Utility of early colonoscopy for acute lower gastrointestinal bleeding: a retrospective cohort study

Adi Lahat [ID], Eyal Klang, Nisim Rahman, Nitzan Halabi, Benjamin Avidan and Noam Barda

Abstract

Background: Early colonoscopy (within 8–24 h) is recommended in different guidelines for acute lower gastrointestinal bleeding (LGIB). Despite this recommendation, evidence for its effectiveness are conflicting, and early colonoscopy is often not performed.

Objectives: We aimed to evaluate the utility of early colonoscopy by examining the findings during the procedure, and by comparing in-hospital and long-term outcomes between patients who did and did not undergo early colonoscopy.

Design: This is a retrospective cohort study based on the electronic medical records of a large tertiary hospital in Israel.

Methods: All patients hospitalized with acute LGIB to acute wards between 2012 and 2022 were included. First, structured and free-text procedure notes from patients who did undergo early colonoscopy were examined. Second, we compared in-hospital and long-term outcomes between patients who did and did not undergo early colonoscopy while adjusting for possible confounders using multivariable regression of the type appropriate for each outcome.

Results: Overall, 953 patients were included, of which 90 underwent early colonoscopy. The majority (54%) were found insufficiently prepared. Common findings were diverticulosis (38%) and colon polyps (20%). The procedure was effective for hemostasis in only 13% of the cases. Early colonoscopy was not significantly associated with increased survival (exponentiated coefficient = 1.19, 95% CI: 0.76, 1.87), decreased length of hospitalization (exponentiated coefficient = 1.08, 95% CI: 0.97, 1.21), or increased blood hemoglobin at discharge (coefficient = −0.27, 95% CI: −0.58, 0.03).

Conclusions: Early colonoscopy was often not effective and was not associated with significantly improved outcomes.

Keywords: diagnostic yield, early colonoscopy, lower GI bleeding, prognosis

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Introduction

Acute lower gastrointestinal bleeding (LGIB) is among the most common gastrointestinal (GI) pathologic conditions worldwide, with an incidence of 35–51/100,000 persons yearly.[1,2] In many cases bleeding is severe, and mandates hospitalization and fluid resuscitation, including blood transfusion. Usually, however, the bleeding is self-limited and does not require further and more invasive interventions.[3,4]

Large bowel visualization via colonoscopy is the diagnostic procedure of choice for these patients, in order to identify the source of bleeding, and in some cases, as a therapeutic tool, to treat the source of bleeding, achieve hemostasis when feasible, and prevent further bleeding.[5] Early colonoscopy is defined as colonoscopy performed within 8–24 h from admission and is recommended in the American Society for Gastrointestinal Endoscopy guidelines as well as in the

American College of Gastroenterology guidelines for acute severe lower GI bleeding.[5,6] Notably, cross-sectional imaging is recommended for severe LGIB before doing bowel preparation or colonoscopy.[5]

However, data regarding the effectiveness of early colonoscopy in terms of its diagnostic yield, prevention of re-bleeding, shortening of hospitalization and therapeutic interventions are conflicting.[7–10] Moreover, in order to achieve adequate mucosal visualization during colonoscopy, a proper colonic preparation is mandatory, but will usually only be partial (or absent altogether) during acute bleeding. This not only limits mucosal visualization, but also increases the risk for colonic perforation during the procedure. Therefore, the ideal timing for colonoscopy during LGIB is still under debate, and in many cases early colonoscopy is not the common practice.

In this study we aim to examine the utility of performing early colonoscopy for patients admitted with lower GI bleeding. To this end, we retrospectively follow a large cohort of patients admitted with lower GI bleeding, examine the colonoscopy findings of the patients who did undergo early colonoscopy, and compare in-hospital and long-term outcomes between patients who have and who have not undergone early colonoscopy, adjusting for important confounders.

Methods

Study setting and design
This is a retrospective cohort study conducted in Sheba Medical Center (SMC), the largest medical center in Israel, constantly ranked among the leading medical centers worldwide.[11] All services offered by SMC (inpatient, outpatient, laboratory tests, imaging, etc.) are digitalized and pooled into an integrated data lake for research purposes.

The period of the study is 1 January 2012 to 30 June 2022. We included all patients who were admitted to an internal or surgical ward in SMC with a lower GI bleeding diagnosis, and whose hospitalization lasted between 24h and 14days. Only the first hospitalization event in the study period was included for each patient, and only colonoscopy results during index hospitalization were included for analysis. Patients who were admitted with a non-specified GI bleeding diagnosis (i.e., if it they were hospitalized under the general diagnosis of GI bleeding without specifying the location) were only included if they did not undergo gastroscopy during the hospitalization. While this could miss true lower GI bleeding cases, it was considered preferable to wrongfully including upper GI cases.

The practice in SMC is to decide whether or not to perform early colonoscopy, for each patient with lower GI bleeding, by 10:00 a.m. the day following admittance. The procedure itself is then performed by 14:00 p.m. the same day. Accordingly, the exposure of interest in this study is colonoscopy performed until the end of the day following arrival at the hospital [e.g., if a patient entered the emergency room (ER) on Sunday, then a colonoscopy performed until the end of day on Monday was considered 'early colonoscopy']. As a rule, patients suffering from iatrogenic complications (e.g., post-polypectomy bleeding) are treated urgently and scheduled for early colonoscopy. Other indications for early colonoscopy are based on examinations' availability, as explained above.

All patients underwent standard colonoscopy preparation with a clear-liquids diet 24h prior to colonoscopy, and with 3l PEG solution – to be ingested up to 3h before the procedure. Naturally, patients that underwent an early colonoscopy might have had a shorter clear-liquids diet period, depending on admission timing.

We first examined the findings reported among the patients who underwent early colonoscopy. These consist of two types: first, findings reported from a closed list in structured fields in a dedicated computer system; second, findings abstracted manually from the free-text procedure notes by gastroenterology specialists. We then compared in-hospital and long-term outcomes between patients who did and did not undergo early colonoscopy. The outcomes of interest in this comparison were length of hospitalization in days, number of red blood cell transfusions received during the hospitalization after 14:00 p.m. the day following hospitalization, blood hemoglobin at discharge, and mortality in the year following admission.

Covariates for adjustment were selected based on domain expertise by specialist gastroenterologists

who are routinely involved in the decision of whether or not to perform early colonoscopy. These covariates included age, sex, systolic blood pressure, blood hemoglobin at admittance, the Emergency Severity Index (ESI)[12] as assigned by the triaging nurse in the ER and the number of red blood cell transfusions received before 10:00 a.m. the day following hospitalization. A full list of the variables used in the study and their definitions is included in Supplemental Table 1.

Statistical analysis

The study population is described using summary statistics appropriate for each variable type. Colonoscopy findings are reported as an absolute number and percent.

For the outcomes length of hospitalization and number of red cell transfusions received, we use Poisson regression. For the mortality outcome, we perform time-to-event analysis using Cox proportional hazards. For the outcome blood hemoglobin at discharge we perform linear regression. Each analysis is adjusted for the same list of covariates mentioned above. Because mortality data is received directly from the Israel's ministry of the interior, no loss to follow-up is possible.

When performing linear regression, we report the coefficient from the regression. When performing Cox or Poisson regression, we report the exponentiated coefficient. In each case we include the 95% confidence interval (CI). This reported statistic has a different interpretation depending on the analysis performed (i.e., it is the hazard ratio when performing Cox regression, the multiplicative change in the expected value when performing Poisson regression, and the expected difference in the outcome between the exposed and unexposed when performing linear regression). Missing data, which is rare in SMC's data warehouse for the variables used in this study, was handled using complete case analysis in each analysis separately. All analyses were performed with the R statistical software, version 4.1.2. The study was reported in accordance with the STROBE statement.[13]

Secondary analysis

To address the possibility of residual confounding in our main analysis, we performed an additional analysis exploiting the 'natural experiment' the occurs based on when patients approach the

ER. Because patients approaching on the weekend are less likely to undergo early colonoscopy, we repeated the analysis described above, but this time using as the exposure whether patients approached on the weekend (Thursday–Saturday, as defined in Israel) or on a week-day.

Results

Of 2070 EM visits for lower or unspecified GI bleeding during the study period, 1467 (71%) were admitted to the hospital. Of these, 953 individuals met the eligibility criteria and were included in the study population (Figure 1). The median age of the study population was 75 (interquartile range 64–84), and 44% were female. Overall, 90 (9.4%) of the study population underwent early colonoscopy. Patients who underwent early colonoscopy were overall similar to patients who did not (Table 1).

Among the 90 patients who underwent early colonoscopy, the most common findings were diverticulosis ($n=34$, 37.8%) and colon polyps ($n=18$, 20%). Less common findings were signs of colonic inflammation ($n=7$, 7.8%), anorectal disease ($n=5$, 5.6%), and tumors ($n=3$, 3.3%) (Table 2).

Among the 86 patients who underwent early colonoscopy and for whom the procedure notes were available, 46 (53.5%) were found insufficiently prepared, 24 (27.9%) had a significant diagnosis, and 22 (25.6%) were still actively bleeding during the procedure (Table 2). In 24 (27.9%) a significant diagnosis was found, in 15 (17.4%) an active intervention was performed and in 12 (13.9%) the procedure was deemed effective for hemostasis (Table 2).

Out of 12 colonoscopies in which intervention was effective for hemostasis, in 9 (75%) clipping the area of post-polypectomy bleeding was performed, in one (8%) bleeding hemorrhoids were treated, in one (8%) a bleeding angiodysplasia from radiation proctitis was coagulated, and in one (8%) a rectal anastomotic ulcer was clipped. Notably, in 21 (24.4%) patients the bleeding was found to result from a recent colonic polypectomy.

Comparing these findings to patients who underwent late colonoscopy during the index hospitalization (265 patients, 28%) shows that in the late colonoscopy group the proportion of individuals
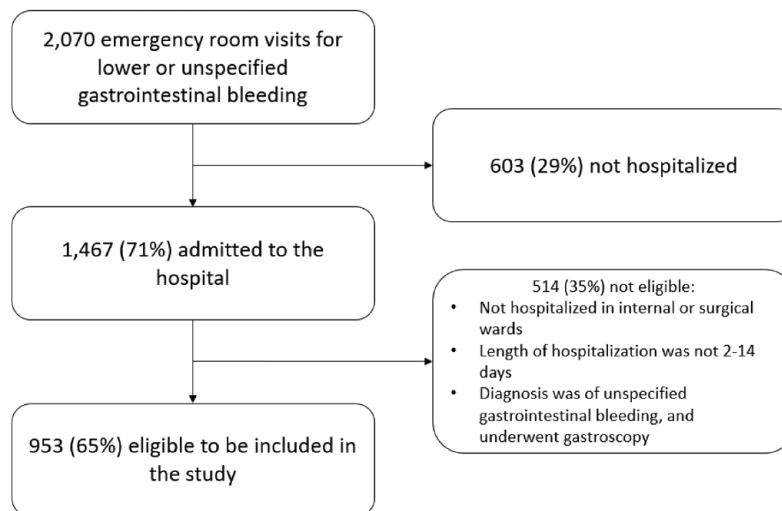
Figure 1. Population flow chart. Absolute number and percent change of the study populations at each inclusion and exclusion criteria.

with a bad preparation is significantly reduced (21% *versus* 53.5%, respectively, $p < 0.001$), active bleeding is less commonly seen (10% *versus* 25.6%, respectively, $p < 0.001$), and that a significantly smaller proportion of active interventions are performed (6.4% *versus* 17.4%, $p = 0.002$). Naturally, since early colonoscopy is often performed for iatrogenic complications, 24.4% of early colonoscopies were performed due to post-polypectomy bleeding, compared to only 3.6% of late colonoscopies ($p < 0.001$) (Table 2).

Comparing the crude probability of survival in the year following hospitalization between patients who underwent early colonoscopy and patients who did not does not reveal a difference between the two groups (log-rank test p-value $= 0.92$, Figure 2).

Adjusted analysis did not detect a significant association between early colonoscopy and 1-year survival (exponentiated coefficient $= 1.19$, 95% CI: 0.76, 1.87), length of the hospitalization (exponentiated coefficient $= 1.08$, 95% CI: 0.97, 1.21), or blood hemoglobin level at discharge (coefficient $= -0.27$, 95% CI: -0.58, 0.03) (Table 3). Patients who underwent early colonoscopy were found to have received more red cell transfusions during the hospitalization (exponentiated coefficient $= 2.49$, 95% CI: 1.82, 3.34).

The secondary analysis comparing patients admitted in the middle of the week to patients admitted on the weekend found that in our sample, being admitted during the weekend resulted in a smaller probability of having an early colonoscopy (Relative risk (RR) $= 0.67$, Table 4). The adjusted analysis using admittance during the weekend as a surrogate for receiving early colonoscopy did not detect an association with 1-year survival (exponentiated coefficient $= 1.04$, 95% CI: 0.79, 1.36), with the number of red cell transfusions received the hospitalization (exponentiated coefficient $= 1.1$, 95% CI: 0.86, 1.41) or with blood hemoglobin level at discharge (coefficient $= -0.14$, 95% CI: -0.32, 0.04). It was however significantly associated with an 8% longer hospital stay (exponentiated coefficient $= 1.08$, 95% CI: 1.01–1.16).

Discussion

In this study we examined the colonoscopy findings of patients who were admitted with lower GI bleeding and underwent early colonoscopy, and compared in-hospital and post-hospitalization outcomes between patients with lower GI bleeding who underwent early colonoscopy and patients who did not. We found that the main finding observed during early colonoscopy for lower GI bleeding is diverticulosis, followed by colonic polyps. We additionally found that over 50% of early colonoscopies were marred by bad colonic preparation and only 15% were found effective for hemostasis. Finally, we found that undergoing early colonoscopy is not significantly

Table 1. Baseline characteristics of the study population.

Variable	Study population, *N* = 953	Did not undergo early colonoscopy, *N* = 863	Underwent early colonoscopy, *N* = 90	Missing	*p*-Value
Age, median (IQR)	75 (64, 84)	75 (64, 84)	74 (62, 84)	0%	0.6
Sex, *N* (%)				0%	0.8
Female	424 (44%)	383 (44%)	41 (46%)		
Male	529 (56%)	480 (56%)	49 (54%)		
Systolic blood pressure, median (IQR)	125 (109, 140)	124 (109, 139)	125 (112, 144)	0.3%	0.5
Blood hemoglobin at admittance, median (IQR)	10 (8.2, 11.9)	10 (8.1, 11.9)	10 (8.5, 12.2)	0.4%	0.5
Red cell transfusions given before decision regarding early colonoscopy, median (IQR)	0 (0, 1)	0 (0, 0)	0 (0, 1)	0%	0.08
ESI				1.3%	0.7
1	6 (0.6%)	6 (0.7%)	0 (0%)		
2	107 (11.4%)	94 (11.0%)	13 (14.8%)		
3	796 (84.6%)	724 (84.9%)	72 (81.8%)		
4	32 (3.4%)	29 (3.4%)	3 (3.4%)		
5	0 (0%)	0 (0%)	0 (0%)		
Background diagnoses				0%	
COPD, *N* (%)	2 (0.2%)	1 (0.1%)	1 (1.1%)		0.2
Cancer, *N* (%)	13 (1.4%)	13 (1.5%)	0 (0%)		0.6
CVD, *N* (%)	24 (2.5%)	22 (2.5%)	2 (2.2%)		>0.9
CKD, *N* (%)	7 (0.7%)	6 (0.7%)	1 (1.1%)		0.5
Admitted during the weekend	395 (41.4%)	366 (42.4%)	29 (32.2%)	0%	0.06

Characteristics of the different study populations following application of all eligibility criteria. Statistical tests include Wilcoxon rank sum test, Pearson's Chi-squared test, and Fisher's exact test, as appropriate.
CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; IQR, interquartile range.

associated with improved 1-year survival nor with an improved discharge blood hemoglobin or shorter length of hospitalization. Using admittance on the weekend as a 'natural experiment' surrogate for the probability of undergoing early colonoscopy, findings were similar, though a predictably increased length of hospitalization was observed in those admitted during the weekend.

Our results agree with a few recently published meta-analyses that assessed the outcome of early colonoscopy *versus* delayed colonoscopy for acute lower GI bleeding.[10,14,15] Combined results showed no difference in mortality, in hospitalization length, or in re-bleeding rates between the groups. Furthermore, a recent review of four randomized trials found no difference in mortality or in the diagnostic yield between the two groups, and concluded that early colonoscopy does not provide any clinical benefit over delayed colonoscopy.[16] This issue was specifically addressed in the recent European Society of Gastrointestinal

Table 2. Findings during colonoscopy.

Finding	Did not undergo early colonoscopy, *N* = 265	Underwent early colonoscopy, *N* = 90	*p*-Value
Electronic record available for review	259 (98%)	90 (100%)	
Diverticulosis	113 (43.6%)	34 (37.8%)	0.3
Colonic polyp	55 (21.2%)	18 (20%)	0.8
Neoplasm	12 (4.6%)	3 (3.3%)	0.8
Colonic inflammation	20 (7.7%)	7 (7.8%)	>0.9
Anorectal disease	29 (11.2%)	5 (5.6%)	0.12
Vascular lesions	12 (4.6%)	4 (4.4%)	>0.9
Colonic obstruction	1 (0.4%)	0 (0%)	>0.9
Manual procedure notes available for review	250 (97%)	86 (96%)	
Bad preparation	52 (21%)	46 (53.5%)	<0.001
Bleeding as a complication of a recent intervention	9 (3.6%)	21 (24.4%)	<0.001
Active intervention performed	16 (6.4%)	15 (17.4%)	0.002
Effective colonoscopy	23 (9.2%)	13 (15.1%)	0.13
Active bleeding	26 (10%)	22 (25.6%)	<0.001
Significant diagnosis	60 (24%)	24 (27.9%)	0.5
Early colonoscopy likely to change prognosis	35 (14%)	12 (14%)	>0.9

Findings documented during colonoscopy among patients who did and did not undergo early colonoscopy. Includes both findings documented in structured fields in the electronic medical record, and findings abstracted from the procedure notes by gastroenterology specialists. Findings were only analyzed for the subset of patients who underwent colonoscopy at any point during the index hospitalization. Statistical tests used were Pearson's Chi-Square test and Fisher's exact test, as appropriate. The definition of each finding appears in Supplemental Table 1.

Endoscopy guidelines,[17] which state: 'in patients with major acute lower gastrointestinal bleeding, colonoscopy should be performed sometime during their hospital stay because there is no high-quality evidence that early colonoscopy influences patient outcomes'.

Our study adds to existing evidence a relatively large sample size from a high-quality medical center, coupled with an analysis that incorporates both outcomes from the electronic medical record and from manual review of the procedure notes by experts. This enables a broad view of the utility of early colonoscopy incorporating both immediate and longer-term outcomes.

Taken together, our results and the above-cited data do not support the practice of performing early colonoscopy for lower GI bleeding in the general population. Furthermore, according to the data, it is clear that despite current guidelines, most patients admitted with acute lower GI bleeding do not in fact undergo colonoscopy within 24 h. In our study, less than 10% of patients underwent early colonoscopy, and numbers in the literature show up to 25% of patients performing early colonoscopy in the real life setting.[18]

As shown in our results, early colonoscopy has the major disadvantage of poor bowel preparation. In our study, half the patients undergoing early colonoscopy were found not properly prepared, compared to less than a quarter of those undergoing late colonoscopy during index hospitalization. Bowel cleaning is one of the most
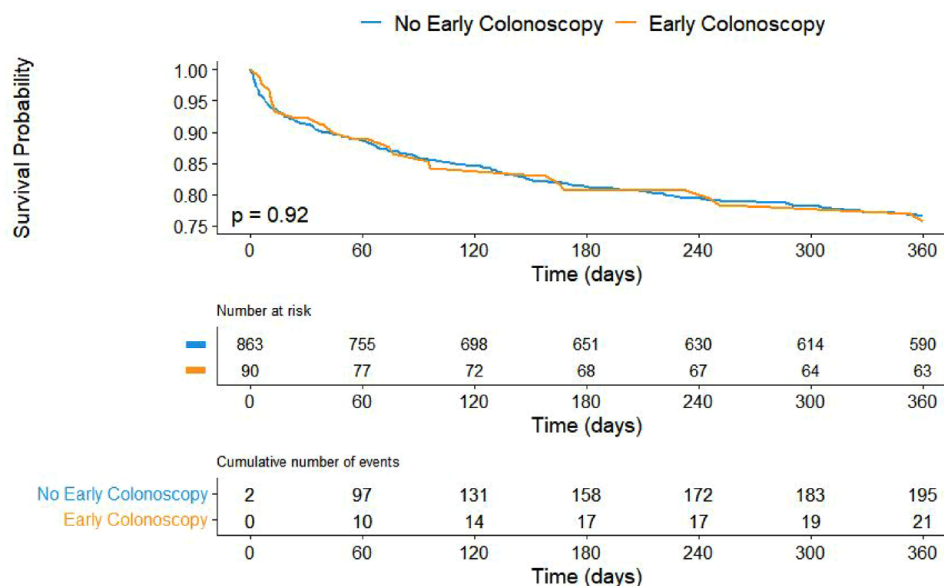
Figure 2. One-year survival following hospitalization due to lower gastrointestinal bleeding among patients who did and did not undergo early colonoscopy.
Survival was estimated using the Kaplan-Meier method, though no loss to follow-up occurred. The number at risk and cumulative number of events are included below the chart, and the *p*-value from a log-rank test is included in the bottom-left corner of the chart.

Table 3. The association between early colonoscopy and the study outcomes.

Outcome	Model and parameter	Estimate
One-year survival	Exponentiated coefficient from a Cox proportional hazards regression	1.19 (0.76, 1.87)
Length of hospitalization	Exponentiated coefficient from a Poisson regression	1.08 (0.97, 1.21)
Number of red cell transfusions received	Exponentiated coefficient from a Poisson regression	2.49 (1.82, 3.34)
Blood hemoglobin at discharge	Coefficient from a linear regression	−0.27 (−0.57, 0.03)

The association between the main exposure, early colonoscopy, and the different outcomes, using multivariable regression. All models were adjusted for age, sex, number of red blood cell transfusions received up to the decision to perform early colonoscopy, systolic blood pressure at admittance, blood hemoglobin at admittance, and the ESI as assigned by the triaging nurse in the ER.

important quality indicators for colonoscopy,[19] and obviously, poor preparation invariably equals low-quality colonoscopy – with inadequate visualization of the bowel mucosa, the possibility of missing important findings and an increased risk of colonic perforation. Lastly, as a result of insufficient mucosal visualization, a repeated examination is indicated.[20]

Notably, in 24% of patients, early colonoscopy was performed following bleeding after polypectomy in a previous colonoscopy. Furthermore, of the 15 interventions performed, 9 were clipping areas of post-polypectomy bleeding, and these same 9 interventions constituted 75% of the interventions effective for hemostasis. These findings may indicate that early colonoscopy might

Table 4. The association between admittance during the weekend and the study outcomes*.

Outcome	Model and parameter	Estimate
One-year survival	Exponentiated coefficient from a Cox proportional hazards regression	1.04 (0.79, 1.36)
Length of hospitalization	Exponentiated coefficient from a Poisson regression	1.08 (1.01, 1.16)
Number of red cell transfusions received	Exponentiated coefficient from a Poisson regression	1.1 (0.86, 1.41)
Blood hemoglobin at discharge	Coefficient from a linear regression	−0.14 (−0.32, 0.04)

The association between being admitted on a weekend (Thursday–Saturday) and the different outcomes using multivariable regression. All models were adjusted for age, sex, number of red blood cell transfusions received before the decision regarding early colonoscopy, systolic blood pressure at admittance, blood hemoglobin at admittance, and the ESI as assigned by the triaging nurse in the ER.
*Being admitted on a weekend was associated with a 33% lower probability of undergoing early colonoscopy.

have a positive yield and be specifically indicated in the subgroup of post-polypectomy patients. However, the numbers in our study are too small to reach a solid conclusion.

This study has several important limitations. First, despite the adjustment performed, residual confounding is possible. This concern is aggravated by the significantly increased receipt of red blood cells in the group undergoing early colonoscopy, but is mitigated by the similar findings when using admittance during the weekend as a 'natural experiment' that is unrelated to patients' condition but does change the probability of undergoing early colonoscopy. Additionally, the concordance between the often ineffectiveness of early colonoscopy (as found when examining the procedure charts) and the lack of evidence for utility further supports the study's findings. Second, the study is based in large part on historical data collected from patients' electronic medical record. Thus, errors in coding could lead to measurement error in different variables. Third, the quality of colonic preparation was not assessed via a standard scale, but was rather noted according to the endoscopists' free-text notes. However, bad preparation is an acceptable category and is frequently used to assess preparation quality.[21] Fourth, our analysis included only colonoscopies performed during the index hospitalization, while most patients (63%) were discharged with a recommendation to perform colonoscopy on an ambulatory basis, and these colonoscopy results were not available to us. However, these patients were discharged without having undergone a colonoscopy based on clinical considerations (i.e., were at stable condition on discharge). Finally, the estimate for the mortality outcome is not precise (i.e., has a wide CI), limiting its use.

To conclude, in this study we found that early colonoscopy for acute lower GI bleeding often suffers from poor colonic preparation, is usually not effective, and is not significantly associated with a shorter length of hospitalization, receipt of less blood transfusions during hospitalization or with improved discharge blood hemoglobin levels. A significant reduction in 1-year mortality was also not detected, though the CI was wide and included a range of both beneficial and harmful effects. Further research is needed to assess the benefit of early colonoscopy in the special group of patients with acute lower GI bleeding following endoscopic polypectomy.

Declarations

Author contribution(s)
Adi Lahat: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Supervision; Visualization; Writing – original draft; Writing – review & editing.

Eyal Klang: Data curation; Formal analysis; Investigation; Methodology; Software; Writing – original draft; Writing – review & editing.

Nisim Rahman: Formal analysis; Investigation; Software; Validation.

Nitzan Halabi: Data curation; Formal analysis; Software; Validation.

Benjamin Avidan: Conceptualization; Writing – review & editing.

Noam Barda: Data curation; Formal analysis; Investigation; Methodology; Software; Supervision; Validation; Writing – original draft; Writing – review & editing.

Competing interests
The authors declare that there is no conflict of interest.

Availability of data and materials
Due to data privacy regulations, the raw data of this study cannot be shared.

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Supplemental material
Supplemental material for this article is available online.

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