Rates of minor adverse events and health resource utilization postcolonoscopy

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BACKGROUND: Little is known about minor adverse events (MAEs) following outpatient colonoscopies and associated health care resource utilization.
OBJECTIVE: To estimate the rates of incident MAE at two, 14 and 30 days postcolonoscopy, and associated health care resource utilization. A secondary aim was to identify factors associated with cumulative 30-day MAE incidence.
METHODS: A longitudinal cohort study was conducted among individuals undergoing an outpatient colonoscopy at the Montreal General Hospital (Montreal, Quebec). Before colonoscopy, consecutive individuals were enrolled and interviewed to obtain data regarding age, sex, comorbidities, use of antiplatelets/anticoagulants and previous symptoms. Endoscopy reports were reviewed for intracolonoscopy procedures (biopsy, polypectomy). Telephone or Internet follow-up was used to obtain data regarding MAEs (abdominal pain, bloating, diarrhea, constipation, nausea, vomiting, blood in the stools, rectal or anal pain, headaches, other) and health resource use (visits to emergency department, primary care doctor, gastroenterologist; consults with nurse, pharmacist or telephone hotline). Rates of incident MAEs and health resources utilization were estimated using Bayesian hierarchical modelling to account for patient clustering within physician practices.
RESULTS: Of the 705 individuals approached, 420 (59.6%) were enrolled. Incident MAE rates at the two-, 14- and 30-day follow-ups were 17.3% (95% credible interval [CrI] 8.1% to 30%), 10.5% (95% CrI 2.9% to 23.7%) and 3.2% (95% CrI 0.01% to 19.8%), respectively. The 30-day rate of health resources utilization was 1.7%, with 0.95% of participants seeking the services of a physician. No predictors of the cumulative 30-day incidence of MAEs were identified.
DISCUSSION: The incidence of MAEs was highest in the 48 h following colonoscopy and uncommon after two weeks, supporting the Canadian Association of Gastroenterology's recommendation for assessment of late complications at 14 days. Predictors of new onset of MAEs were not identified, but wide CrIs did not rule out possible associations. Although <1% of participants reported consulting a physician for MAEs, this figure may represent a substantial number of visits given the increasing number of colonoscopies performed annually.
CONCLUSION: Postcolonoscopy MAEs are common, occur mainly in the first two weeks postcolonoscopy and result in little use of health resources.

Key Words: *Colonoscopy; Health services utilization; Minor adverse events; Patient-centred care*

Le taux d'événements indésirables mineurs et d'utilisation des ressources de santé après une coloscopie

HISTORIQUE : On ne sait pas grand-chose des événements indésirables mineurs (ÉIM) qui suivent les coloscopies ambulatoires et de l'utilisation des ressources de santé qui s'y rattachent.
OBJECTIF : Évaluer le taux d'ÉIM deux, 14 et 30 jours après la coloscopie, de même que l'utilisation des ressources de santé s'y rapportant. L'objectif secondaire consistait à déterminer les facteurs associés à l'incidence d'ÉIM cumulatifs au bout de 30 jours.
MÉTHODOLOGIE : Les chercheurs ont mené une étude de cohorte auprès de personnes qui subissaient une coloscopie ambulatoire à l'Hôpital général de Montréal (HGM), au Québec. Avant la coloscopie, des personnes consécutives ont été enrôlées et interviewées. Elles ont donné de l'information sur leur âge, leur sexe, leurs comorbidités, leur utilisation d'antiplaquettaires et d'anticoagulants ainsi que leurs symptômes antérieurs. Les chercheurs ont examiné les rapports d'endoscopie pour connaître l'intervention privilégiée (biopsie, polypectomie). Lors du suivi par téléphone ou par Internet, les chercheurs ont obtenu les données relatives aux ÉIM (douleurs abdominales, gonflements, diarrhée, constipation, nausées, vomissements, sang dans les selles, douleurs rectales ou anales, céphalées, autre) et à l'utilisation des services de santé (visite à l'urgence, rendez-vous avec le médecin de première ligne ou le gastroentérologue, consultations avec une infirmière, un pharmacien ou une ligne téléphonique d'urgence). Ils ont évalué le taux d'ÉIM et d'utilisation des ressources de santé au moyen du modèle bayésien hiérarchique pour tenir compte du regroupement de patients au sein des pratiques des médecins.
RÉSULTATS : Sur les 705 personnes abordées, 420 (59,6 %) ont participé. Les taux d'ÉIM au suivi au bout de deux, 14 et 30 jours s'élevaient à 17,3 % (95 % intervalle de crédibilité [ICr] 8,1 % à 30 %), 10,5 % (95 % ICr 2,9 % à 23,7 %) et 3,2 % (95 % ICr 0,01 % à 19,8 %), respectivement. Le taux d'utilisation des ressources de santé au bout de 30 jours était de 1,7 %, puisque 0,95 % des participants avaient recouru aux services d'un médecin. Aucun prédicteur d'occurrence d'ÉIM n'a été déterminé.
EXPOSÉ : L'incidence d'ÉIM était plus élevée dans les 48 heures suivant la coloscopie et très basse au bout de deux semaines, ce qui appuie la recommandation d'évaluer les complications tardives au quatorzième jour, émise par l'Association canadienne de gastroentérologie. Les prédicteurs de nouveaux ÉIM n'ont pas été établis, mais les vastes ICr n'écartaient pas la possibilité d'associations. Même si moins de 1 % des participants déclaraient avoir consulté un médecin en raison d'ÉIM, ce résultat peut représenter un nombre substantiel de rendez-vous, car de plus en plus de coloscopies sont effectuées chaque année.
CONCLUSION : Les ÉIM sont courantes après la coloscopie, surtout dans les deux semaines suivant l'intervention, mais nécessitent peu de ressources de santé.

In Canada, colorectal cancer (CRC) is the second leading cause of cancer death and the fourth most common cancer diagnosed overall (1). It is possible to decrease the mortality related to CRC by screening, which is now recommended for all Canadians 50 through 75 years of age who are at average risk for developing CRC (ie, no personal or familiar risk factors other than age) (2). For most individuals, CRC screening begins with stool testing, followed by colonoscopy when the stool test is positive. Colonoscopy is the recommended modality for individuals at higher risk for CRC including those with a family history of CRC or personal history of polypectomy (3-5). While many Canadian provinces have implemented organized screening programs in the past three years, including quality assurance structures aimed at

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ensuring delivery of high standard care (6), most CRC screening in the province of Quebec is peformed opportunistically.

Extensive research and recommendations have been made to enhance the quality of all colonoscopies. The resulting quality indicators have focused primarily on physician performance (adenoma detection rate, cecal intubation rate and colonoscope withdrawal time) and safety (serious adverse events rate). As interest in the patient-centred care model shifts attention to patient satisfaction and comfort (7,8), information regarding the incidence of minor adverse events (MAEs), which do not result in hospitalization but cause significant discomfort, becomes important. To date, the few studies that have addressed MAEs after colonoscopy have reported rates that vary from 16.6% to 40.7% (9-15). These studies were heterogeneous in terms of the definitions of MAEs and the time points for their evaluation. Some studies failed to indicate the indication for colonoscopy (screening/nonscreening); calculate the MAE rates according to the endoscopic procedure (gastroscopy or colonoscopy); report the performance of intracolonoscopy procedures (polypectomy, biopsy) that could increase the risk of adverse events; and evaluate the presence of the discomfort before colonoscopy. In other studies, recall bias may have influenced the estimated rates, especially for lengthy follow-up intervals. Conducting a longitudinal study that includes short, medium and lengthy follow-up would not only provide better estimates of the rates and nature of MAEs, it would also yield information as to when these events occur.

Increasing our knowledge of the health resources used for post-colonoscopy MAEs would be helpful in decreasing unnecessary utilization. However, data are scant and substantial variability exists in the services assessed (12,13,16). Some studies included visits to the emergency department but did not include visits to primary care physicians, walk-in clinics or telephone consultations (16). In contrast, other studies considered visits to the emergency department as serious adverse events independent of the final discharge diagnosis (12,13), or relied on diagnosis and procedure codes (ie, *International Classification of Diseases, Ninth and 10th Revisions*) that would not capture MAEs.

Thus, the purpose of the present study was to estimate the rates and nature of incident MAEs at three assessment time points and 30-day cumulative incidence following outpatient colonoscopy, and the rate of health care resources use (visits to the emergency department, primary care doctor or gastroenterologist, and consultations with nurse(s), pharmacists or use of a telephone hotline) that resulted from MAEs. A secondary aim was to identify factors associated with the 30-day cumulative incidence of MAEs.

METHODS

Data collection

A longitudinal cohort study was conducted at the Montreal General Hospital (Montreal, Quebec). Eligible individuals were 40 to 76 years of age, scheduled for an outpatient colonoscopy, able to communicate in English or French, and provide informed consent. Individuals 40 to 50 years of age had to have a positive family history of CRC for whom the recommendation was to begin CRC screening at 40 years of age with colonoscopy (3,5).

Individuals were excluded if they were scheduled for a sigmoidoscopy, proctoscopy or same-day gastroscopy, had an active history of CRC, or were under investigation for a possible flare of known inflammatory bowel disease. Ethics approval was obtained from the McGill University Faculty of Medicine Institutional Review Board (Montreal, Quebec) before study inception, and all participants provided written informed consent.

Five trained research assistants were responsible for recruitment, administration of the baseline questionnaire, review of endoscopy reports and telephone follow-up. The baseline questionnaire collected data regarding medical history (diabetes, heart conditions, pulmonary diseases, kidney disease, liver disease, neurological conditions, inflammatory bowel disease), use of high-risk medications for colonoscopy outcomes (acetylsalicylic acid, clopidogrel [Plavix, sanofi, USA], dabigatran, warfarin (Coumadin, Bristol-Myers Squibb, USA) ticagrelor, prasugrel and nonsteroidal anti-inflammatory drugs), presence of symptoms in the 30 days before the colonoscopy (abdominal pain, bloating, diarrhea, constipation, nausea or vomiting, blood in the stools, rectal or anal pain, headaches or migraine, other symptoms) and demographics (age, sex, ethnicity, smoking status, level of education). The endoscopy report provided data on the physician performing the colonoscopy, trainee participation during the index colonoscopy (yes/no), colonoscopy indication (screening/not screening), doses of midazolam (mg) and fentanyl (µg) used, physician's evaluation of bowel preparation quality (excellent, good, fair/poor), performance of biopsy or polypectomy (yes/no), method of colon insufflation (air/carbon dioxide) and duration of the colonoscopy (min).

For the purpose of the present study, screening colonoscopy was defined as a procedure performed in asymptomatic individuals 50 to 76 years of age (2). The presence/absence of symptoms was derived from the baseline questionnaire and the endoscopy report. Nonscreening colonoscopy was defined as one performed for investigation of gastrointestinal symptoms, dysplasia detection in inflammatory bowel disease, iron deficiency anemia; follow-up to resolution of an episode of acute diverticulitis, past polypectomy, surgically removed CRC, positive nonendoscopy CRC screening test (eg, fecal immunochemical test, fecal occult blood test, virtual colonoscopy, double-contrast barium enema); or family history of CRC.

Follow-up occurred by telephone interview, or e-mail and Internet-based survey at three time points: two, 14 and 30 days after the colonoscopy. The questions were exactly the same for the two modes of data collection. When participants were not reached, they were telephoned daily for the next three consecutive days (one attempt per day). When participants were not reached on the same day but within the next three consecutive days, the MAE was recorded as having occurred at that assessment time point. If the participant remained unreachable, the research assistants waited until the next scheduled follow-up to contact them again. Similarly, e-mails were sent for follow-ups, and a reminder e-mail daily for the next three consecutive days for non-response. The surveys were created using the Survey Monkey Internet service (www.surveymonkey.net).

MAE was defined as any discomfort the patient experienced after discharge home from the endoscopy unit that did not require any of the following: an overnight stay in the emergency room; hospitalization, blood product transfusion, prescription of antibiotics, surgical or endoscopic intervention or caused death, and that was not present in the 30 days before the colonoscopy as reported in the baseline questionnaire. Data regarding the nature of the discomfort (abdominal pain, bloating, diarrhea, constipation, nausea or vomiting, blood in the stools, rectal or anal pain, headaches or migraine or other symptoms) were obtained. The participant was asked about consulting a health professional/service for the discomfort, the type of professional/service consulted (*Info-Santé* Help Line, emergency room physician, family doctor, gastroenterologist, nurse, pharmacist or other professional), and whether the patient was hospitalized or received a blood transfusion. Predictors of MAEs were determined a priori based on previous studies, and included age (9,12), sex (12,13), presence of comorbidities (10), performance of a polypectomy (13,14), colonoscopy duration (13), trainee participation (10,12) and modality of colon insufflation (17). Information regarding the independent variables was obtained from the baseline questionnaire and the endoscopist report.

Statistical analysis

Description of the study population at entry included means and SDs for continuous data and frequency distributions for categorical data. The descriptive analyses were performed using STATA/SE version 11.2 (StataCorp, USA). Bayesian binomial hierarchical modelling was used to estimate the MAE rates in the cohort to account for patient clustering within physicians (18). Incident MAE rates at each assessment time point were calculated as the sum of individuals who reported at least one MAE at that time point. The 30-day cumulative incidence

MAE rate was calculated as the sum of all individuals who reported at least one MAE at any follow-up. Normal noninformative priors for all parameters were used. Univariate and multivariate logistic regression were used to identify factors associated with the 30-day cumulative incidence MAE rate. Missing data for independent variables were handled using multiple imputation. Bayesian analyses were performed using WinBUGS version 1.4.3 (MRC Biostatistics Unit, United Kingdom).

Sample size

The sample size calculation was based on the estimate of MAEs at seven days according to Ko et al (13). The proportion of patients with at least one MAE at two days was expected to be 34%, the aim was to estimate this proportion to an accuracy of ±5% using a 95% CI. This criterion suggested that 345 participants needed to be recruited. An 20% attrition rate was expected based on the completion rate observed in similar studies (10,13,14). Thus, a total of 414 participants was needed to attain the desired level of accuracy.

RESULTS

Recruitment

Of the 705 consecutive patients approached for participation, 451 (64%) eligible individuals accepted. After excluding 31 individuals (protocol violations, improper consent, age <40 or >76 years, concomitant gastroscopy, scheduled for a sigmoidoscopy, scheduled for an endoscopic ultrasound), the final sample size was 420. Response rates for the day 2, 14 and 30 follow-ups were 342 (81.4%), 335 (79.8%) and 310 (73.8%), respectively. In total, 268 (63.8%) participants responded to all follow-ups and 378 (90.0%) responded to at least one follow-up.

Participant and endoscopy characteristics

Table 1 summarizes participant and endoscopy characteristics. Participants were a mean (± SD) 58.7±8.3 years of age and 192 (45.7%) were female. Ninety-five (22.6%) participants reported at least one comorbidity (diabetes 7.1%, cardiac disease 5.2%, pulmonary disease 4.8%, inflammatory bowel disease 3.8%, kidney disease 2.6%, liver disease 1.4% and neurological disease 1.9%), and 89 (21.2%) reported regular use of at least one high-risk medication (acetylsalicylic acid 16.2%, nonsteroidal anti-inflammatory drugs 4.1%, clopidogrel 0.7%, warfarin [Coumadin, Bristol-Myers Squibb]/dabigatran 0.7%). Of all colonoscopies, 302 (71.9%) were performed by eight gastroenterologists and 118 (28.1%) by five general surgeons. Trainees participated in 30 (7.2%) colonoscopies. The 13 endoscopists performed between four and 80 (median 26) colonoscopies, and 10 reported carbon dioxide as the method of bowel insufflation. The endoscopy report was available for 418 (99.2%) participants. The cecal intubation rate was 96±0.2% and the polypectomy rate was 34±0.47%.

MAE rates

The day 2 follow-up occurred 2.6±0.99 days after the index colonoscopy. Of the 342 respondents, 59 reported at least one MAE, corresponding to an incident MAE rate of 17.3% (95% credible interval [CrI] 8.1% to 30%). The day 14 follow-up occurred 14.7±0.99 days after the index colonoscopy. Of the 335 respondents, 33 reported at least one MAE, yielding an incident MAE rate of 10.5% (95% CrI 2.9% to 23.7%). The 30-day follow-up occurred 30.7±1.07 days after the index colonoscopy. Of the 310 respondents, six reported at least one MAE, yielding an incident MAE rate of 3.2 % (95% CrI 0.01% to 19.8%). Of the 378 (90%) individuals who responded to at least one follow-up, 88 reported at least one MAE, corresponding to a 30-day cumulative incidence MAE rate of 23.3% (95% CrI 19.1% to 27.6%). Eight (1.9%) respondents reported a different symptom at a different assessment time point, and contributed only to the MAE rate for the earlier assessment time point. Table 2 summarizes the discomfort experienced at all three assessment time points. Abdominal pain and bloating were the most commonly reported symptoms at day 2 and day 14, while abdominal pain and constipation were the most commonly reported symptoms at day 30.

TABLE 1
Baseline patient and colonoscopy characteristics of the study population (n=420)

Patient characteristic	
Age, years mean ± SD	58.7±8.3
Female sex	192 (45.7)
Preferred contact method	
E-mail	267 (63.6)
Telephone	153 (36.4)
Comorbidities	95 (22.6)
High-risk medications	89 (21.2)
Symptoms in the 30 days before colonoscopy (n=418)	
Any symptom	237 (56.4)
Abdominal pain	73 (17.4)
Bloating	107 (25.5)
Diarrhea	56 (13.3)
Constipation	81 (19.3)
Nausea/vomiting	32 (7.6)
Blood in stools	39 (9.3)
Rectal pain	40 (9.5)
Headache/migraine	77 (18.3)
Other	57 (13.6)
Ethnic background	
White	367 (87.4)
Nonwhite	53 (12.6)
Endoscopy characteristics	
Colonoscopy indication	
Screening	200 (47.6)
Not screening	220 (52.4)
Fentanyl dose, µg, mean ± SD	83.6±35.9
Midazolam* dose, mg, mean ± SD	3.1±1.3
Endoscopy duration, min, mean ± SD	21.7±7.8
Trainee participation	30 (7.2)
Method of colon insufflation	
Air	100 (24)
Carbon dioxide	320 (76)
Cecal intubation, %, mean ± SD	96±0.2
Preparation quality	
Excellent or good	372 (88.6)
Poor or fair	44 (10.5)

*Data presented as n (%) unless otherwise indicated. *Versed (Roche, USA)*

Table 3 presents the results of the univariate and multivariate logistic regression models used to estimate the effect of participant and endoscopy characteristics on the 30-day incidence of MAE. No associations were found, although wide CrIs throughout preclude definitive conclusions.

Health resource utilization

Table 4 presents the health resources used in the 30 days following colonoscopy. Seven (1.7%) participants reported consulting a health professional for an MAE, four of whom consulted a physician. In addition, two participants reported experiencing a serious adverse event; each had visited the emergency department and required hospitalization for syncope and hemothorax (day 2 follow-up) and for post-polypectomy bleeding (day 30 follow-up).

DISCUSSION

The present longitudinal cohort study reports on the incidence, nature and predictors of outpatient postcolonoscopy MAEs. The incidence of MAEs was highest in the first 48 h following colonoscopy and

TABLE 2
Frequency of incident* minor adverse events reported at days 2, 14 and 30 postcolonoscopy

	Assessment time point		
Minor adverse event	**Day 2 (n=342)**	**Day 14 (n=335)**	**Day 30 (n=310)**
Abdominal pain	30 (8.6)	14 (4.1)	3 (0.9)
Bloating	22 (6.3)	17 (5.0)	0 (0)
Diarrhea	9 (2.6)	6 (1.8)	1 (0.3)
Constipation	9 (2.6)	7 (2.1)	3 (0.9)
Nausea/vomiting	6 (1.7)	2 (0.6)	0 (0)
Blood in the stools	2 (0.6)	2 (0.6)	0 (0)
Rectal/anal pain	9 (2.6)	1 (0.3)	2 (0.6)
Headache	13 (3.7)	2 (0.3)	0 (0)
Other	20 (5.8)†	7 (2.1)‡	1 (0.3)
Any	59 (17)	33 (9.7)	6 (1.9)

*Data presented as n (%). *Defined as no report in the 30 days before colonoscopy; †Includes fatigue, dizziness, fever, shivers, nasal irritation, pain at venopuncture site, dehydration, back pain and anxiety; ‡Includes disorientation, fatigue, itchiness, fever and dehydration; 'reaction to anesthesia' does not total to 100 because more than one symptom could be reported*

TABLE 3
Univariate and multivariate results for predictors of 30-day cumulative incidence of minor adverse events

	Univariate	Multivariate
Variable	**OR (95% CI)**	**OR (95% CI)**
Age	1.01 (0.97–1.03)	0.99 (0.97–1.02)
Sex		
Female	Reference	Reference
Male	0.81 (0.49–1.29)	0.81 (0.49–1.27)
Medical problem		
No	Reference	Reference
Yes	1.60 (0.89–2.66)	1.60 (0.87–2.68)
Trainee participation		
No	Reference	Reference
Yes	0.57 (0.14–1.41)	0.53 (0.15–1.27)
Duration, min	1.01 (0.99–1.03)	1.01 (0.99–1.04)
Polypectomy		
No	Reference	Reference
Yes	1.16 (0.68–1.85)	1.13 (0.64–1.85)
Insufflation with		
Air	Reference	Reference
Carbon dioxide	0.88 (0.41–1.58)	0.84 (0.41–1.50)

uncommon after 14 days. Abdominal pain and bloating were consistently the two most frequently MAEs reported at days 2 and 14, while abdominal pain and constipation were the most frequently reported at day 30. No predictors of the 30-day cumulative incidence rate of MAE were identified. Less than 1% of respondents sought the services of a physician for an MAE.

Our 30-day incident MAE rate was similar to rates found in some studies (9-11), but substantially different from others (12-15). Zubarik et al (14,15) conducted two studies. In one (14), the MAE rate at 30 days (16.6%) may have been underestimated due to recall bias and, in the other (15), the rate (36.6%) included symptoms that occurred in the endoscopy unit recovery area before discharge as well as those that occurred up to 30 days postcolonoscopy. The 34% MAE rate at seven days reported by Ko et al (13) did not account for previous symptoms and is likely an overestimate of incident MAEs. Finally, de Jonge et al (12) reported an MAE rate of 40.7% at 30 days; however, the subanalysis that restricted MAEs to those definitely related to the colonoscopy

TABLE 4
Number of individuals who used health resources for minor adverse events according to assessment time point

Health resource	**Day 2 (n=342)**	**Day 14 (n=335)**	**Day 30 (n=310)**
Family physician	2	0	1
Gastroenterologist	0	1	0
Emergency department*	0	0	0
Pharmacist	0	1	0
Nurse	1	0	0
Info-Santé Help Line	0	0	0
Other	1†	0	0
Any use	4	2	1

*Data presented as n. *Two individuals visited the emergency department for serious adverse events and they are not counted in the minor adverse events; †Acupuncture*

showed a rate of 29%. Our 30-day incident MAE rate is lower than the sum of MAE rates at each assessment time point because patients who reported more than one MAE or at more than one assessment time point were counted only once in determining this rate.

We did not identify any predictors of new-onset MAEs, but wide CrIs meant that associations could not be ruled out. It is possible that the impact of polypectomy was diluted because we did not specify the method of polyp removal (eg, forceps or electrocautery-assisted); electrocautery has been associated with increased odds for MAEs (13). Contrary to a recent meta-analysis, the method of insufflation (air versus carbon dioxide) was not a predictor of postcolonoscopy discomfort in our study, possibly due to the lack of statistical power (17).

The evaluation of health care resources utilization for MAEs revealed that seven (1.7%) participants had contacted a health professional, a finding that supports the belief that MAEs are generally mild and short lived. Our follow-up relied on direct contact with patients to learn about the consultations to physicians and other health professionals, which represent real-world health care resources use. Four (0.95%) participants reported medical consultations; although this was a small percentage of our sample in the context of the large number of colonoscopies performed annually, it may represent a significant number of physician visits for MAEs. Some of these consultations may be avoided with a 24 h telephone follow-up because they were not avoided with the detailed discharge information that patients routinely received in the studied endoscopy unit.

Our findings showed that the majority of MAEs occur within 48 h after the colonoscopy and almost all occur within the first two weeks, supporting the Canadian Association of Gastroenterology's recommendation that late complications should be assessed at 14 days (19). Nevertheless, the timing for contacting the patient for colonoscopy follow-up is debatable and depends on the purpose of the assessment. If the purpose is to inquire about the patient's condition, satisfaction with the colonoscopy experience or to reinforce postdischarge instructions, then early follow-up (within two days) may be preferred. However, if the purpose is to monitor serious adverse events, then a longer time interval may be preferred. A population-based study by Rabeneck et al (20) found that a 14-day interval would capture the majority of bleeds requiring hospital admission. Similarly, we found that the majority of MAEs occurred within the first 14 days after colonoscopy. Our findings that polypectomy and/or comorbidities increase the risk for MAEs mirror those of others; these variables could be used to identify patients targeted for colonoscopy aftercare.

Our observational study had several limitations. Selection bias may have occurred if respondents were different from nonrespondents with regard to MAE occurrence. The endoscopic report software uses 'screening' as the default indication for colonoscopy, and this may have resulted in misclassification. However, we reviewed the patient's clinical history as summarized in the endoscopy report to classify the colonoscopy indication according to our definition. Limited generalizability

of our findings is possible because the study was conducted in a large academic centre, where physicians had performed several thousand endoscopies. Finally, the small sample size produced very wide CrIs for predictors of MAEs precluding definitive conclusions.

CONCLUSIONS

Our study presents the first prospective estimates of incident MAE rates after outpatient colonoscopies. Our single-institution longitudinal findings provide empirical evidence on the timing and nature of MAE occurrence. Replication of our findings may be informative as to the type of after-care that could be implemented to avoid unnecessary physician consults.

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