Acute lower gastrointestinal bleeding and risk factors for re-admissions

WAFA IFTEKHAR, SHIKI FUJINO, SUELLYN CENTAURI, RHEA TUMMON, ZEEV DUIEB, ELLATHIOS ANTONIOU, KRISHANTH NAIDU, ASIRI ARACHCHI, VIGNESH NARASIMHAN, THOMAS SURYA SUHARDJA, YENG KWANG TAY, JAMES LIM, CHAMINDA SARANASURIYA, THANG CHIEN NGUYEN, WILLIAM TEOH and HANUMANT CHOUHAN

Colorectal Surgery Unit, Dandenong Hospital, Monash Health, Melbourne, Victoria 3175, Australia

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Abstract. The present retrospective study evaluated the role of inpatient lower gastrointestinal (LGI) endoscopy in adults with acute lower gastrointestinal bleeding between 2014 and 2018. The primary outcome was 6-month readmission due to recurrent bleeding, analyzed using propensity score matching (PSM). Of the 567 patients, 120 (21.2%) underwent inpatient LGI endoscopy, with overall readmission in 57 (10.1%). In the univariate analysis, inpatient LGI endoscopy was not associated with a significant difference in readmission rates. Patients receiving antiplatelet and/or anticoagulant therapy demonstrated higher numerical readmission rates; however, this association did not reach statistical significance. Prior to PSM, endoscopy patients showed higher transfusion and CT angiography rates, indicating selection bias toward higher-risk cases. After PSM, no significant difference in readmission was observed between groups. Colonoscopy had a diagnostic yield of 36% with 19% therapeutic intervention, while flexible sigmoidoscopy was less effective. Findings suggest inpatient LGI endoscopy should be selectively applied, with guidelines refined to target high-risk patients.

Introduction

Acute lower gastrointestinal bleeding (ALGIB) is a common cause of hospital admission, with rectal bleeding being the most frequent presentation (1). Australia's most extensive cohort study of lower gastrointestinal (LGI) bleeding demonstrated that 0.05% of patients >70 would have clinically significant bleeding during 4 years of prospective follow-up (2). The management of these presentations is often resource-intensive, with treatment ranging from blood transfusions to endoscopy, radiological intervention and surgery. LGI endoscopy serves both diagnostic and therapeutic roles in patients with ALGIB.

Guidelines for the treatment of ALGIB have been published in the USA (3), Europe (4,5) and Asia (6); however, no consensus exists on the ideal time required to perform an endoscopy. The American College of Gastroenterology and the American Society for Gastrointestinal Endoscopy recommend performing a colonoscopy within 24 h of presentation in patients with high-risk features and ongoing bleeding, and as an inpatient for low-risk patients (3), while the British Society of Gastroenterology (4) and the European Society of Gastrointestinal Endoscopy (5) do not recommend urgent colonoscopy (<24 h) for patients with ALGIB and outpatient investigations for minor self-limiting bleeding as part of the usual clinical practice. As per the Japan Gastroenterological Association, the conduct of a colonoscopy within 24 h is recommended to identify the source of bleeding and the therapeutic intervention (6).

Several randomized controlled trials have compared early colonoscopy with elective colonoscopy and have shown that performing an early (≤24 h) colonoscopy does not improve the diagnostic yield or reduce re-bleeding or mortality (7,8). However, an urgent colonoscopy increases the detection rate of signs of recent bleeding (8).

In Australia, a lack of published local data has been reported on the burden of LGIB on emergency department presentations or overall hospital admissions. In addition, no published national guidelines advocate the use of LGI endoscopy in the setting of ALGIB, and the optimal timing of colonoscopy for patients with ALGIB remains uncertain. It is essential to examine whether colonoscopy needs to be performed as an emergency procedure, for instance, during hospitalization, or whether it can be conducted as an outpatient procedure without causing any disadvantage to the patient.

Patients taking antiplatelet and/or anticoagulant medications are considered high-risk, and early endoscopy is recommended for them (2,3,9). However, it is still unclear

Correspondence to: Dr Shiki Fujino, Colorectal Surgery Unit, Dandenong Hospital, Monash Health, 135 David Street, Dandenong, Melbourne, Victoria 3175, Australia
E-mail: shiki226@hotmail.com

Abbreviations: ALGIB, acute lower gastrointestinal bleeding, LGI endoscopy, lower gastrointestinal endoscopy; PSM, propensity score matching

Key words: acute lower gastrointestinal bleeding, gastrointestinal hemorrhage, re-admission risk factors, endoscopic interventions

whether endoscopy should be performed during hospitalization and whether it has an impact on readmission. In the present study, it was hypothesized that the use of a patient database could clarify the effectiveness of LGI endoscopy by examining the readmission rates among patients receiving antiplatelet and/or anticoagulant medications, with or without LGI endoscopy. The primary aim of the present study was to evaluate the role of inpatient endoscopies for patients presenting with ALGIB and their impact on re-admissions. The secondary aim included the comparison of re-admission rates in patients using or not using anticoagulants and/or antiplatelets and identifying risk factors.

Patients and methods

Patients and study design. The present single-center, retrospective cohort study was conducted in the Colorectal Unit at Monash Health, Melbourne, Australia. All patients aged ≥18 years with an admission coded as 'per-rectal bleeding' under the Colorectal Unit >5 years from January 1, 2014 to December 31, 2018, were included in the study. Demographic data, anticoagulant and antiplatelet use, LGI endoscopy findings and computed tomography angiography investigations, interventions, diagnoses and inpatient readmission to the hospital with 'per-rectal bleeding' within 6 months of discharge were extracted from patient records. Patients deemed medically unfit to have an inpatient or outpatient LGI endoscopy were excluded.

Outcome. The primary outcome was the number of readmissions and a 6-month readmission rate. In the subgroup analyses, the predictors of readmission were identified in patients presenting with ALGIB.

Statistical analysis. All statistical analyses were conducted using R (version 4.4.2). A descriptive summary of readmission within 6-month rates was performed using the Chi-squared test or Fisher's exact test (for cases, where the Chi-squared test's assumptions are not reached) for categorical variables. Subsequent baseline characteristics of the patients who underwent inpatient LGI endoscopy compared with those who did not, stratified by use of antiplatelet or anticoagulants, were analyzed using the standard Wilcoxon rank-sum test for continuous variables and either the Chi-squared test or Fisher's exact test (as above) for categorical variables. To identify risk factors associated with 6-month readmission due to bleeding, both univariate and multivariate logistic regression analyses were performed. The significance for the multivariate model was set at $P<0.05$. The results of these analyses are presented side-by-side as odds ratios (ORs), 95% confidence intervals (CIs) and P-values.

To minimize selection bias, propensity score matching (PSM) was conducted to balance the baseline characteristics between the LGI endoscopy and the non-LGI endoscopy groups; results are described in the text rather than shown graphically. The propensity score was estimated using logistic regression while adjusting for age, sex, unstable vital signs, the requirement for blood transfusion, antiplatelet and/or anticoagulant use and the requirement for computerized tomography angiographic embolization. The estimated propensity scores were subsequently used to match treated and control patients. The logit-transformed score was used in certain analyses to ensure linearity, where the logit(p) is the natural log of the odds of receiving treatment. Matching was performed using a 1:1 nearest neighbor algorithm with a caliper width of 0.2. The caliper width of 0.2 was selected as it represents the conventional threshold (0.2 x standard deviation of the logit of the propensity score) recommended by Austin (2011) (10) to optimize bias-variance trade-off. Following matching, the treatment and control groups were well-balanced on the baseline characteristics. The final matched dataset included 117 patients who underwent LGI endoscopy and 117 patients who did not. In all statistical analyses, values of $P<0.05$ were considered to indicate statistically significant differences.

Results

A total of 2,751 admissions were screened, and 567 patients were included in the study over the specified time frame, categorized according to their antiplatelet/anticoagulant use and whether they received LGI endoscopy (Fig. 1). Out of the 120 patients who underwent LGI endoscopy, 100 patients had a colonoscopy, while 20 patients had a flexible sigmoidoscopy. Among the 100 patients who had a colonoscopy, the source of bleeding was identified in 34 cases. Of these, 8 patients required endoscopic treatment, and 11 patients underwent hemorrhoid surgery. In the group that had flexible sigmoidoscopy, the cause of bleeding was identified in 9 patients, with 3 of those receiving treatment (Fig. 2). All patients underwent complete 6-month follow-up via linkage with the Monash Health electronic medical record system, which captures all readmissions within the health network. In total, 7 patients (1.2%) succumbed during follow-up; none of the deaths were directly attributed to recurrent LGI bleeding.

The factors linked to readmission for bleeding within 6 months are outlined in Table I. These factors are derived from demographic data, hemodynamic status, the requirement for blood transfusions, the use of anticoagulants and/or antiplatelet agents, the requirement for CT angiography and subsequent CT angiographic interventions and inpatient GI endoscopy and interventions for bleeding based on endoscopic findings. This analysis compared two groups regarding their readmission rates within 6 months. No significant difference was noted in the re-admission rates between patients who had inpatient endoscopy and those who did not ($P=0.775$) Similarly, antiplatelet use alone was not associated with a significant difference in readmission rates ($P=0.836$). Blood transfusion requirements, CT angiography and angiographic embolization were also not independently associated with readmission in the univariate analysis (all $P>0.05$). There was a numerical increase in readmission rates among patients receiving anticoagulant therapy and among those receiving combined antiplatelet and/or anticoagulant therapy; however, these differences did not reach statistical significance in the univariate analysis ($P=0.053$ and $P=0.121$, respectively) (Table I).

Subgroup analysis was performed using antiplatelet and/or anticoagulant therapy (Table II). Among the patients receiving antiplatelet or anticoagulant therapy, inpatient LGI endoscopy was not associated with a statistically significant difference

Table I. Demographic data, anticoagulant and antiplatelet use, and blood transfusion and inpatient LGI endoscopy stratified by readmission within 6 months.

Parameters	Readmission within 6 months		P-value
	No	Yes	
Age, median (IQR)[b]	74 (59-82)	77 (68-84)	0.287
Sex, n (%)[c]			0.913
Female	174 (42.0)	16 (41.0)	
Male	241 (58.0)	23 (59.0)	
Inpatient LGI endoscopy, n (%)[c]			0.621
No	333 (80.0)	30 (77.0)	
Yes	82 (20.0)	9 (23.0)	
Antiplatelet use, n (%)[c]			0.706
No	247 (60.0)	22 (56.0)	
Yes	168 (40.0)	17 (44.0)	
Anticoagulant use, n (%)[c]			0.033[a]
No	319 (77.0)	24 (62.0)	
Yes	96 (23.0)	17 (44.0)	
Antiplatelet and/or anticoagulant use, n (%)[c]			0.085
No	187 (45.0)	12 (31.0)	
Yes	228 (55.0)	27 (69.0)	
Blood transfusion, n (%)[d]			0.756
No	383 (92.0)	37 (95.0)	
Yes	32 (7.7)	2 (5.1)	
Angioembolization, n (%)[d]			0.172
No	401 (97.0)	36 (92.0)	
Yes	14 (3.4)	3 (7.7)	
CT angiography, n (%)[c]			0.518
No	297 (72.0)	26 (67.0)	
Yes	118 (28.0)	13 (33.3)	

[a]Indicates a statistically significant difference. Data were analysed using the [b]Wilcoxon rank-sum test, [c]Chi-squared test, or [d]Fisher's exact test. The significance level was set at P<0.05. LGI, lower gastrointestinal.

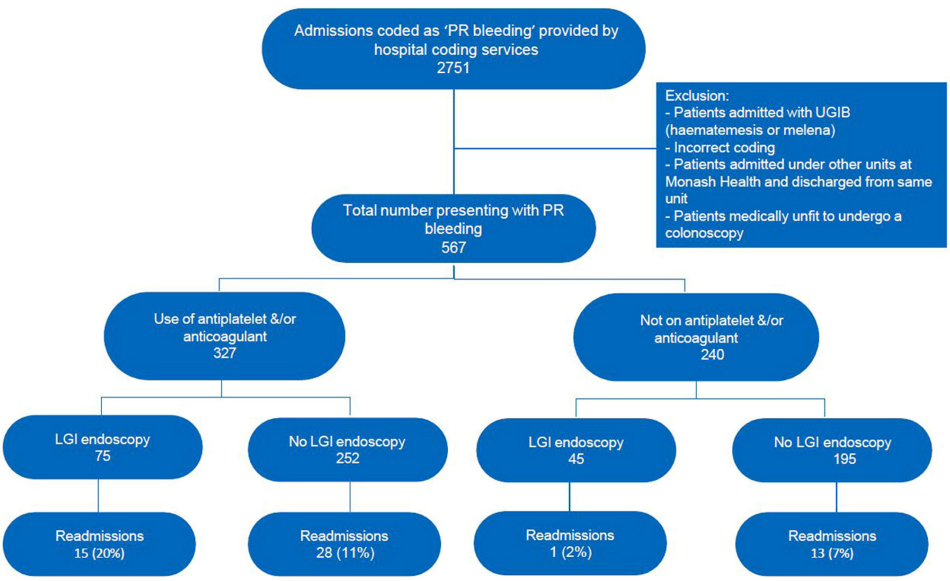

Figure 1. Patient screening and inclusion flowchart. LGI, lower gastrointestinal; PR, per rectal; UGIB, upper gastrointestinal bleeding.

Table II. Demographic data, anticoagulant and antiplatelet use, blood transfusion and re-admission rates within 6 months for all patients stratified by inpatient LGI endoscopy and layered by risk grade.

	Use of antiplatelet or anticoagulant			No antiplatelet or anticoagulant		
	Inpatient LGI endoscopy			Inpatient LGI endoscopy		
Layer Parameters	No	Yes	P-value No	No	Yes	P-value
Age, median (IQR)[b]	79.0 (71.0-85.0)	78.0 (68.0-83.6)	0.209	61.0 (48.3-76.8)	57.0 (45.0-78.0)	0.350
Sex[c]			0.279			0.255
Female	73 (36.7)	25 (44.6)		79 (48.2)	13 (37.1)	
Male	126 (63.3)	31 (55.4)		85 (51.8)	22 (62.9)	
Blood transfusion[d]			0.081			0.166
No	188 (94.5)	49 (87.5)		153 (93.3)	30 (85.7)	
Yes	11 (5.5)	7 (12.5)		11 (6.7)	5 (14.3)	
CT angiography[c]			0.819			0.007[a]
No	179 (70.8)	49 (66.2)		150 (76.5)	25 (56.8)	
Yes	74 (29.2)	25 (33.8)		46 (23.5)	19 (43.2)	
Angioembolization[d]			0.535			0.176
No	185 (93.0)	54 (96.4)		164 (100.0)	34 (97.1)	
Yes	14 (7.0)	2 (3.6)		-	1 (2.9)	
NA						
Re-admission within 6 months[d]			0.309			NS
No	180 (90.5)	48 (85.7)		153 (93.3)	24 (97.1)	
Yes	19 (9.5)	8 (14.3)		11 (6.7)	1 (2.9)	

[a]Indicates a statistically significant difference. Data were analyzed using the [b]Wilcoxon rank-sum test, [c]Chi-squared test, or [d]Fisher's exact test. The significance level was set at P<0.05. NS, not significant due to no perceived difference between groups; IQR, interquartile range; LGI, lower gastrointestinal.

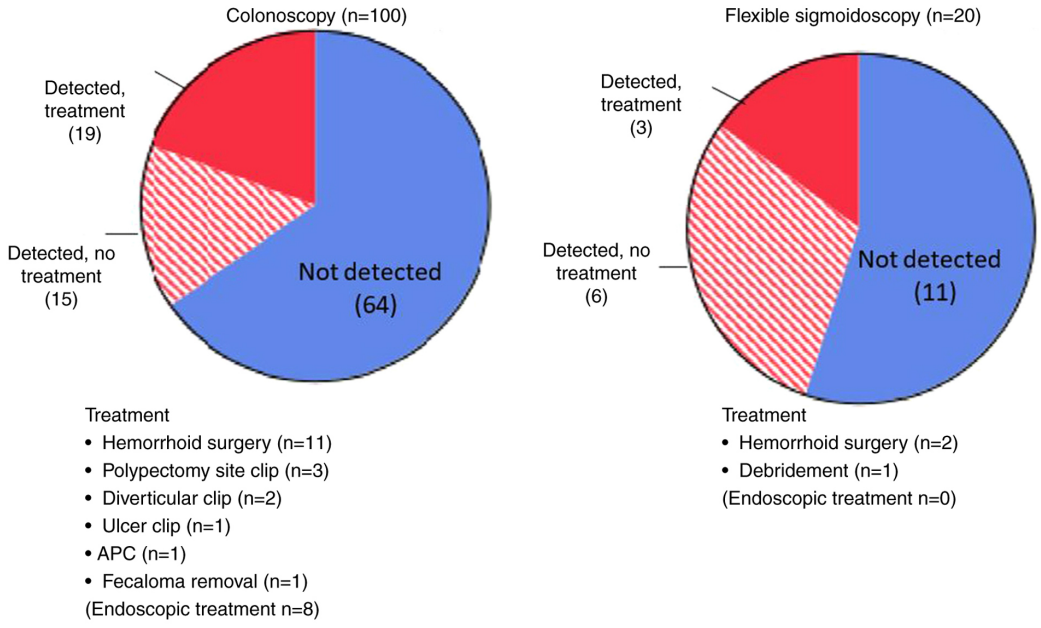

Figure 2. Details of lower gastrointestinal endoscopy. APC, argon plasma coagulation.

in readmission rates (P=0.309). Within the subgroup not receiving antiplatelet or anticoagulant therapy, patients undergoing inpatient LGI endoscopy were more likely to undergo CT angiography (P=0.007), reflecting greater diagnostic investigation in this cohort; however, this did not translate into higher readmission rates.

Table III. Univariable logistic regression model for risk of readmission at 6 months between patient characteristics.

Characteristic	OR	95% CI	P-value
Colonoscopy			
No colonoscopy	-	-	
Had colonoscopy	1.22	0.53-2.57	0.621
Antiplatelet or anticoagulants			
No	-	-	
Yes	1.85	0.93-3.87	0.089[a]
Age	1.01	0.99-1.04	0.258
Sex			
Female	-	-	
Male	1.04	0.54-2.06	0.913
Transfusion			
No transfusion	-	-	
Yes transfusion	0.65	0.10-2.25	0.561
Angioembolization			
No	-	-	
Yes	1.14	0.58-2.20	0.706
CT angiography			
No	-	-	
Yes	1.26	0.61-2.49	0.519

[a]Indicates a statistically significant difference. The significance level was set at P<0.25. OR, odds ratio; CI, confidence interval.

Univariable logistic regression (Table III) identified antiplatelet/anticoagulant therapy as showing a trend toward increased odds of readmission (OR, 1.85; 95% CI, 0.93-3.87; P=0.089). Other factors, including age, sex, transfusion, CTA and angioembolization were not significantly associated with readmission. In the reduced multivariable model (Table IV), antiplatelet/anticoagulant therapy remained the only variable approaching significance (OR, 1.85; 95% CI, 0.93-3.87; P=0.089).

Propensity score matching was used to balance the endoscopic and non-endoscopic groups concerning key demographic and clinical variables. Prior to PSM, significant differences were noted between the treatment and control groups with regard to their transfusion requirements (P=0.002) and CT angiography (P=0.02), with higher rates in those who underwent LGI endoscopy. Following matching, the group baseline characteristics were more balanced, and the differences in transfusion requirements and CT angiography were no longer significant (all P>0.05), indicating successful balancing by PSM. Following matching, standardized mean differences for all covariates were <0.1, confirming adequate balance between the LGI endoscopy and non-endoscopy groups (Fig. S1).

Discussion

The present retrospective study aimed to determine the optimal timing for LGI endoscopy in patients with ALGIB and its impact on the rate of readmissions. Studies evaluating the role of inpatient endoscopies for ALGIB on readmission rates in the public hospital setting in Australia have not been published previously.

Endoscopic treatment was performed in only 8 patients (8% of colonoscopy cases and 1.4% of all patients). The exclusion of bleeding from polypectomy (3 out of 8) significantly impacts the overall evaluation of the clinical utility of colonoscopy in the context of ALGIB. When bleeding from polypectomy is excluded, the incidence of bleeding decreases to just 5 out of 564 cases (0.8%). The diagnostic yield (36%) and therapeutic intervention rate (19%) align with international studies on inpatient ALGIB management, which report diagnostic yields of 30-45% and therapeutic yields of 15-25% (7). These values reflect real-world practice rather than sampling bias. Post-matching covariates were well balanced, confirming model stability. Sonnenberg (11) performed a decision analysis and demonstrated that pursuing colonoscopy for delayed PPB was effective in detecting and addressing a bleeding lesion in 22% of cases, requiring treatment for 4.5 patients. The author concluded that attempting a repeat colonoscopy would be advantageous, while also acknowledging that it is prudent to manage certain patients conservatively. This finding indicates that by recognizing patients at risk for polypectomy-related bleeding through their history, it is possible to pinpoint those for whom colonoscopy may offer limited clinical benefit. Consequently, it appears that colonoscopy may not be essential for treating ALGIB in patients without a history of polypectomy-associated bleeding.

The data further indicates a lack of therapeutic benefit of LGI endoscopy in reducing readmission rates. However, not

Table IV. Full to reduced multivariable logistic regression model for risk of readmission at 6 months between patient characteristics.

	Full model			Reduced model		
Characteristic	OR	95% CI	P-value	OR	95% CI	P-value
Antiplatelet or anticoagulants						
No	-	-				
Yes	1.65	0.76-3.80	0.221	1.85	0.93-3.87	0.089
Age	1.00	0.98-1.03	0.734			
Sex						
Female	-	-				
Male	0.97	0.49-1.94	0.928			
Transfusion						
No transfusion	-	-				
Yes transfusion	0.63	0.10-2.25	0.543			
Angioembolization						
No	-	-				
Yes	1.93	0.39-7.54	0.371			
CTA						
No	-	-				
Yes	1.10	0.49-2.32	0.801			

AIC full model: 275.38; AIC reduced model: 266.92, five stepwise iterations to achieve final reduced model. The significance level was at set at $P<0.05$. Model iteration 5 Loglikelihood to full model=-1.355, P=0.929. OR, odds ratio; CI, confidence interval.

surprisingly, the use of antiplatelets and/or anticoagulants increased the risk of readmission in 6 months. Although previous research, such as the ASPREE trial, reported an increased GI bleeding risk with aspirin, single antiplatelet therapy was not associated with increased readmission in the cohort examined in the present study (2).

A similar retrospective cohort study conducted in the USA with the primary outcome of 30-day all-cause readmission and a secondary outcome of the impact of early colonoscopy on 30-day readmission indicated similar results to those observed in the present study. The 30-day readmission rate was 16.4% compared with that noted in the 6-month readmission rate (10%). However, it was also suggested that early colonoscopy did not affect the 30-day readmission rate (12).

Rebleeding is a significant complication following initial control of ALGIB. ALGIB exhibits a rebleeding rate that is >2-fold of that noted in upper GI bleeding (13). Previous studies have demonstrated that early colonoscopy (≤24 h) employed for acute lower GI bleeding does not reduce rebleeding (14) or mortality rates compared with elective colonoscopy (15-17). Based on these findings, previous studies have suggested that patients generally do not require an early colonoscopy examination (7,8).

A multicenter retrospective cohort study suggested that early colonoscopy correlated with increased risk of rebleeding and reduced length of hospitalization (15). By contrast, the present study did not demonstrate a significant difference in readmission rates between patients who underwent inpatient endoscopy and those who did not (P=0.775, Table I). Subgroup analyses likewise showed no significant impact of endoscopic interventions on readmission (Table II). While patients receiving antiplatelet and/or anticoagulant therapy exhibited a trend toward higher readmission rates, this appeared independent of endoscopy itself. These findings suggest that, although colonoscopy may facilitate identification of recent bleeding, its role in reducing rebleeding or readmission remains uncertain. A recent large retrospective study from Japan indicated similar results. The present study indicated that early colonoscopy was limited to higher detection of recent signs of bleeding, and the 30-day rebleeding rate was not reduced in patients who underwent early colonoscopy compared with those who underwent elective or late colonoscopy (7).

Active bleeding requiring angiographic embolization has been identified as a significant risk factor for both rebleeding and readmission. Gobinet-Suguro *et al* (18) reported that the incidence of early and late rebleeding was notably higher in patients experiencing active bleeding associated with diverticular LGI bleeding compared with those with non-active bleeding, which supports the aforementioned observation.

The present study provides further insight to previous studies that have demonstrated that the lack of readily apparent benefit in performing LGI endoscopy can be used to reduce the readmission rate for ALGIB. The conduct of inpatient colonoscopies increases the burden caused on already overburdened hospital resources for emergency and endoscopy equipment access without clear evidence of benefit to patients or the healthcare system. An Australian guideline on the indication for early colonoscopies in ALGIB would be useful to streamline subsets of patients who may benefit from them. Further research into the financial implications

of LGI endoscopy on the public health system in Australia is required.

The present retrospective study exhibits certain limitations, such as coding errors, which were addressed via meticulous record reviews. The 6-month follow-up period may be inadequate, and only in-hospital readmissions within Monash Health were captured, excluding other health services. This study has limitations, including the lack of specific data on the use of non-steroidal anti-inflammatory drugs and granular classification of antithrombotic regimens. Additionally, clinical and laboratory parameters such as comorbidities, body mass index and biochemical data were inconsistently recorded and thus excluded. These constraints limit the scope of multivariate analysis to consistently available variables. The lack of quantitative data on bleeding volume and inconsistent recording of comorbidities limited certain types of analyses; however, key predictors such as age, hemodynamics, transfusions, antithrombotic use and angiography were included. Future studies are thus required to incorporate standardized comorbidity scoring and account for changes in antithrombotic therapy over time. The reliance on medication use at admission may potentially cause a misclassification of exposure; however, its results align with previous findings on anticoagulants and rebleeding. Clinicians selected patients for LGI endoscopy individually, with PSM used to control confounding parameters. Residual bias likely exists due to the more frequent selection for inpatient procedures in patients who were in a more serious disease state. This resulted in inpatient endoscopy being a marker of severity rather than a cause of readmission. Future prospective studies are required to clarify procedural effects and unmeasured confounders. The present study excluded patients with multiple Emergency Department visits and lacked detailed bleeding source classification, requiring future multicenter, prospective research with comprehensive data and longer follow-up to enable an improved understanding of rebleeding risks.

In conclusion, the present study suggests that the rationale for LGI endoscopy in an algorithm used to manage ALGIB should not focus on the presumed benefit of early detection of pathology to minimize readmission. The results demonstrate a lack of evidence of a reduction in the 6-month readmission rate for patients with LGIB following LGI endoscopy. To the best of our knowledge, this is the first study to analyze the impact of inpatient LGI endoscopy on readmission risk in an Australian public hospital setting. These findings provide critical local data that can be used in the establishment of Australian-specific clinical pathways and guidelines for managing acute LGI, an area currently guided largely by international evidence. The development of Australian guidelines on the indications for LGI endoscopy is required to guide healthcare resource expenditure. However, there is an urge to at least add pro-rata costing against the impact to justify the intervention.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

SC, RT, HC, ZD, TCN and WT conceptualized the study. SF, WI, YKT, JL and KN were involved in data curation. SF, WI, JL, CS and EA were involved in formal analysis. SF, TCN, AA, CS and VN were involved in data analysis. SF, TCN, HC and TSS were involved in the study methodology. YKT and JL were involved in project administration. WI and RT were involved in the writing of the original draft of the manuscript. WI, SF, HC and CS were involved in the writing, reviewing and editing of the manuscript. All authors have read and approved the final manuscript. WI, SF and RT confirm the authenticity of all the raw data.

Ethics approval and consent to participate

All research was performed per relevant guidelines and regulations, including the Declaration of Helsinki. Monash Health Research Support Services approved and exempted the project from Human Research Ethics Review, categorizing it as Quality Assurance/Minimal Risk Research. Informed consent was waived due to the retrospective nature of the study.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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