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Impact of inter-hospital transfer on success of angioembolization for lower gastrointestinal bleeding

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Abstract

Background: Angioembolization is a useful therapeutic tool for lower gastrointestinal bleeding (LGIB) however is only available at centres with specialist interventional radiology departments. Delay in angioembolization of greater than 120–150 minutes is associated with higher rates of non-therapeutic angioembolization.

Methods: This retrospective review analysed the impact of interhospital transfer on timing and success of angioembolization in adults with LGIB.

Results: Of the 121 patients who underwent CTMA at a peripheral hospital for LGIB, only 20.7% had positive CTMA ($n = 25$). Of the 24 patients who were transferred for the purpose of angioembolization, only five ultimately had successful embolisation (20.1%). Patients who had unsuccessful angioembolization had a significantly longer mean time from arrival at the tertiary hospital to angioembolization compared to patients who had successful angioembolization (mean 375 versus 175 min, $P = 0.001$). There was no association of patient haemodynamics, use of anticoagulant or antiplatelet therapy, and transfusion requirement with success of angioembolization.

Conclusion: Interhospital transfer is associated with delay in angioembolization. Delay after arrival at the receiving hospital is associated with unsuccessful angioembolization.

Introduction

Lower gastrointestinal bleeding (LGIB) is a common emergency presentation, with an annual incidence of hospitalization of 72 per 100 000 population.[1] The mortality rate associated with LGIB is approximately 2.4%–3.9%.[2] In hospital mortality has been reported at 18% without intervention in patients who develop LGIB and 20% in patients requiring four or more units of red cells.[1]

Angiography allows further diagnostic localisation and treatment through the use of aniogembolisation.[3–5] Whilst angioembolization is a useful therapeutic tool for the management of lower gastrointestinal bleeding (LGIB), it is only available in hospitals with specialist interventional radiology services.[6] In some countries, there is increasing shift towards centralisation of health care provision including management of patients with gastrointestinal bleeding at hospitals that have readily available access to specialist gastroenterology, interventional radiology and surgical services.[7]

Timing of intervention for LGIB is crucial. angioembolization performed less than 120–150 min after positive CT mesenteric angiogram (CTMA) is associated with better localisation of the bleeding point and lower rates of non-therapeutic angioembolization.[4,8,9] Inter-hospital transfer for LGIB has higher rates of total abdominal colectomy, as well as greater length of stays and total hospital costs.[10] In the literature upper gastrointestinal bleeding has been closely studied, but there remains limited information of on the outcomes of inter-hospital transfers of patients with lower gastrointestinal bleeding.

Understanding which patients are most likely to benefit from angioembolization would allow better resource allocation to ensure that unnecessary transfers are avoided without any difference in morbidity or mortality. The primary aim of this study was to determine the proportion of patients undergoing CTMA for LGIB at a peripheral hospital who were transferred for the purposes of angioembolization and subsequently underwent successful angioembolization. The secondary aims were to delineate the factors associated with delay in angioembolization, and successful versus unsuccessful angioembolization after interhospital transfer.

Methods

Study design

A retrospective review was conducted of all adult patients aged 18 years or over undergoing CTMA for lower gastrointestinal

bleeding at a peripheral hospital in New South Wales between January 2014 and June 2017. Data were obtained from the electronic medical record. Ethics approval for the study was received from the South Western Sydney Local Health District Human Research Ethics Committee (HREC ID 2019/ETH13992).

Data collected were patient age, sex, time of index bleed, clinical status (initial heart rate, blood pressure, haemoglobin, INR, APTT and lactate), medications (including anti-platelets or anti-coagulation), and blood transfusion requirements. Incidence of transfer, time to transfer, time to angioembolization, success of angioembolization and hospital length of stay were analysed. Shock index (defined as heart rate in beats per minute divided by systolic blood pressure in mm Hg) was calculated for each patient at time of initial presentation and at time of arrival to the receiving hospital.

Statistical analysis

Data were recorded and analysed using Jamovi software (The Jamovi project (2021). Jamovi version 2.3.0). Descriptive statistics were computed. Distribution of continuous data was tested for normality using the Shapiro–Wilk test. Mann–Whitney *U* tests were performed to assess differences in patient age, haemodynamic parameters, haemoglobin, INR, APTT, lactate, shock index and length of stay between patients who were transferred, who underwent angioembolization and who had successful versus unsuccessful angioembolization. Mann–Whitney *U* tests were also used to assess differences in time of index bleed, time from presentation to angioembolization, CTMA to angioembolization, and arrival at the receiving hospital to angioembolization for patients with successful versus unsuccessful angioembolization. Statistical significance was set at $P < 0.05$.

Results

Patient characteristics and transfer status

A total of 121 patients underwent CTMA at the study hospital for lower gastrointestinal bleeding. Median age was 68 years (range 23–95 years), 54.5% were male and 47.9% were female. 46.3% were not on any antiplatelets/anticoagulants, 47.9% were on antiplatelets or anticoagulants and 5.8% had unknown medication history (Table 1). Blood product transfusion was required for 59.5% of patients overall (56.2% of patients with negative CTMA versus 72% of patients with positive CTMA). There were 25 positive CTMAs (20.7%) and 96 negative CTMAs (79.3%). Twenty-four patients were transferred to a tertiary hospital (19.8%) with view to undergo angioembolization, and 97 patients were not transferred (80.2%). Six patients with positive CTMA were not transferred; due to resolution of bleeding in two patients and unclear reasons in four patients. Five patients with negative CTMA were transferred; due to haemodynamic instability in two patients and unclear reasons in three patients (Fig. 1). Mean time from CTMA to transfer was 303 min (SD 201 min) and mean time from arrival at the receiving hospital to angioembolization was 298 min (SD 249 min).

Characteristics of patients based on transfer status are demonstrated in Table 1. There was a significant difference in patient age between the transferred and non-transferred groups (77.5 versus 68.0 years, $P = 0.015$). A significantly higher proportion of transferred patients received blood transfusion (82.6% versus 55.2% of non-transferred patients, $P = 0.016$). There were no significant differences in median time of index bleed, heart rate, systolic blood pressure, haemoglobin, INR, APTT and lactate between transferred and non-transferred groups. There was also no significant difference in median time from index bleed in patients who had a positive versus negative CTMA (4.5 versus 4.0 hours, $P = 0.833$).

Success of angioembolization

Of the 24 patients transferred to the tertiary hospital for the purpose of angioembolization, only 13 patients proceeded to angiography (Table 2). angioembolization was successful in only five patients (38.5%) and unsuccessful in eight patients (61.5%), meaning no active bleed was identified on angiography. Of the 11 transferred patients who did not undergo angiography, three patients had spontaneous resolution of bleeding, three patients had no bleeding found on repeat CTMA, one patient deteriorated and was deceased prior to angiography, and four had unclear reasons for not proceeding. Of the 19 patients who did not undergo or did not have successful angioembolization, two subsequently required repeat

Table 1 Characteristics of study population by transfer status[†]

	Transferred $n = 24$	Not transferred $n = 97$	*P*-value[‡]
Sex			
Male	16 (66.7)	50 (51.5)	0.015
Age (years)	77.5 (19.3)	68.0 (22.0)	0.435
Time of index bleed (hours)	8.6 (9.8)	11.4 (8.0)	0.758
Vitals at initial presentation			
Heart rate	82 (27)	85 (27)	0.576
Systolic blood pressure (mm Hg)	117 (33)	122 (29)	0.457
Shock index	0.66 (0.23)	0.70 (0.28)	0.411
Laboratory indices			
Hb	95 (36)	98 (43)	0.471
Lactate	1.70 (1.19)	1.69 (1.15)	0.618
INR	1.1 (0.3)	1.1 (0.2)	0.657
APTT	29 (7)	30 (4)	0.910
Antiplatelet/ anticoagulant therapy			
Yes	12 (54.5)	46 (50.0)	0.702
No	10 (45.5)	46 (50.0)	
Packed red blood cell transfusion			
No	4 (17.4)	43 (44.8)	0.016
Yes	19 (82.6)	53 (55.2)	
CTMA			-
Positive	19	6	
Negative	5	91	

[†]Discrete data expressed as *n* (%), continuous data expressed as median (IQR).

[‡]χ^2 *P*-value for discrete data, Mann–Whitney *U*-test for continuous data.

angioembolization (32.4%), four underwent gastroscopy (67.7%) and one underwent colonoscopy (16.7%) for haemostasis. No patients in the study population proceeded to surgical management. There was no significant association between vital signs (either on initial presentation or on arrival at the receiving hospital), haemoglobin, lactate, INR, APTT, time from index bleed, antiplatelet/anticoagulant therapy or need for blood transfusion with success of embolisation (Table 2). Of the eight patients who required re-intervention, all had normal INR and APTT and shock index at time of arrival at the receiving hospital.

Time to angioembolization

Mean time from CTMA to angioembolization was 559 min, and mean time from arrival at the receiving hospital to angioembolization was 277 min. Patients who had unsuccessful angioembolization had

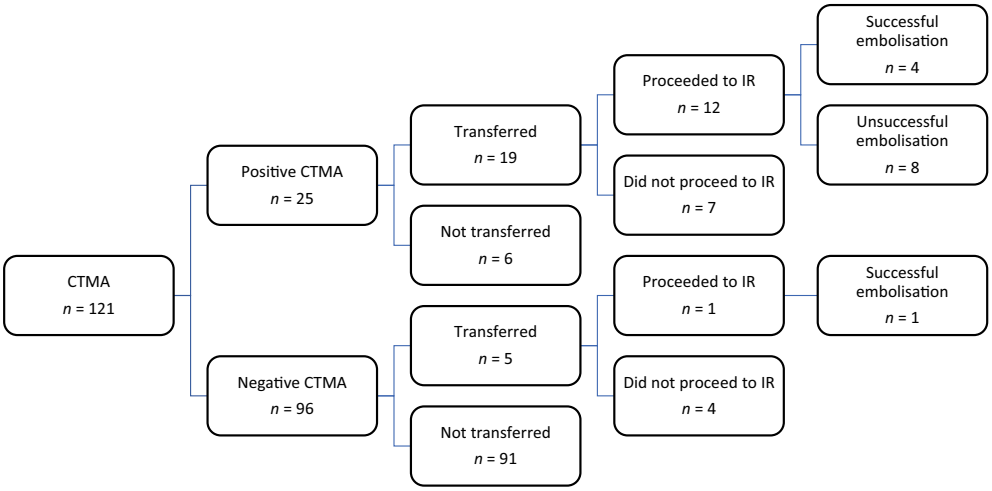

Fig. 1. Patient disposition.

Table 2 Characteristics of patients who had successful versus unsuccessful embolization[†]

	Successful angioembolization $n = 5$	Unsuccessful angioembolization $n = 8$	Mean difference	*P*-value[‡]
Sex				
Male	3 (60.0)	5 (62.5)	–	0.928
Age (years)	65.0 (21.0)	75.5 (23.0)	–	0.908
Time of index bleed (hours)	5.0 (7.5)	3.5 (2.5)	–	0.123
Vitals at initial presentation			–	
Heart rate	82 (4)	86 (40)		1.000
Systolic blood pressure (mm Hg)	103 (22)	121 (30)		0.464
Shock index	0.70 (0.24)	0.68 (0.32)		0.626
Laboratory indices				
Hb	78 (13)	113 (41)	–	0.106
Lactate	2.39 (0.96)	1.06 (0.67)		0.095
INR	1.2 (0.2)	1.1 (0.2)		0.411
APTT	28 (2)	30 (7)		0.604
Antiplatelet/anticoagulant therapy				
Yes	1 (33.3)	4 (50.0)	–	0.621
No	2 (66.7)	4 (50.0)		
Packed red blood cell transfusion				
No	0 (0.0)	2 (28.6)	–	0.190
Yes	5 (100.0)	5 (71.4)		
Vitals on arrival at receiving hospital				
Heart rate	79 (3)	81 (16)	–	1.000
Systolic blood pressure (mm Hg)	120 (5)	142 (61)		0.533
Shock index	0.66 (0.05)	0.63 (0.18)		0.599
Mean time (minutes)				
Time from CTMA to transfer	531 (±250)	148 (±25)	383	0.002
Time from CTMA to angioembolization	681 (±348)	552 (±304)	129	0.622
Time in transit	45 (±22)	30 (±7)	15	0.368
Time from arrival at receiving hospital to angioembolization	175 (±63)	375 (±295)	200	0.001
Length of stay (days)	4 (3)	5 (3.75)		0.475

[†]Discrete data expressed as *n* (%); age, vitals, Hb and lactate expressed as median (IQR); times expressed as mean (in minutes) ±SD.

[‡]χ^2 *P*-value for discrete data, Mann–Whitney *U*-test for continuous data.

a significantly longer mean time from arrival at the tertiary hospital to angioembolization compared to patients who had successful angioembolization (mean 375 versus 175 minutes, $P = 0.001$). There was however no significant difference in mean overall time from CTMA to angioembolization between those who had successful versus unsuccessful angioembolization (552 versus 681 min, $P = 0.622$). Mean time from CTMA to transfer was significantly shorter in the unsuccessful angioembolization group compared to the successful angioembolization group (148 versus 531 min, $P = 0.002$). There was no significant difference in transit time, patient parameters, use of anticoagulant or antiplatelet therapy, and transfusion requirements between groups.

Subgroup analysis of patients with shock index >1.0

CTMA was positive in 33.3% (n = 4) of patients with shock index >1.0 at time of initial presentation compared to 17.8% of patients with shock index ≤1.0 ($P = 0.195$). Blood transfusion was also administered more frequently in patients with shock index >1.0 (91.7% compared to 56.1% of patients with shock index <1.0, $P = 0.058$). Of the 12 patients with shock index >1.0 at time of initial presentation, four were transferred and none had persistent shock index >1.0 at time of arrival at the receiving hospital. Of these patients, three proceeded to angioembolization and one had successful angioembolization. Two patients with shock index ≤1.0 at time of initial presentation had shock index >1 at time of arrival at the receiving hospital. Both these patients were managed with blood transfusion and did not proceed to angioembolization.

Length of stay

There was no significant difference in mean length of stay between patients who had successful versus unsuccessful angioembolization (4 versus 5 days, $P = 0.475$). There was also no significant difference in mean length of stay between patients who required re-intervention versus patients who had either successful embolisation or no intervention performed (6 versus 4.5 days, P = 0.625).

Mortality

There was one in-hospital mortality in the study population. This patient was an 87 year old male on clopidogrel who was transferred after a positive CTMA. They had normal INR, APTT and shock index ≤1.0 at initial presentation. Index bleed was 2 h prior to presentation. On arrival at the receiving hospital they deteriorated rapidly despite resuscitation prior to angioembolization.

Discussion

A high proportion of patients transferred for the purpose of angioembolization in this study either did not proceed to angioembolization or had no active bleed at time of angioembolization. Overall, only five of the 24 transferred patients had successful angioembolization (20.1%). The transfer of these patients presents a substantial cost burden to the healthcare system and warrants the development of protocols to guide patient selection and expedite transfer. In this study, the median heart rate was 82 and 85 beats per minute, and systolic blood pressure 117 and 122 mmHg for the transferred and non-transferred patients respectively. It is noted in the literature that CTMA has low diagnostic yield in patients that are haemodynamically stable.[11] Previous studies examining prediction models for clinically significant LGIB found that factors significantly associated with positive CTMA included heart rate greater than 100 beats per minute, systolic blood pressure less than 100 mmHg, requirement for greater then three packed red blood cell transfusions, or recent bowel resection or endoscopic therapy.[12,13]

One significant finding was that the time from patient arrival at the receiving hospital to angiography had a significant association with successful versus unsuccessful angioembolization. This highlights the importance of expediting angiography in bleeding patients to obtain the greatest therapeutic yield. Paradoxically, the mean time from CTMA to transfer was shorter in the unsuccessful group. This suggests that delay in time to angioembolization after arrival at the receiving hospital may be more important than delay at transferring hospital. The cumulative effect of delays at both the initial and receiving hospitals resulted in a timeframe much longer than the recommended 120–150 min between positive CTMA and angioembolization. During the mean 303 min delay between CTMA and transfer and mean 298 min delay in angioembolization after arrival at the receiving hospital in our study, many patients had spontaneous resolution of their LGIB, as is the natural history. This poses issues when patients present with LGIB to a peripheral hospital without angioembolization facilities and represents an area in our healthcare system that requires improvement.

Another salient finding of this study is that no association was identified between successful embolisation and patient haemodynamic status (as measured by heart rate, systolic blood pressure and shock index), haemoglobin, lactate or requirement for blood transfusion. In the literature, shock index >1.0 has been widely demonstrated to predict increased risk of mortality and morbidity including need for massive transfusion.[14] In our study, however, no patients who had shock index >1.0 initially had persistent shock index >1.0 on arrival at the receiving hospital. Furthermore, the two additional patients who had shock index >1.0 at the receiving hospital were resuscitated with blood products and had spontaneous resolution of their bleeding without requiring angioembolization. The lack of association of haemodynamic and laboratory indices with outcomes in our study is likely to be largely related to small sample size, and such factors may be further elicited by a larger study in order to better inform protocols for management and transfer of these patients. Other confounding factors that would be important to analyse with a larger study include the effect of type of anticoagulation used, given that previous studies have indicated that apixaban has been shown to have lower rates of major gastrointestinal bleeding compared with the other direct oral anticoagulants (DOACs).[15]

Further limitations of this study include its retrospective nature. Accuracy of subjective data (including time from index bleeding episode, reasons for proceeding or not proceeding with transfer or angioembolization) was highly reliant on accurate documentation by clinicians at time of patient review. Furthermore, the study was inadequately powered to assess outcomes such as length of stay and mortality. An important area of future research is the cost (both financial and resource) associated with transfer, unsuccessful

angioembolization and inpatient stay in this patient group. Another key area of future research is the factors contributing to delay in transfer and delay in angioembolization at the receiving hospital. We hypothesise that these may have included delays in radiology reporting, obtaining an accepting consultant at the receiving hospital, interhospital transport availability, patient reassessment at the receiving hospital and availability of interventional radiology staff and theatres.

Conclusion

In this study, inter-hospital transfer of patients with LGIB resulted in a delay in angioembolization that significantly exceeded the recommended time frame of 120–150 min. Very few patients who were transferred for the purpose of angioembolization actually proceeded to successful angioembolization. Unsuccessful angioembolization was particularly associated with a delayed time from arriving at the tertiary hospital to angioembolization. Haemodynamic parameters, initial haemoglobin, and anticoagulation use were not associated with any significant difference in success of angioembolization in this study.

Author contributions

Tahmina Lata: Conceptualization; data curation; investigation; project administration; writing – original draft. **Timothy Peacock:** Visualization; writing – review and editing. **Alexandra Limmer:** Formal analysis; investigation; methodology; software; supervision; writing – review and editing. **Juen Tan:** Data curation. **Sara Wu:** Data curation; investigation; project administration; writing – original draft. **Dean Yeh:** Supervision.

Conflict of interest

The authors do not have any conflict of interest to declare

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