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Risk Factors Associated with Stool Retention Assessed by Abdominal Radiography for Constipation

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Abstract

OBJECTIVES—To assess the reliability of applying a radiographic scoring system in estimating the severity of stool retention (SR) in hospitalized older adults with constipation, and to identify risk factors associated with clinical constipation and SR scores.

DESIGN—Retrospective, case series study.

SETTING—Southeast Ohio community hospital.

PARTICIPANTS—Adults aged ≥65 years with constipation or fecal impaction and abdominal radiographs available (N=122). Bowel obstruction was excluded.

MEASUREMENT—Radiographs were independently scored by four readers twice, “5” being the most severe, for each quadrant of an abdominal film; possible total score was 0 to 20. Clinical constipation was defined as an average SR score ≥13. Intra-class correlation was used to measure inter-rater agreement.

RESULTS—The overall inter-rater agreement on abdominal radiograph readings was 0.91, 95% confidence interval (CI) =.88-.93. Clinical constipation was associated with the use of statins and antimuscarinics by univariate logistic regression analysis. After adjusting for age, sex, residency, smoking history, oral laxatives and self-reported constipation, the use of statins remained

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significantly associated with clinical constipation (OR=3.86, 95% CI=1.08-13.77, p=.036). Univariate linear regression analysis revealed that higher SR scores were associated with community residency, self-reported constipation, and the use of statins and antimuscarinics. After adjusting for the above confounders by multiple linear regression analyses, the use of antimuscarinics was independently associated with higher SR score (β=1.769, 95% CI =0.008-3.531, p=.049).

CONCLUSION—Abdominal radiography was reliable in assessing the severity of SR in older adults with constipation. The use of statins and antimuscarinics was associated with clinical constipation and greater SR.

Keywords

constipation; stool retention; abdominal radiography; hospitalized older adults; risk factors

INTRODUCTION

Constipation is highly prevalent in the elderly. Prevalence rates of constipation are as high as 40% and are higher in females than males.[1,2] While only a small proportion of constipated patients seek medical care, constipation still accounts for 2.7 million visits to health care providers each year in the United States.[3]

Constipation is defined variably,[4-5] and patient's perception of constipation is frequently quite different from those of health care providers.[6-8] Objective criteria, such as bowel movement (BM) frequency, often used by health care providers to define constipation,[6,8-9] are not well perceived for many constipated patients.[8-9] That said, health care providers' levels of awareness and understanding of patients' concerns often determine, in part, how aggressively treatment will be provided. Constipation was shown to be independently associated with physical aggression in a large study (N>100,000) of nursing home residents with dementia in addition to depression and delusions.[10]

Information based on symptoms could, at times, be difficult to ascertain in the elderly, a group with a high prevalence rate of cognitive impairment. Quantitative assessment of stool retention (SR) using abdominal radiography has been used in pediatric,[11-14] adult[15] and elderly patients[16-18] although opinions differed regarding its accuracy in diagnosis of childhood constipation.[19-20] It has been recommended that abdominal radiography be used to assess constipation[15] and to exclude the possibility of fecal impaction[21] or megacolon[22] in older adults. While the radiographic scoring system has been validated in pediatric patients,[11-14] its reliability in the assessment of constipation in older adults has not been examined rigorously.

This study used abdominal radiography to assess the severity of SR in hospitalized older adults with constipation who had abdominal radiography during the hospital stay. The study assessed the reliability of the radiographic scoring system among four readers and also analyzed the association between risk factors for constipation and SR severity.

METHODS

Setting

Archived data that were collected from January 1, 2005 through June 30, 2008 were retrieved from the medical records of a community hospital. All data were recorded on standardized paper forms and all medical records under study were reviewed and verified by the principal investigator for accuracy. This hospital is the primary health care provider in Athens County in Southeast Ohio and provides 62,000 residents first-line access to an emergency department

(ED) and/or hospitalizations. This study was approved by the Ohio University Institutional Review Board.

Cases

Patients aged ≥ 65 years with constipation were identified by the discharge diagnosis codes (constipation 564.00 -- 564.09; and fecal impaction: 560.30-- 560.39) either as a primary or secondary diagnosis. Approximately 500 patients were identified during the study period. Patients with the following conditions were excluded from analyses: (1) complete or partial bowel obstruction as reported by the radiologists; and/or (2) no radiography obtained during the hospital stay. Patients with multiple admissions and/or with multiple abdominal radiographs available were reviewed only on their first admission record that had the first radiograph for review. After excluding poor-quality radiographs (n=9), 122 patients were included for the final data analytic effort. Ninety-three percent of patients (113/122) had a length of hospital stay ≥ 3 days (ranges: 1-14 days). Patients who were initially placed on observation status and later changed to a full admission were treated as a full admission on the first observation day. On chart review, 95% (116/122) of patients had documented constipation in the progress notes.

Data Collection

Participant demographic data, admission and discharge diagnoses, smoking history, bowel health symptoms on admission, past medical history and medication use prior to admission were recorded.

Medication use prior to admission was based on self-report (current use vs. non-use) and the documentation on the medication reconciliation form. Medications listed in medical records, including nutritional and herbal supplements, were included when aggregating the total number of medications taken by patients. Antimuscarinic drug is the group of medications that are used mainly for the treatment of over-reactive bladders or urinary incontinence. Statin drug is the group of medications that inhibit 3-hydroxy-3-methyl-glutaryl-CoA (HMG-CoA) reductase, including atorvastatin, fluvastatin, lorvastatin, pravastatin, simvastatin, and rosuvastatin. Oral laxative is the group of medications that include milk of magnesium, osmotic and stimulating drugs for the treatment of constipation. Docusate sodium was not included.

Past medical history (such as diabetes, stroke, depression, and constipation) was the documented previous event, and it was recorded as ever vs. never. Bowel health symptoms were patients' self-reported complaints or symptoms (recorded as presence or absence, or missing), including nausea, emesis, abdominal pain, and constipation *on* admission.

Bowel movement (BM) frequency and fecal smearing/ soiling episodes during hospital stay were obtained from records documented by nursing staff. Information on BM was recorded dichotomously: (1) average BM frequency < three times in 7 days (i.e., < 3/7 based on the calculation: number of total BM frequency divided by the number of hospital stay in days; those with hospital stay < 3 days were excluded from this data analysis; (2) no BM in the first three days; (3) ≥ 3 episodes of fecal smearing during the hospital stay; (4) number of BM frequency exceeded 6 times in one day, which may suggest a severely-loaded bowel. None of the study patients had the discharge diagnosis of *Clostridium difficile* colitis.

Missing data were encountered in participants' smoking histories and in the reviews of bowel health symptom on admission notes. Missing data were excluded from data analyses, and were described in the footnotes of the tables when relevant.

Grading of the Severity of SR on Abdominal Radiographs

A grading system was adopted based on a modified system developed by Starreveld et al.[15] and Harari.[23] Radiographs were first divided into four quadrants by two imaginary cross-lines; one from left splenic flexure toward the great trochanter of the right hip and the other from right hepatic flexure toward the great trochanter of the left hip (as illustrated in Figure 1). Each quadrant was graded with a score from 0 to 5 (total possible scores: 0 to 20).

Scores were based on the following criteria: zero (0) was assigned if no stool or minimal stool was present in a quadrant; 1 was assigned if ¼ of the quadrant was occupied by stool; 2 was assigned if ¼ to ½ of the quadrant was occupied by stool; 3 was assigned if ½ to ¾ of the quadrant was occupied by stool; 4 was assigned if ¾ to the entire quadrant was occupied by stool; and 5 was assigned if the entire quadrant was filled with stool and the bowel dilated. Dilation was operationally defined as the maximal transverse dimension of colon ≥ 6 cm or ≥ 5 cm in the rectum.

Each of 122 films was read and graded by three trained medical students and one geriatrician on two separate occasions. Readers were not accessible to patients' medical information or previous score records while reading the films. Only code numbers and names were available when recording scores. The first reading was conducted by two pairs of two readers while the second reading was conducted by four readers simultaneously. Both readings took two consecutive days to finish.

Clinical constipation[23] was defined as an average SR score ≥ 13. The score 13 was selected as the cutoff because the mean SR score of all study patients (N=122) in the current study was 13.39.

Statistical Analysis

Averaged SR scores from four readers were used for statistical analysis. Mean scores and standard deviations (SD) were computed for the primary study variable. Two sample t-test was used to compare two groups. Inter-rater agreement was assessed by intra-class correlation.[24] The assumptions made were that all radiographs included in the study and the readers were both random samples. Thus, two-way random effect analysis of variance model was used to estimate the intra-class correlation coefficient (reliability).

Univariate logistic regression was used to assess the association between a risk factor and clinical constipation. Potential confounders included in the multiple logistic regression model were age, sex, residency status, smoking status, self-reported constipation, and the use of statins and oral laxatives. Multiple linear regression model was used to assess if there was a significant association between a risk factor and an average SR score, by adjusting for the same variables as listed above and the use of antimuscarinic drugs. Regression diagnostics revealed that our multivariable models were reasonable and there was no collinearity among the independent variables in the models. Statistical significance level was set at a level of .05. Statistical software package, PC SAS version 9.1 (SAS Institute, Inc., Cary, NC) was used to perform the statistical analyses.

RESULTS

The overall inter-rater agreement on abdominal radiograph readings was 0.91 (95% CI=.88-.93) among the four readers. The inter-rater agreement for each abdominal quadrant reading was all > .90. Average SR scores ranged from 7.75 to 18.63 (possible total score: 0-20). Patients who had extensive fecal debris or fecal impaction noted on the radiologist's report (46/122 or 38%) had significantly higher scores than those who did not have such a report (14.3 ± 2.5 vs. 12.8 ± 2.3; p=.002).

Seventy-seven (of 122, or 63%) patients had abdominal X-ray obtained at ED or on admission; 45 (or 37%) had X-ray done after admission (on post-admission day: range 1st-7th day; median: 2nd day). Patients with abdominal X-ray obtained at ED/or on admission had higher scores than those whose X-rays obtained after admission (13.8 ± 2.4 vs. 12.8 ± 2.6, p=.035).

As shown in Table 1, most patients were of advanced age (mean± SD: 83.5 ± 8.4 years) and white-females (75%). Approximately 58% were community-residing residents and 21% ex-smokers. Discharge diagnosis included acute respiratory illness (i.e., pneumonia and acute exacerbation of chronic obstructive pulmonary disease), or acute congestive heart failure (15%). Thirty percent of patients had bacteriuria (including urinary tract infections on discharge diagnosis) and 10% had acute urine retention.

Community-residing patients and those without previous smoking histories had significantly higher SR scores than nursing home residents and those with smoking histories, respectively (Table 1). Among other factors considered, only the use of statins (p=.049) and antimuscarinic drugs (p=.002) was associated with higher SR scores. Patients who self-reported constipation on admission had significantly higher SR scores than those without such a complaint, p=.022. Other features of BM records (such as frequency) were not associated with SR scores (all p values > .10).

Because SR severity can be affected by the use of oral laxative(s) prior to admission, this study estimated the odds ratio of taking oral laxative(s) in patients with risk factors for constipation by univariate logistic regression analysis (table not shown). Community-residing patients were less likely to receive oral laxative(s) than nursing home residents (crude OR= .43; 95% CI= .21-.90, p= .023). Patients with cognitive impairment, a history of constipation, fracture of any site, taking ≥ 10 medications, and uses of narcotic drugs were more likely to receive oral laxatives (all p values < .05), but not in those patients taking statins or antimuscarinic drugs. Patients who had stool smearing ≥ 3 episodes during the hospital stay were more likely to have used oral laxatives prior to admission (table not shown).

Table 2 revealed that clinical constipation, defined as an average SR score ≥ 13, was significantly associated with the use of statins (crude OR =3.46, 95% CI =1.20-9.97, p=.021) and antimuscarinic drugs (p=.021), and was negatively associated with the age (crude OR =.93, 95% CI = .88-.97, p=.003) and the use of oral laxatives (crude OR =.46, 95% CI = .22-.96, p=.039) by univariate logistic regression analysis. As shown in Table 3, the association between the use of statin and clinical constipation remained significant (adjusted OR= 3.86, 95% CI= 1.08-13.77, p=.036) after adjusting for age, sex, residency status, smoking history, the use of oral laxatives, and self-reported constipation in a multiple logistic regression model.

Univariate linear regression analysis revealed that SR scores were significantly associated with community residency, self-reported constipation, and the use of statins and antimuscarinic drugs, and was negatively associated with age and ex-smoking history (table not shown), all p values < .05. As shown in Table 4, the use of antimuscarinic drugs was independently associated with higher SR scores (β=1.769, 95% CI =0.008-3.531, p=.049) after adjusting for age, sex, residency status, smoking history, self-reported constipation, and the use of oral laxatives and statins in a multiple linear regression model.

DISCUSSION

This case-series study found that increased SR was associated with patients' self-reported constipation on admission in hospitalized older adults. Greater SR was also associated with radiologists' reports of fecal impaction or the presence of extensive fecal debris. The inter-rater reliability of applying the abdominal radiographic scoring system among the four readers was excellent (exceeding 0.90), suggesting that it is a reliable tool for the assessment of SR

severity. The current study also found that the use of statins and antimuscarinic drugs was associated with greater SR and conveyed an increased risk for clinical constipation.

Several studies have examined "independent" risk factors for constipation in older adults.[1, 25-26] By using a radiographic scoring system, this study examined the association between risk factors and SR severity, a quantitative indicator of constipation. These results are consistent with previous research which showed that medications such as antimuscarinic drugs (with anticholinergic effects) and a high number of drugs used (> 7)[26] are associated with constipation. However, the current study did not find a difference in SR scores between narcotic users and non-users. This may be because narcotic users were more likely to also use oral laxatives.

Statin use can cause constipation as demonstrated in clinical trials.[27-28] The current study found that statin use was significantly associated with greater SR and a greater risk for clinical constipation. However, statin use associated with constipation may not be well-perceived among health care providers or patients in clinical practice. Results from the current study clearly provide quantitative evidence of increased SR among statin users.

Although atypical antipsychotics, calcium channel blockers, calcium and iron supplements, and diuretics have been shown to be associated with constipation,[26] these drugs were not associated with greater SR in the current study. One limitation of the current study is that subjective symptoms of constipation (such as straining, hard and lumpy stool during defecation) were not included in the data collection. Therefore, the lack of a quantitative association between the use of these drugs and SR could not, and should not, exclude their constipating effects.

The current study found that community-residing residents were less likely to receive oral laxative(s) than nursing home residents, which may explain, in part, why greater SR was found in community residents than nursing home patients. With the adjustment of confounders, community residency no longer predicted clinical constipation or higher SR scores. The current study also demonstrated that patients with the following conditions were likely to take oral laxative(s): cognitive impairment, a history of constipation or fractures of any site, taking ≥ 10 medications, use of narcotics, and having fecal smearing ≥3 episodes, but not in those taking statins and antimuscarinic agents.

The appearance and distribution of SR in abdominal radiographs was well described in details by Barr et al.[11] From our experience, fecal materials are easy to identify in most "moderate" to "severe" cases. However, in very rare instances, certain pathology could present as fecal material-like appearance as described as "gas accordion" sign.[29] As radiologists do not always report the severity and distribution of fecal materials in the reports, it is always desirable to review the abdominal films by health care providers for better understanding and managing their patients.

There are several limitations in our study. Because of the study's retrospective design, abdominal X-ray was not consistently performed in the time frame during the hospitalization. However, a prospective study of 18 elderly patients suggested that fecal loading remained stable within 3 days of hospitalization.[16] For those X-rays obtained after admission in our study, the median day of X-ray obtained was on the second day of hospitalization. Therefore, we consider such an inconsistency a minor variation and probably will not affect the results in our study. Second, the definition of constipation in this study was based on the discharge diagnosis codes. The diagnostic criteria for constipation may vary from case to case and from physician to physician. Third, as certain medications (such as oral laxatives and nutritional supplements) are available without prescription, the current study may not have collected all relevant information on medication use. Fourth, this study did not include patients' mobility

and functional status among those risk factors for constipation in the multiple logistic regression analyses. Fifth, trained medical students may have limited experiences in the interpretation of abdominal radiographs which may affect the accuracy of scoring.[20] Finally, study patients were primarily Caucasians and from only one study site; results from the current study may not generalize to other ethnic groups and should be interpreted cautiously.

In conclusion, this case-series study found that abdominal radiography was a reliable tool to assess the severity of stool retention in older adults. The use of statins and antimuscarinic drugs was associated with greater stool retention and an increased risk for clinical constipation. Patients taking these two medications may not have been treated adequately with oral laxatives for constipation, which may suggest a therapeutic and/or preventive implication for these patients.

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Figure 1.
An example of an abdominal radiograph in a patient with constipation. Two imaginary lines crossing the center of abdomen, one from left splenic flexure toward the great trochanter of the right hip and the other from right hepatic flexure toward the great trochanter of the left hip, approximately divided the abdomen into 4 areas, corresponding to ascending (quadrant 1), transverse (quadrant 2), descending (quadrant 3), and rectosigmoid colon (quadrant 4). The total stool retention (SR) score of this patient was 15 (3, 2, 5 and 5 from quadrant 1 to 4, respectively), as graded by one of the four readers.

Table 1

Mean Stool Retention Score of 122 Hospitalized Older Adults with Constipation

Variables*	Patients N (%)	Variable Present Mean score ± SD	Variable Absent Mean score ± SD	P value
Mean Age (yr +/− SD)	83.5 ± 8.4	--	--	
White race	120 (98)	--	--	
Sex: Female vs. male	91 (75)	13.5 ± 2.5	13.0 ± 2.6	.379
Community vs. nursing home residency	71 (58)	13.8 ± 2.4	12.8 ± 2.6	.037‡
Ex-smoker vs. non-ex-smoker§	23/112 (21)	12.5 ± 2.3	13.7 ± 2.6	.040‡
Discharge Diagnosis				
Pneumonia	21 (17)	13.6 ± 2.3	13.3 ± 2.6	.636
COPD exacerbation	14 (11)	13.3 ± 2.5	13.4 ± 2.5	.899
Bacteriuria/UTI‖	35 (29)	13.1 ± 3.1	13.5 ± 2.3	.465
Acute urine retention	11 (9)	12.0 ± 2.4	13.5 ± 2.5	.062
Acute CHF	18 (15)	13.2 ± 2.6	13.4 ± 2.5	.785
Past Medical History				
Diabetes mellitus	40 (33)	14.0 ± 2.4	13.1 ± 2.5	.064
Cognitive impairment	31 (25)	13.3 ± 2.9	13.4 ± 2.4	.889
Depression	44 (36)	12.9 ± 3.0	13.7 ± 2.2	.104
Stroke	19 (16)	14.0 ± 2.4	13.3 ± 2.5	.224
Constipation	28 (23)	13.0 ± 2.9	13.5 ± 2.4	.337
Medication				
Taking ≥ 8 medications¶	87 (71)	13.3 ± 2.6	13.5 ± 2.4	.672
Atypical antipsychotics	21 (17)	13.1 ± 2.8	13.5 ± 2.5	.553
Calcium channel blocker	25 (20)	13.5 ± 2.6	13.4 ± 2.5	.745
Calcium supplement	48 (39)	13.4 ± 2.3	13.4 ± 2.7	.919
Iron supplement	32 (26)	12.7 ± 2.6	13.6 ± 2.5	.077
Diuretics	58 (48)	13.6 ± 2.5	13.2 ± 2.5	.313
Narcotics analgesics	55 (45)	13.2 ± 2.3	13.5 ± 2.7	.528
Antiplatelet agents	46 (38)	13.9 ± 2.3	13.1 ± 2.6	.059
Statins	25 (20)	14.3 ± 2.4	13.2 ± 2.5	.049‡
Oral laxative(s)	57 (47)	13.0 ± 2.6	13.8 ± 2.4	.084
Antimuscarinic drugs	8 (7)	16.0 ± 1.9	13.2 ± 2.5	.002‡
Antibiotic use prior to admission	20 (16)	12.4 ± 2.5	13.6 ± 2.5	.056
GI symptoms #				
Abdominal pain	46/119 (39)	13.3 ± 2.4	13.5 ± 2.5	.644
Nausea or emesis	44/119 (37)	13.4 ± 2.1	13.4 ± 2.7	.913
Self-reported Constipation	49/119 (41)	14.0 ± 2.2	13.0 ± 2.6	.022‡
Bowel movement (BM)				

Variables*	Patients N (%)	Variable Present Mean score ± SD	Variable Absent Mean score ± SD	P value
Records **				
BM Frequency < 3 times in a week	7/113 (6)	13.6 ± 2.1	13.3 ± 2.6	.819
No BM in first three days	8/113 (7)	13.0 ± 2.8	13.4 ± 2.5	.695
Episode of fecal smearing ≥ 3 times	15/113 (13)	12.6 ± 2.9	13.5 ± 2.5	.217
> 6 BM at least for one day	33/113 (29)	13.7 ± 2.6	13.2 ± 2.5	.348

Abbreviation: BM, bowel movement; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; SD, standard deviation; UTI, urinary tract infections.

* Data are presented as number (%) unless indicated otherwise.

‡ Significant (p< .05), two-sample t-test.

§ No documentation of smoking status in 10 patients. Only three patients were active smokers.

// Included all cases of bacteriuria without discriminating the diagnosis of asymptomatic bacteriuria vs. UTI.

¶ Included nutritional supplements (such as calcium and multiple vitamins) and herbal/complimentary medication.

GI symptoms were retrieved from review of systems on admission notes. There were missing data in 3 patients.

** Data were retrieved from medical records documented by nursing staff during patients' hospital stay. Patients with a length of hospital stay < 3 days (N=9) were excluded from the data analysis. BM Frequency < 3 times in a week was based on the calculation of the average; i.e., number of total BM frequency divided by the number of the length of hospital stay in days.

Table 2

Unadjusted Odds Ratios for Clinical Constipation*

Risk Factors (N)=number	Clinical Constipation		Crude Odds Ratio† (95% CI)	pvalue
	YES	NO		
	N (%)			
Age (mean±SD, in years)	81.6±8.2 (N=72)	86.4±8.0 (N=50)	0.93 (0.88-0.97)	.003‡
Female (N=91) vs. Male (N=31)	55 (76%) 17 (24%)	36 (72%) 14 (28%)	1.26 (0.55-2.87)	.584
Ex-smoking (23) vs. Non ex-smoker§ (89)	12 (18%) 55 (82%)	11 (24%) 34 (76%)	0.67 (0.27-1.70)	.403
Community (71) vs. Nursing home (51)	44 (61%) 28 (39%)	27 (54%) 23 (46%)	1.34 (0.65-2.78)	.434
Self-reported constipation//				
Yes (49) vs. No (70)	34 (48%) 37 (52%)	15 (31%) 33 (69%)	2.02 (0.94-4.36)	.072
Medical history				
Cognitive impairment				
Yes (31) vs. No (91)	17 (24%) 55 (76%)	14 (28%) 36 (72%)	0.80 (0.35-1.81)	.584
Depression				
Yes (44) vs. No (78)	24 (33%) 48 (67%)	20 (40%) 30 (60%)	0.75 (0.36-1.59)	.451
Constipation				
Yes (28) vs. No (94)	13 (18%) 59 (82%)	15 (30%) 35 (70%)	0.51 (0.22-1.21)	.126
Fracture of any site				
Yes (18) vs. No (104)	7 (10%) 65 (90%)	11 (22%) 39 (78%)	0.38 (0.14-1.07)	.066
Medication use prior to admission				
Atypical antipsychotics				
Yes (21) vs. No (101)	12 (17%) 60 (83%)	9 (18%) 41 (82%)	0.91 (0.35-2.36)	.848
Calcium channel blocker				
Yes (25) vs. No (97)	15 (21%) 57 (79%)	10 (20%) 40 (80%)	1.05 (0.43-2.58)	.911
Calcium supplement				
Yes (48) vs. No (74)	27 (37%) 45 (63%)	21 (42%) 29 (58%)	0.83 (0.40-1.73)	.617
Iron supplement				
Yes (32) vs. No (90)	15 (21%) 57 (79%)	17 (34%) 33 (66%)	0.51 (0.23-1.16)	.107
Diuretic				
Yes (58) vs. No (64)	38 (53%) 34 (47%)	20 (40%) 30 (60%)	1.68 (0.81-3.48)	.166
Narcotic				
Yes (55) vs.	31 (43%) 41 (57%)	24 (48%) 26 (52%)	0.82 (0.40-1.69)	.590

Risk Factors (N)=number	Clinical Constipation		Crude Odds Ratio[†] (95% CI)	pvalue
	YES	NO		
	N (%)			
No (67)				
SSRI antidepressant				
Yes (56) vs.	34 (47%)	22 (44%)	1.14 (0.55-2.35)	.726
No (66)	38 (53%)	28 (56%)		
Statins				
Yes (25) vs.	20 (28%)	5 (10%)	3.46 (1.20-9.97)	.021[‡]
No (97)	52 (72%)	45 (90%)		
Antimuscarinic drugs				
Yes (8) vs.	8 (11%)	0 (0%)	NA[#]	.021[‡¶]
No (114)	64 (89%)	50 (100%)		
Oral laxative				
Yes (57) vs.	28 (39%)	29 (58%)	0.46 (0.22-0.96)	.039[‡]
No (65)	44 (61%)	21 (42%)		
NSAIDs				
Yes (10) vs.	5 (7%)	5 (10%)	0.67 (0.18-2.45)	.547
No (112)	67 (93%)	45 (90%)		

Abbreviation: NSAIDs, non-steroidal anti-inflammatory drugs; SD, standard deviation; SSRI, selective serotonin re-uptake inhibitor.

[*] Clinical constipation was defined as an average SR score ≥ 13.

[†] Univariate logistic regression.

[‡] Significant (p< .05)

[§] No documentation of smoking status in 10 patients. Only three patients were active smokers.

[//] There were missing data in 3 patients.

[¶] Fisher's exact test.

[#] Not able to estimate due to a convergence issue.

Table 3

Adjusted Odds Ratios for Clinical Constipation in Multiple Logistic Regression Model (N=109)

Variables†	Adjusted OR	95% CI	P value
Age	0.93	[0.88, 0.99]	.018‡
Sex (female=1; male=0)	2.08	[0.71, 6.08]	.189
Community	0.77	[0.29, 2.07]	.657
Ex-smoking history	0.51	[0.17, 1.55]	.265
Statin use	3.86	[1.08, 13.77]	.036‡
Self-reported constipation	2.08	[0.80, 5.42]	.142
Oral laxative use	0.42	[0.17, 1.04]	.061

Abbreviations: CI, confidence interval; OR, odds ratio.

*Clinical constipation was defined as an average SR score ≥ 13. The use of antimuscarinic drugs was not included in the model due to a convergence issue.

†Variables were dichotomized as 1=yes, 0=no (baseline) unless stated otherwise. Hosmer and Lemeshow goodness-of-fit test: chi square= 7.16, df= 8, p= .520.

‡Significant (p<.05)

Table 4

Multiple Linear Regression Model for Stool Retention Scores (N=109)

Variables*	Coefficient β	95% CI	P value
Intercept	19.21	[14.17, 24.25]	<.001
Age , yrs	−0.075	[−0.134, −0.016]	.013†
Sex (female=1, male=0)	0.458	[−0.595, 1.510]	.390
Community residency	0.308	[−0.705, 1.322]	.548
Ex-smoking status	−1.374	[−2.484, −0.265]	.016†
Self-reported constipation	0.652	[−0.294, 1.598]	.174
Antimuscarinic drugs	1.769	[0.008, 3.531]	.049†
Oral laxative(s)	−0.496	[−1.407, 0.415]	.283
Statins	0.575	[−0.522, 1.672]	.301
Coefficient of determination, $R^2 = 0.2477$.			

Abbreviations: CI=confidence interval.

*Variables were dichotomized as 1=yes, 0=no (baseline) unless stated otherwise. The results were similar if the use of antimuscarinic agents was not included in this model.

†Significant (p<.05)