluer la consignation et l'exécution de la coloscopie dans un grand centre urbain.

**MÉTHODOLOGIE :** Les chercheurs ont extrait les coloscopies exécutées entre janvier et avril 2008 dans des centres hospitaliers communautaires et universitaires de l'Office régional de santé de Winnipeg, au Manitoba, contenues dans les bases de données des congés hospitaliers et l'analyse rétrospective d'un échantillon aléatoire de dossiers sélectionnés. Ils en ont tiré l'information relative à la consignation des coloscopies (y compris la préparation intestinale, la documentation photo du cæcum et de l'iléon, ainsi que la dimension, les caractéristiques et la méthode d'ablation des polypes), le taux d'achèvement des coloscopies et les recommandations de suivi. Ils ont comparé le taux d'achèvement des coloscopies entre les divers groupes de médecins.

**RÉSULTATS :** Au total, les chercheurs ont évalué 797 coloscopies, et ils ont repéré plusieurs lacunes de consignation. Par exemple, la qualité de la préparation intestinale était précisée dans 20 % des cas seulement, l'agent utilisé pour la préparation intestinale, dans 50 % des cas, la documentation photo de l'achèvement de la coloscopie, dans 6 % des cas, l'apparence des polypes (pédunculée ou non), dans 34 % des cas, et la dimension des polypes, dans 66 % des cas. Même si le taux global d'achèvement des coloscopies s'élevait à 92 %, il y avait des différences significatives entre médecins selon la spécialité et le volume d'interventions exécutées. Les recommandations sur les interventions de suivi (lavement baryté, coloscopie par tomomodensitométrie ou reprise de la coloscopie) étaient consignées pour une minorité de patients dont la préparation était mauvaise ou la coloscopie, incomplète.

**CONCLUSIONS :** La présente étude a démontré plusieurs lacunes dans la consignation de la coloscopie au sein des pratiques cliniques urbaines ordinaires. Le taux d'achèvement des coloscopies variait selon les spécialités. Il est urgent d'adopter des systèmes standardisés de consignation des coloscopies dans la pratique quotidienne, de même que de souligner aux médecins les lacunes qui peuvent être rectifiées.

that colonoscopy, as performed in usual clinical practice, is less effective in reducing CRC incidence and mortality due to proximal colon CRC than to distal colon CRC (4,6). However, other studies have reported a large reduction in subsequent incidence and mortality due to proximal colon CRC postcolonoscopy (7-9). The differences in the performance of colonoscopy by different health care providers may be responsible for these apparently inconsistent findings from different studies. While the biology of proximal and distal CRCs may be different, colonoscopy technique is considered to be an important cause of missed proximal colon lesions. This may be because of incomplete colonoscopies (not examining the entire proximal colon), lack of

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recognition of subtle lesions and/or poor bowel preparation. Hence, over the past decade, there has been an increasing emphasis on assessment and enhancement of colonoscopy performance (1,10).

We performed a retrospective review of reports of the colonoscopies performed in our large health care region to assess the performance and recording of colonoscopies in our region.

## METHODS

Manitoba is a central Canadian province with a population of 1.25 million. Approximately two-thirds of the colonoscopies in the province are performed in the capital city of Winnipeg. The majority (85%) of the colonoscopies performed in the city are through the six hospitals and their affiliated endoscopy units, all of which are administered by a single regional health authority, the Winnipeg Regional Health Authority (WRHA). The current study was performed as a quality assessment and improvement project. The study was a practice audit performed for the WRHA's Medicine Standards Committee and was, therefore, exempt from ethics board review. Identifying information accessed by the WRHA Standards Committees and the audit teams are protected by law from disclosure to anyone, including WRHA management and administration.

All hospitals in Manitoba abstract admission and discharge information on outpatient (day surgery) endoscopies performed in hospitals, in addition to all inpatients. Hospital discharge abstracts are reported to Manitoba Health (MH), which reports to the Canadian Institute for Health Information. MH is the provincial agency with overall responsibility for health care in the entire province. In addition to submitting to MH, all hospitals in Winnipeg also submit hospital discharge abstracts to the WRHA, which maintains a decision support system to aid in the planning of the services in the city.

An electronic search of WRHA decision support system was performed to identify all individuals  $\geq 16$  years of age who underwent a lower gastrointestinal endoscopy at one of the six hospitals in Winnipeg between January 1 and March 31, 2008. The Canadian Classification of Interventions codes 1.NM.?.BA\*, 2.NM.?.BA\*, 1.NP.13.BA\* and 2.NK.?.BA.I were used to identify the lower gastrointestinal endoscopies. A random sample of 25% of the procedures performed in this time period was reviewed. Individuals identified in the chart review to have undergone previous colorectal surgery or flexible sigmoidoscopies instead of colonoscopies on the index date were excluded. However, the procedures reported as flexible sigmoidoscopy were included when the intent of the examination (determined from the review of the preprocedure information) was colonoscopy, but the procedure was stopped in the distal colon. For the individuals who underwent multiple colonoscopies, only the first colonoscopy performed in the study time period was included.

A trained, experienced nurse auditor abstracted information from the charts including patient demographics, comorbidities, indication for the procedures, laxative agent(s) used for bowel preparation, sedative agent and dose used, duration of the procedure, extent of the colon examined (as reported by the endoscopists), documentation of quality of bowel preparation on colonoscopy, documentation of colonic polyps, method of colonic polyp removal and follow-up recommendations, including that for those with incomplete colonoscopies, those with poor bowel preparation and polyps.

## Statistical analysis

Results were tabulated using standard descriptive analyses. Fisher's exact test was used to compare differences in proportions. A priori, it was planned to compare colonoscopy reporting and completion rate between different groups of endoscopists (physician medical speciality, volume of procedures performed) and site of the procedure. Multivariate logistic regression analysis was performed to determine the association of physician medical speciality, volume of procedures performed or hospital site of the procedure with incomplete colonoscopies, with adjustment for patient age, sex, inpatient versus outpatient status and indication for the procedure (CRC screening/surveillance versus

diagnostic). There were correlations between volume of procedures performed, physician medical speciality and hospital site of endoscopy and, hence, to avoid multicollinearity, effect of physician medical speciality, volume of procedures performed and hospital site were assessed in separate models.

Because the number of colonoscopies performed by general practitioners was small, they were not included in the comparison between physician medical specialities. In addition, six cases, for which the end point reached during colonoscopy was not recorded, were excluded from the analysis of colonoscopy completion rate. In the primary analysis, the colonoscopy was considered to be complete when the end point reached was recorded to be the cecum, ileum or the ileocecal valve. Because visualization of the cecal pole is important to complete a colonoscopy and is not feasible in some cases, in sensitivity analyses, those with the recorded end point of ileocecal valve were considered to be incomplete colonoscopies. Overall colonoscopy completion rate and adjusted colonoscopy completion rate (excluding cases with mass lesions, strictures, and severe colitis from both the numerator and the denominator) were calculated.

## RESULTS

A total of 797 patients (44% men; median age 59 years [interquartile range (IQR) 49 to 69 years]; 78% residents of Winnipeg) and their colonoscopies were included in the study. There were 65 (8%) inpatients and 239 (30%) were performed in one of the two teaching hospitals. Gastroenterologists performed 339 (43%) of the procedures, general surgeons 415 (52%) and general practitioners 43 (5%). Snare polypectomy was performed during 20% of the colonoscopies and biopsies during an additional 28%. A slightly higher proportion of colonoscopies performed for individuals  $>50$  years of age were accompanied by snare polypectomy (24%).

The most common recorded comorbidities included hypertension (26%), diabetes (14%), obesity (9%), previous diagnosis of any cancer (8%), coronary artery disease (6%) and asthma (6%).

## Indications for the procedures

Of the 732 colonoscopies performed on outpatients, 25% (n=183) were performed for CRC screening and/or surveillance, but only 2% were recorded to be performed for primary, average-risk CRC screening. Other CRC screening/surveillance indications included family history of CRC (17%), a personal history of colon polyps (12%), positive fecal occult blood test (5%) and family history of colon polyps (1%). The most common symptoms for outpatient colonoscopy included rectal bleeding (20%), abdominal pain (11%), anemia (9%), diarrhea (7%), inflammatory bowel disease (4%) and change in bowel habits (4%).

The most common indications for colonoscopies for hospitalized inpatients included rectal bleeding (42%), diarrhea (21%), anemia (18%) and abdominal pain (15%).

Of the 74 colonoscopies performed for diarrhea, one-third (n=25) did not have a biopsy performed.

## Agents used for bowel preparation before the colonoscopy

Five hospitalized patients underwent colonoscopy for rectal bleeding without bowel preparation. For another nine (1% [all outpatients]), there was no documentation as to whether bowel preparation was used. Of the remaining 783 procedures, the specific agent used was recorded for only 388 (49.6%). Sodium picosulfate was the most common agent used (67%), followed by polyethylene glycol 3350 with electrolytes oral solution (20%) and, for the remainder of cases, varying combinations of oral phospho soda, magnesium citrate, enemas and bisacodyl (oral or rectal) were used.

## Quality of bowel preparation during colonoscopy

A vast majority (80%) of cases did not have documentation regarding the quality of the bowel preparation in the report, with wide variation among the six hospitals, but not between gastroenterologists and general surgeons or according to volume of procedures performed (Table 1).

The documentation was not limited to cases with poor bowel preparation because two-thirds of the cases in which quality of bowel preparation was recorded were rated to have adequate, good or excellent preparation.

The colonoscopy completion rate was 89% for the cases with recorded quality of bowel preparation during colonoscopy: 71% for those with poor preparation and 100% for those with excellent preparation. Of cases with poor preparation and complete colonoscopy, 36% were reported to have colonic polyps.

### Sedation

A majority (99%) of the procedures were performed using midazolam and/or fentanyl (97% both drugs). Only four procedures were performed without sedation and another four received propofol. Most individuals (68%) received between 3 mg and 5 mg of midazolam and 50 µg to 100 µg of fentanyl (referred to as the 'usual dose' in the present study), with a median dose of 5 mg for midazolam and 100 µg for fentanyl.

Although there was no difference between the gastroenterologists and general surgeons with regard to the use of more than the usual dose of sedation, a higher proportion of procedures performed by gastroenterologist involved lower-than-usual doses (4% versus 12% for general surgeons;  $P<0.001$ ). A higher proportion of incomplete colonoscopies received lower than the usual dose (23% versus 5%;  $P<0.001$ ).

### Colonoscopy completion rate

Photographic documentation of the cecum and/or ileum was recorded in 6% of cases and ileal biopsy was obtained in an additional 5%. For the remainder of the cases, the authors had to rely on self-reported end points. Of note, equipment for photodocumentation was available at all sites during the time period the colonoscopies in the study were performed.

The most common reasons listed for the 65 incomplete colonoscopies were: poor bowel preparation (22%); inability to advance because of patient discomfort (14%); patient safety (11%); and/or looping of the colonoscope (8%).

The overall colonoscopy completion rate was 92% (726 of 791 cases) and the adjusted colonoscopy completion rate was 94% (722 of 772 cases). After excluding cases with documented poor bowel preparation, the adjusted colonoscopy completion rate was 95% (686 of 723 cases). Considering the cases in which the recorded end point reached was the ileocecal valve as incomplete colonoscopies, the overall colonoscopy completion rate was 89% (703 of 791) and adjusted colonoscopy completion rate was 91% (700 of 772 cases).

The inpatients had a lower colonoscopy completion rate, as did the procedures performed by general surgeons (Table 2). There was no significant difference with regard to age, sex or indication of the procedure (CRC screening/surveillance versus diagnostic). There was a significant difference in colonoscopy completion rates among the different hospitals, with a higher proportion of the procedures performed by general surgeons at the hospitals with a lower completion rate. When the cases with the reported end point of ileocecal valve were included among the incomplete colonoscopies, the difference between gastroenterologists and general surgeons was larger (overall colonoscopy completion rate: general surgeons 84%, gastroenterologists 94%; adjusted colonoscopy completion rate: general surgeons 86%, gastroenterologists 97%;  $P<0.001$  for both comparisons). The colonoscopy completion rate was higher for the group of endoscopists with higher procedure volume (Table 2). Of the 42 endoscopy physicians included in the present study, 10 with the lowest completion rate (eight general surgeons) performed 55% of the incomplete colonoscopies; the colonoscopy completion rate among these physicians ranged between 76% and 86%. In the multivariate analysis, the difference among hospitals, physician medical specialties and according to procedure volume persisted (Table 3).

TABLE 1

Documentation of quality of bowel preparation during colonoscopy performed in Winnipeg (Manitoba) hospitals between January 1 and March 31, 2008

	Proportion of cases with no documentation of quality of bowel preparation during colonoscopy, %	P
Hospital site		<0.001
A	94	
B	76	
C	70	
D	58	
E	83	
F	85	
Physician medical speciality		1.00
General surgery	80	
Gastroenterology	79	
Volume of procedures performed*		0.43
Quartile 1 (<16 procedures)	79	
Quartile 2 (17–21 procedures)	84	
Quartile 3 (22–25 procedures)	82	
Quartile 4 (>25 procedures)	78	

\*Quartiles were defined by number of physicians, which were 11, 11, 10 and 10 in the four groups, respectively. The volume of procedures was based on the colonoscopies included in the study, which would translate to annualized procedure volume quartiles of <256, 272 to 336, 352 to 400, and >400 per year

### Duration of procedure

The median duration of colonoscopy (without biopsy or polypectomy) was 14 min (IQR 10 min to 20 min) and for incomplete colonoscopies was 21 min (IQR 12 min to 26 min). The withdrawal time was not documented for any cases.

The median duration of patient stay at the hospitals from admission to discharge for outpatients was 2.9 h (IQR 2.5 h to 3.4 h).

### Polyp findings

Thirty-one percent ( $n=250$ ) of the cases were documented to have colonic polyps and 3.3% ( $n=26$ ) had suspected CRC. Of the 401 polyps reported in the study, 66% ( $n=263$ ) had comments regarding their size; among the 250 patients with polyps, size was mentioned for 72% ( $n=180$ ). There was no mention of colonic site for 2% of the polyps and, for another 6%, the polyp site was mentioned as a distance from the anal verge. There was no mention as to how 10% of the polyps were managed; 41% were removed with a snare, 33% with biopsy, 11% with hot biopsy and 5% were cauterized. For only 34% of the polyps, there was mention as to whether the polyps were sessile, flat or pedunculated.

### Complications

A reversal agent for sedation was used in a single case and two patients experienced vasovagal episodes.

### Follow-up recommendations

Of the 52 cases with documented poor bowel preparation, recommendations for follow-up procedures (barium enema, computed tomography colonography or repeat colonoscopy) were recorded for 21% ( $n=11$ ). Similarly, of the 50 cases with incomplete colonoscopy and no structural lesions, 50% ( $n=25$ ) had recommendations for follow-up procedures recorded.

Of the 250 cases with polyps, no follow-up recommendations were recorded for 28% ( $n=69$ ). Follow-up was considered to include scheduling an office visit to discuss pathology, follow-up colonoscopy or simply a mention that follow-up would be decided based on the pathology results. Of the 53 cases with one or two low-risk polyps (<1 cm in size

**TABLE 2**

**Overall and adjusted colonoscopy completion rates, stratified according to type of procedure, indication of procedure, patient characteristics and site of the procedure for colonoscopies performed in Winnipeg (Manitoba) hospitals between January 1 and March 31, 2008**

Variable	Colonoscopy		P	Adjusted colonoscopy completion rate, %	P
	Total number	Overall completion rate, %			
Colonoscopy with or without additional procedures			0.08		0.01
Colonoscopy alone	416	90		91	
Colonoscopy with biopsy	219	95		97	
Colonoscopy with polypectomy	156	92		95	
Outpatient versus inpatient			<0.01		0.02
Outpatient	729	93		94	
Inpatient	62	76		85	
Patient age, years			0.24		0.87
<50	211	94		94	
≥50	580	91		93	
Patient sex			0.70		0.66
Male	352	92		94	
Female	439	91		93	
Sex and age, years			0.55		0.84
Male <50	91	96		96	
Female <50	120	93		92	
Male ≥50	261	91		93	
Female ≥50	319	91		93	
Procedure indication			0.17		0.39
Colorectal cancer screening/surveillance	182	95		95	
Diagnostic	609	91		93	
Hospital site			0.03		0.02
A	124	87		89	
B	99	87		88	
C	124	94		97	
D	115	92		93	
E	114	92		94	
F	215	96		97	
Physician medical speciality			<0.01		<0.01
Gastroenterology	337	96		97	
General surgery	411	89		91	
Volume of procedures performed*			<0.01		<0.01
Quartile 1 (<16 procedures)	73	89		89	
Quartile 2 (17–21 procedures)	156	87		89	
Quartile 3 (22–25 procedures)	180	90		92	
Quartile 4 (>25 procedures)	382	95		96	

\*Quartiles were defined by number of physicians, which were 11, 11, 10 and 10 in the four groups, respectively. The volume of procedures is based on the colonoscopies included in the study, which would translate to annualized procedure volume quartiles of <256, 272 to 336, 352 to 400, and >400 per year

and no villous features or high-grade dysplasia on the subsequent pathology report) and a recommendation for follow-up colonoscopy, colonoscopy was recommended within five years for 58% (n=31).

### DISCUSSION

The present study suggests that overall, the colonoscopy completion rate in the WRHA was within the recommended range in 2008, albeit at the lower limit and less than that reported in other major centres (11). However, completion rates are only one aspect of measuring the adequacy of colonoscopy. There were considerable differences between different groups of physicians performing the colonoscopy. There were several deficiencies in reporting, including quality of the bowel preparation, photodocumentation, polyp characteristics and follow-up recommendations. Many individuals with small colonic polyps were recommended surveillance colonoscopies at short intervals.

The recommended overall colonoscopy completion rate is at least 90% (10,11). In our study, the gastroenterologists, as a group, had an

overall colonoscopy completion rate of 96%. Several other series involving expert endoscopists have also reported higher completion rates (11). Our study results from a large city wide practice suggest that overall colonoscopy completion rates >95% are achievable in usual clinical practice. Therefore, based on our study results and those of previous studies, and to ensure that most patients receive high-quality care, we believe the minimum acceptable overall colonoscopy completion rate should be immediately increased to >95%.

The wide variation in colonoscopy performance, including colonoscopy completion rates among different gastroenterologists versus surgical endoscopists, is potentially contributing to the variation in CRC incidence and mortality after performance of colonoscopy. This includes differences between proximal and distal colonic CRC cancer protection afforded by colonoscopy as well as in terms of interval cancers, all of which have been reported by us for colonoscopies performed in Manitoba (3,6,12).

Although the 31% polyp detection rate in our study was greater than the recommended adenoma detection rate of 25% for men and



15% for women (10) (and similar to the equivalent polyp detection rate of 40% and 30%, respectively, among men and women [13]), the poor recording of polyp characteristics is surprising. The follow-up for polyps is dependent on their size, which must be dependent on the assessment during colonoscopy for polyps resected piecemeal. In addition, the management of polyps found to be malignant on pathology assessments is different for pedunculated polyps (colonoscopic polypectomy is considered to be adequate and full treatment, if the histology is favourable) and nonpedunculated polyps (surgery must be considered for most).

The follow-up recommendations recorded in our study suggest many individuals may not be obtaining appropriate follow-up (no follow-up for incomplete colonoscopy or colonoscopy with poor bowel preparation) or surveillance colonoscopy at short intervals for those with low-risk polyps.

Our study highlights the need for standardized training, and clinical practice and colonoscopy reporting templates. Endoscopists should be provided with report cards detailing their colonoscopy completion rates and adequacy of procedure documentation. If one completes a colonoscopy to the cecum, but the bowel preparation was very poor, it has very different implications for outcomes and future plans. An electronic endoscopy reporting system with mandatory data entry fields would facilitate better recording of findings on colonoscopy, follow-up recommendations and generation of report cards for individual physicians. Regular provision of report cards to endoscopists has been associated with improved colonoscopy quality indicators (14) including colonoscopy completion rates (15). Alternatively, especially when electronic endoscopy reporting systems are not financially feasible, endoscopists could be mandated to participate in practice audit programs such as those offered by the Canadian Association of Gastroenterology, which provide feedback to individual endoscopists. However, such practice audit programs do not provide individual endoscopist-level data to the directors of endoscopy units and, therefore, do not allow for discussion among individual endoscopists and their unit directors, as may be necessary when feedback does not lead to practice change.

In the absence of independent verification of colonoscopy preparation quality, a report of 'poor prep' may be justification for – rather than the cause of – an incomplete colonoscopy. Therefore, the proportion of colonoscopies with reported poor colonoscopy preparation should be monitored as one of the colonoscopy quality measures. In addition, because of the possibility of attempts to 'game' the system by reporting 'poor prep' when the colonoscopy cannot be completed, we believe when colonoscopy quality measures are regularly recorded and reported, it is preferable to report on overall colonoscopy completion rates.

In 2008, an endoscopy redesign initiative was introduced by the WRHA internal medicine and surgery programs to streamline and standardize the delivery of the endoscopy services in Winnipeg. Our study results have provided background information on the practice patterns for the proposals submitted and currently pending with the provincial government for improving delivery and documentation of endoscopy services in the city, and for facilitating individual physician feedback as a nonthreatening learning and information tool.

Our results should be interpreted in the context of study strengths and limitations. The present study was an evaluation of a city-wide practice of a large number of endoscopists (n=42). Because the analysis was performed retrospectively, there was no incentive for the physicians to modify their usual clinical practices in response to observations (Hawthorne effect, which may skew actual practice). This was a chart review rather than an analysis of administrative claims data, in which the reporting of colonoscopy completion may be altered if the reimbursements are linked to the reported colonoscopy completion. We were able to incorporate intent of the procedures and, hence, the colonoscopies that were reported as flexible sigmoidoscopies were considered to be incomplete. However, because several potential predictors of interest (physician medical specialty, place of practice and procedure volumes) correlated with one another (general surgeons

**TABLE 3**  
**Multivariate logistic regression analysis for overall incomplete colonoscopies performed in Winnipeg (Manitoba) hospitals between January 1 and March 31, 2008**

Variable*	Adjusted OR† (95% CI)
Physician medical specialty	
General surgery	3.19 (1.68–6.07)
Gastroenterology	Reference
Hospital site	
A	3.20 (1.35–7.59)
B	3.27 (1.33–8.04)
C	1.41 (0.52–3.96)
D	2.29 (0.89–5.91)
E	1.61 (0.60–4.30)
F	Reference
Volume of procedures performed‡	
Quartile 1 (<16 procedures)	2.91 (1.19–7.12)
Quartile 2 (17–21 procedures)	3.37 (1.71–6.62)
Quartile 3 (22–25 procedures)	2.30 (1.15–4.60)
Quartile 4 (>25 procedures)	Reference

\*Separate models were developed for physician medical specialty, hospital site and volume of procedures performed; †Adjusted for patient age, sex, inpatient versus outpatient status and indication of the procedure (colorectal cancer screening/surveillance versus diagnostic); ‡Quartiles were defined by number of physicians, which were 11, 11, 10 and 10 in the four groups, respectively. The volume of procedures is based on the colonoscopies included in the study, which would translate to annualized procedure volume quartiles of <256, 272 to 336, 352 to 400, and >400 per year

performed lower volume of procedures at certain hospitals), we were unable to determine the independent effect of some of these factors. Nevertheless, this does not limit the most important interpretation of our results in that there are significant differences among physicians with regard to reporting of colonoscopy and colonoscopy completion rates. Further improvement and education efforts should focus on individual physicians rather than groups of physicians because there is likely a difference, even within the different groups. We did not have a sufficient number of procedures per endoscopist to be able to provide stable individual estimates, which will be feasible only when data are collected electronically. Our colonoscopy completion rate calculations were based on individual physician reporting rather than photodocumentation. Our estimate of the effect of procedure volume was based on the colonoscopies randomly included in the study, which, however, does correlate with the annual volume of endoscopic procedures performed (data not shown). We have reported on colonoscopies performed several years ago and it is possible that practice patterns have changed regarding endoscopy in Winnipeg; however, considering that reporting methods have not changed across the entire region and our personal practice review of contemporary reports suggests they are still lacking, we do not believe the passage of five years would have markedly altered the data.

## CONCLUSION

The present study demonstrated that, while recommended colonoscopy completion rates were being achieved by most physicians (of various backgrounds) in usual clinical practice in 2008, there were significant variations among different groups of physicians and some individual physicians may have much lower colonoscopy completion rates. Poor colonoscopy reporting is extremely common in usual clinical practice. There is an urgent need for adoption of standardized mandatory reporting systems.

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