



## Brief Report

# The impact of a multidisciplinary algorithmic approach to acute lower gastrointestinal bleeding



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## 1. Introduction

Acute lower gastrointestinal bleeding (LGIB) is associated with significant morbidity and mortality and is a leading cause for presentation to the emergency department (ED) [1–4]. LGIB is responsible for >160,000 hospitalizations in the US every year, costing nearly \$1.5 billion annually [3]. Standardized treatment algorithms for LGIB have been associated with improved outcomes [4,5]. We therefore sought to improve the care of patients presenting to our ED with LGIB by developing and testing a standardized, multidisciplinary evaluation and management algorithm.

## 2. Methods

The algorithm was developed by a team of physicians and nurses from the GI, Emergency, Interventional Radiology (IR), Intensive Care, and Surgery departments at Boston Medical Center (BMC), a large, urban, safety-net academic medical center in Boston, MA (Fig. 1). The algorithm was implemented in March 2014 and instructed treating providers to involve both GI and surgical consulting services while initial

resuscitation measures were being undertaken. CT angiography was relied upon as the initial imaging study, unless the patient had renal dysfunction, in which case tagged red blood cell scanning or urgent colonoscopy (within 24 h) were performed. If active bleeding was detected with CT angiography, IR was consulted for possible angiogram. If active bleeding was not detected, consulting services directed further management. ED physicians were instructed to use the algorithm when evaluating any patient with a clinically significant LGIB defined as one or more of the following: heart rate > 100 beats per minute, systolic blood pressure < 100 mm Hg, hematocrit < 35%, or requiring a red blood cell transfusion within 24 h of presentation. These parameters were selected as they have been associated with poor prognosis in patients presenting with acute LGIB [6–8].

To test the algorithm, we performed a retrospective chart review of all patients admitted to BMC through the ED with an admitting diagnosis of LGIB from May 1, 2012 through December 31, 2013 (pre-algorithm) and from May 1, 2014 through December 31, 2015 (post-algorithm), two-months after the algorithm phase-in. Cases were identified from a prospectively-maintained data warehouse containing clinical information about all patients seen at BMC. Chart abstractors then performed a standardized chart audit of the hospital's electronic medical record. There were no exclusion criteria, but data was only analyzed from those cases meeting the inclusion definition of clinically significant LGIB. For patients readmitted with LGIB during the study time-frame, only the first admission was included for analysis. The retrospective chart review was exempted by our Institutional Review Board. Our primary endpoint was length of hospitalization. Secondary endpoints are shown in Table 2. Multiple logistic regression analyses were used to determine whether implementation of the algorithm was associated with secondary endpoints. Analyses were conducted using SAS v9.4.

## 3. Results

There were 97 records reviewed for 87 patients admitted with LGIB during the pre-algorithm period and 129 records reviewed for 100 patients admitted with LGIB post-algorithm. Seven patients in the post-algorithm period were admitted during the pre-algorithm period, leaving 93 patients for analysis for this time period. Average patient age was 66 years, 51% of patients were male, 45% self-identified as African-American and 17% self-identified as Hispanic. There were no statistically

*Abbreviations:* BMC, Boston Medical Center; ED, emergency department; IR, Interventional radiology; LGIB, lower gastrointestinal bleed.

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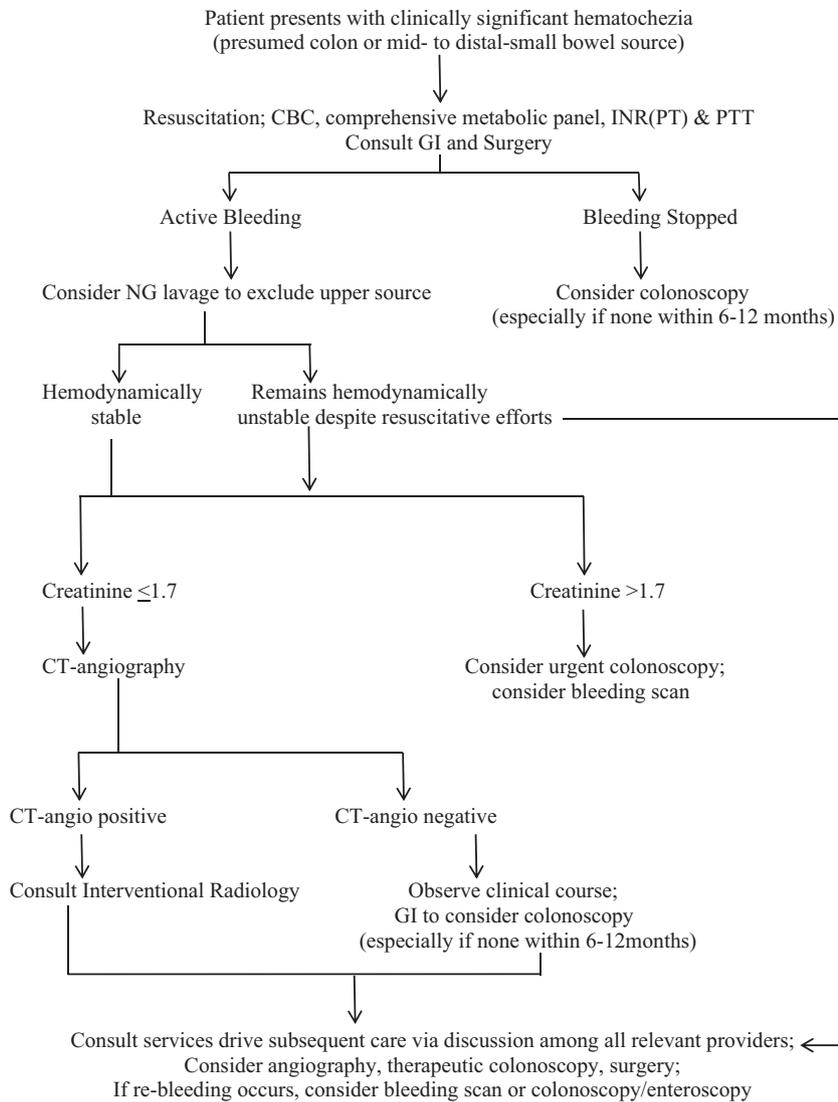


Fig. 1. Algorithm for lower gastrointestinal bleeding for emergency department use.

significant differences in characteristics between the two groups regarding body mass index, age, sex, race/ethnicity, anticoagulant use or history of prior LGIB (Table 1). Primary and secondary outcomes are presented in Table 2. The median hospital length of stay was four days during the pre-algorithm period and five days during the post-algorithm period ( $p = 0.99$  by log-rank test). Patients cared for with the algorithm in place were more likely to receive a GI consultation (92.5% vs 81.6%,  $p = 0.011$ ) and to undergo CT angiography (29% vs 10.3%,  $p = 0.005$ ). The mean number of units of blood transfused was

2.2 during the pre-algorithm period and 1.3 during the post-algorithm period ( $p = 0.01$  by Wilcoxon rank sum test).

#### 4. Discussion

We developed a multidisciplinary, algorithmic approach to acute LGIB. While we found no evidence that our algorithm resulted in a shorter length of hospitalization, we considered this a successful initiative which has resulted in the algorithm's adoption as a hospital policy, leading to its ongoing use at our facility to this day. We interpreted our study as successful for the following reasons: 1) the algorithm resulted in greater use of the gastroenterology consult service to provide more rapid input into the care of patients. This meant more consultations performed while patients were still in the Emergency Department, a positive development at our institution where medical consult services do not consistently provide input for patients prior to admission from the ED; 2) the algorithm resulted in greater use of CT angiography which has now replaced tagged red blood cell scanning as first-line imaging in our hospital. The literature has shown CT angiography is more accurate than RBC-tagged scans and is performed much more rapidly than urgent colonoscopy [9,10]; 3) while our study design precluded demonstrating causality, the trends toward greater use of colonoscopy and greater cessation of bleeding by colonoscopy are likely reflections of the rapid use of CT angiography to demonstrate and localize active bleeding, as well as the

Table 1  
Patient characteristics.

	Pre-algorithm (n = 87)	Post-algorithm (n = 93)	p value*
Age, mean (SD)	66.7 (17.5)	65.3 (15.6)	0.57
Body mass index, mean (SD)	27.1 (6.8)	28.8 (7.4)	0.11
Male, %	50.6%	48.4%	0.88
Race/ethnicity (self-identified)			0.13
White	24.1%	22.6%	
Black	51.7%	39.8%	
Hispanic	16.1%	18.3%	
Anticoagulant use on admission	13.8%	19.4%	0.42
Prior lower GI bleed	52.9%	38.7%	0.07

\* p-Values based upon Student's *t*-test or Fisher's Exact test as appropriate.

**Table 2**

The association between implementation of a LGIB algorithm and primary and secondary endpoints.

Outcome	Pre-algorithm	Post-algorithm	p-Value*
Hospital length of stay in days, median (IQR)	4 (IQR 4)	5 (IQR 3)	0.99
ICU admission, n (%)	39 (44.8%)	37 (39.8%)	0.586
GI consult obtained, n (%)	71 (81.6%)	86 (92.5%)	<b>0.011</b>
Surgical consult obtained, n (%)	19 (21.8%)	27 (29%)	0.225
CT angiogram performed, n (%)	9 (10.3%)	27 (29%)	<b>0.005</b>
CT angiogram detected active bleeding, n (%)	2 (22.2%)	11 (40.7%)	0.371
Angiography performed, n (%)	7 (8.1%)	10 (10.8%)	0.856
Successful angiography-directed cessation of bleeding, n (%)	2 (28.6%)	3 (30%)	0.894
Tagged red blood cell scan performed, n (%)	8 (9.2%)	4 (4.3%)	0.224
Colonoscopy performed, n (%)	38 (43.7%)	55 (59.1%)	0.056
Successful colonoscopy-directed cessation of bleeding, n (%)	3 (7.9%)	12 (21.8%)	0.09
Blood transfusion performed, n (%)	55 (63.2%)	45 (48.4%)	0.124
Units of blood transfused per patient, mean (SD)	2.2 (2.8)	1.3 (1.9)	<b>0.01</b>

p-Values in bold are statistically significant.

\* p values based on multivariate regression models controlling for BMI, race, history of prior LGIB and regular use of non-steroidal anti-inflammatory drugs. Logistic regression used for all endpoints except length of stay (log rank test) and units of blood transfused (negative binomial regression);  $p < 0.05$  considered statistically significant; analyses conducted using SAS v9.4.

greater use of GI consultation; and 4) while length of stay was not shortened with use of the algorithm, the decreased use of blood transfusion suggests a positive patient-centered benefit.

The ability of a standardized algorithm to reduce transfusions has been shown previously [4], and may be an important way to ensure more efficient use of blood products. Because CT angiography can be performed rapidly in the ED, it is perhaps not surprising that the algorithm was associated with greater use of this modality. While some previously published guidelines make use of urgent colonoscopy, our multidisciplinary team was seeking to expedite care of patients with LGIB and to rapidly risk-stratify to determine who required ongoing resources versus those whose bleeding may have been self-limited [2].

In contrast to guidelines that rely on early use of colonoscopy, we found no evidence that initial reliance on CT angiography was associated with poor outcomes. Moreover, GI consultation increased with this algorithm, and there was a non-significant trend toward more use of colonoscopy, including studies wherein a therapeutic intervention was performed. While greater use of CTA and GI consultation may have been predicted by their inclusion in the algorithm, we interpret this outcome as evidence that our algorithm was clinically meaningful and readily adopted by busy ED clinicians.

However, we acknowledge certain limitations to our study. Our study relied on historical controls to demonstrate associations between the algorithm and clinical outcomes. Causality can only be demonstrated through use of a randomized controlled trial. Unfortunately, it would prove very difficult to conduct such a study as providers would need to apply the algorithm only in certain cases and their clinical judgement would likely be influenced by their knowledge of the steps suggested by the algorithm.

Our use of historical controls makes it difficult to interpret our finding that fewer units of blood were transfused after implementation of the algorithm, specifically because of a widely read publication supporting the benefit of limited transfusions for acute upper GI bleeding published in January 2013 [11]. However, that publication date was 12 months prior to the end of the pre-algorithm period, theoretically

leaving many months for its impact to be felt. Moreover, that study focused only on upper GI bleeding, with its authors specifically commenting that their results should not be generalized to all patients with acute gastrointestinal bleeding. Future studies are therefore needed to verify our findings and further explore the use of algorithms to improve the care of patients presenting to the ED with LGIB. Finally, we acknowledge that there were several variables that were not impacted by the algorithm, including frequency of ICU admissions and use of surgical consultations.

Our study raises many questions for future investigation. While we have demonstrated that an algorithm for the management of LGIB can be successfully implemented, it remains to be shown that patient-centered outcomes can be impacted. Future research is needed to determine the optimal timing of GI or surgical consultation (if required in the ED at all), whether CT angiography is more cost-effective than tagged red blood cell scanning, how patients fare comparing early colonoscopy versus delayed colonoscopy versus interventional radiology guided therapy, and whether conservative blood transfusion strategies are as beneficial for LGIB as they are for upper GI bleeding.

In summary, we have developed an algorithm for the management of patients presenting to the ED with acute LGIB. While we found no evidence that our algorithm resulted in a shorter length of hospitalization, changes observed in process outcomes (e.g. more GI consultations and CT angiography) and fewer blood transfusions suggest the algorithm was adopted by hospital-based practitioners. However, future studies are required to demonstrate the clinical utility of algorithms for LGIB.

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#### Declaration of Competing Interest

Brian Jacobson is a consultant for MOTUS, GI; Dark Canyon, LLC; and Remedy Partners. No other authors have any disclosures.

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