



# Transarterial Embolization of Gastrointestinal Hemorrhages: Retrospective Study in Siriraj Hospital

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## ABSTRACT

**Objective:** To determine the technical and clinical results of transarterial embolization of nonvariceal gastrointestinal hemorrhages (GIH) which cannot be managed endoscopically.

**Methods:** A retrospective review of 21 embolizations in 77 patients who underwent arteriography for acute nonvariceal GIH was performed. Gastrointestinal hemorrhage was classified by the site of bleeding as upper, lower, or transpapillar including hemobilia and pancreatic duct bleeding. Clinical parameters and embolized data were assessed for clinical success. In-hospital mortality was also reported.

**Results:** Technical success (bleeding target devascularization) was achieved in all 21 patients (100%). The complete technical success rate was 71.4% (15 out of 21 patients) while the partial technical success rate was 28.6% (6 out of 21 patients). The complication rate was very low (9.5%) including only 2 cases of bowel ischemia. No other complications were found. Eight out of 21 patients (38.1%) had rebleeding within 3 days. Upper GIH seemed to recur more frequently (4 out of 7 patients representing 57.1%) within the first 3 days than did lower (4 out of 11 patients at 36.4%) and transpapillar (0 of 3) GIH. Clinical success (no rebleeding after 30 days) was achieved in 11 of 21 patients (52.4%) including 3 out of 7 patients (42.9%) with UGIH, 7 of 11 patients (63.3%) with LGIH, and all patients with transpapillar hemorrhage. The overall mortality rate was 42.9% (9 out of 21 patients), with 42.9% (3 of 7 patients) for UGIH, 27.3% (3 of 11 patients) for LGIH and none for transpapillar hemorrhage. GIH was the cause of death in 6 of 9 patients (66.7%) while 3 out of 9 patients (33.3%) died from the other causes.

**Conclusion:** Transarterial embolization is an effective treatment modality for lower GIH and transpapillar hemorrhage but less effective in upper GIH.

**Keywords:** Transarterial embolization, gastrointestinal hemorrhages

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Gastrointestinal hemorrhage (GIH) is a medical emergency. For primary diagnosis and treatment of GIH, endoscopy is the method of choice. Only in difficult localizations or when endoscopy is not successful, angiography or surgery are the options. The interventional radiology for GIH is performed by angiography with transarterial embolization.<sup>1,2</sup>

In 10% of the patients with upper GIH, endoscopy is severely impaired by excessive blood and clots in the gastroduodenal tract that obscures diagnosis<sup>3</sup> thus urgent

surgery is required. With lower GIH, delayed colonoscopy after stabilization and oral bowel preparation has been recommended.<sup>4</sup> Even after appropriate cleansing, colonoscopy combined with upper GI endoscopy fails to demonstrate 10-20% of bleeding sources, including small bowel lesions.<sup>5</sup> In the patient with endoscopically unmanageable nonvariceal GIH with unknown cause and bleeding site, blind resection of the colon was performed resulting in 33-57% mortality and a 33% rebleeding rate.<sup>6</sup> If the bleeding source is unclear or if the patient is a poor surgical candidate, the use of visceral arteriography and transarterial embolization or selective infusion of vasopressin has been advised to identify the cause of

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bleeding and control GIH at the same time.<sup>7</sup> Local vasoconstrictive therapy is no longer commonly used due to a high percentage of rebleeding (20-30%), the pharmacologic side-effects, and the drawbacks of using an indwelling catheter for hours or even days.<sup>8,9</sup> Now, the transarterial embolization with embolic materials such as gelatin sponge (Gelfoam®), N-butyl cyanoacrylate (NBCA) or glue, polyvinyl alcohol (PVA) (Ivalon®) and microcoil are more acceptable.

Some articles have reported technical success rates on the transarterial embolization of acute nonvariceal GIH of 80-95%, with 30-day failure rates of 0%-42% and serious complications such as bowel ischemia 7-21%.<sup>10,11</sup>

To our knowledge, there have been no publications evaluating the techniques and clinical results of transarterial embolization of endoscopically unmanageable nonvariceal GIH in Thailand. The purpose of our retrospective study was to determine technical and clinical results that we achieved in 3 years in the Department of Radiology, Siriraj Hospital.

## MATERIALS AND METHODS

### Study design

A single-center retrospectively survey of all patients treated with embolization for acute nonvariceal GIH not manageable by endoscopy during 3 years (August 2002 to September 2005) was performed. The bleeding characteristics, arteriographic findings and embolization techniques were analyzed with respect to rebleeding rate and in-hospital mortality.

### Patient selection

We retrospectively analyzed the findings of all patients with GIH who had been referred for arteriography and embolization on the advice of the referring endoscopists and surgeons on emergency duty.

### Clinical data

Patient age and gender as well as all clinical, endoscopic data and outcome data, were obtained from the medical records. Acute GIH was defined if the patient had symptoms of hematemesis, melena, or hematoschezia. The cause of GIH was traced by consensus analysis of the history, imaging findings and histologic findings, if available. Bleeding was defined as upper or lower GIH if the cause was located either proximal or distal to the ligament of Treitz. Transpapillar GIH was defined as either hemobilia or pancreatic duct bleeding.

### Techniques of Embolization

Celiac and superior mesenteric arteriography were performed transfemorally with a 5-F Cobra catheter with 25-40 mL of nonionic contrast medium (Iopromide®, Iobitridol®), or ionic contrast medium (Ioxitalamate®) injected at a flow rate of 5-6 mL/sec. Inferior mesenteric arteriography required a lower dose of contrast medium (10-20 mL) and injection rate (3-4 mL/sec). In 3/21 cases, a 3-F microcatheter was used for superselective catheterization as close as possible to embolize the bleeding site. Images were obtained with the digital subtraction technique. The arteriographic findings and diagnoses were analyzed by two interventional radiologists (each with more than 15 years of interventional experience). Active GIH was proved by

demonstrating extravasation of the contrast agent. Vascular anomalies, such as pseudoaneurysm, angiodysplasia, or arteriovenous malformation, were considered to be definitive bleeding sources. Less specific but suggestive findings were larger mucosal blushes with localized abnormal vessels (indicating tumor) and prolonged mucosal contrast spots (indicating mucosal focus of inflammation or small vascular malformations).

The choice of embolic agent was left to the judgment of the interventional radiologists by using the general principles of embolization. After the procedure, an immediate angiography was performed to confirm technical success. Patients with subsequent bleeding were referred for surgery, endoscopy or repeated angiography with or without embolization.

Informed consent for embolization was obtained from all conscious patients. This retrospective study was approved by the Ethics Committee of our hospital (project 269/2548).

### Data analysis

Embolization success rates were analyzed according to the guidelines of the Society of Cardiovascular and Interventional Radiology.<sup>12</sup> Technical success means the result of embolization immediately after intervention. Clinical success means 30-day outcome. For the complete clinical or long-term success, we followed up with patients until death or until the end of the study observation time (28 February 2006).

The embolization was defined as technically successful if follow-up arteriography revealed devascularization of the target vascular lesion (partial technical success) or disappearance of contrast material extravasation (complete technical success). Rebleeding was not assessed if normal clinical parameters were encountered including no passage of blood from the GI tract, no falling of hemoglobin concentration and no packed cell transfusion required.

Technical arteriographic and embolization data were evaluated for early 3-day success and for the 30-day clinical-success. Angiographic localizations were first analyzed at their anatomic sites (e.g., stomach, duodenum, jejunum) and further as subgroups (upper or lower gastrointestinal hemorrhage, transpapillar hemorrhage and no visible disease). The arteriographic findings were evaluated by comparing the rebleeding results in patients with and without contrast material extravasation on an angiogram.

The catheterization technique was recorded as selective (with a 5-F catheter), superselective (with a microcatheter system), or a combination of both. Embolic agents were studied for their effect on early rebleeding both separately by using Gelfoam®, glue, Ivalon® and in combination if more than one agent was used in the same patient.

Because survival may depend on the other factors rather than the successful arrest of GIH, embolization success rate and clinical success rate were analyzed separately. We used in-hospital mortality to assess post procedural survival.

SPSS statistical software version 11.5 was used for the statistical analysis. Descriptive statistical analyses were reported with frequency and percentage. Fisher's exact test was used to compare outcomes between three groups of patient with upper, lower and transpapillar GIH respectively.

## RESULTS

A total of 77 patients underwent angiography for acute GIH at Siriraj Hospital between August 2002 and September 2005, but only 27 patients who have been embolized were included in this study. Six patients were excluded due to non-available angiographic film or medical record, thus only 21 patients were analysed. Of the 21 patients, 14 (66.7%) were male and 7 (33.3%) were female. The median age was 42 years (range 7-84 years, S.D. = 20.3). Patient demographic data and bleeding episodes at the time of presentation are summarized in Table 1.

### Causes of bleeding

Lower GIH was found most frequently (11 out of 21 patients, 52.4%) followed by upper GIH and transpapillar hemorrhage respectively (33.3% and 14.3%). The most common cause of all GIH was tumor (4 out of 21 patients, 19%). The most common cause of upper GIH was ulcer with tumor (2 out of 7 patients, 28.5%). Whereas angiodysplasia, ulcer, and ulcer with infection were the causes of lower GIH equally in 18.2% (2 out of 11 patients). Diverticulosis was found to be the cause of LGIH in 9.1% (1 out of 11 patients). The most common cause of transpapillar hemorrhage was tumor (2 of 3 patients, 66.7%).

The bleeding site of GIH most frequently occurred at the ileocecal area (4 out of 21 patients, 19%). The distribution of bleeding sites of the remaining patients showed no significant difference. The most frequent bleeding arteries were the ileocecal and right colic arteries in 3 out of 21 patients (14.3%). Four patients had more than one bleeding points.

### Angiographic findings

Angiogram in nearly half of the patients showed

**TABLE 1.** Patient demographic data and bleeding episodes.

Parameter	Number of patients (Percentage)
<b>Sex</b>	
Male	14 (66.7)
Female	7 (33.3)
<b>Age group (y) median age = 42 years</b>	
≤ 20	2 (9.5)
21-60	13 (61.9)
61-80	4 (19)
> 80	2 (9.5)
<b>Manifestation</b>	
Hematemesis	1 (14.3)
Hematoschezia	7 (33.3)
Melena	1 (4.8)
Hematoschezia + melena	5 (23.8)
Hematemesis + hematoschezia + melena	3 (14.3)
Hematemesis + other	1 (4.8)
Other	1 (4.8)
<b>Time from onset to angiography (d)</b>	
< 1	2 (9.5)
1	5 (23.8)
2-6	9 (42.9)
≥ 7	5 (23.8)
<b>Bleeding episodes</b>	
1	3 (14.3)
2	0 (0)
≥ 3	18 (85.7)

**TABLE 2.** Angiographic findings.

Findings	Number (n=21)	Percentage
Extravasation	10	47.6
Hypervascularity	5	23.8
Tumor blush	4	19
Mucosal contrast spot	1	4.8
Angiodysplasia	1	4.8
Pseudoaneurysm	0	0

contrast extravasation (10 out of 21 patients, 47.6%), followed by an abnormal hypervascularity area (5 out of 21 patients, 23.8%), and tumor blush (4 out of 21 patients, 19%) respectively (Table 2). The remaining angiographic findings were mucosal contrast spots and angiodysplasia in one patient per each group. Pseudoaneurysm was not found in this study.

### Embolization techniques

Gelfoam<sup>®</sup> was used to occlude arteries in 17 of 21 patients (81%) followed by PVA in 2 patients (9.5%). In one patient (4.8%), a combination of Gelfoam and PVA were used. The size of PVA particles was 150-250 microns in two patients. Glue was also used in one patient (4.8%).

### Technical success rate

The overall technical success of embolization was achieved in all 21 patients (100%) while 15 out of 21 patients (71.4%) showed complete technical success (Table 3). The causes of bleeding in partial technical success patients were tumor in 2 patients, infection in 2 patients, iatrogenic in 1 patient and ulcer in 1 patient.

### Three-day clinical success rate

Thirteen out of 21 patients (61.9%, 95% CI= 38.4%, 81.9%) who achieved technically success had no clinical evidence of rebleeding after 3 days (Table 3). Upper GIH seemed to recur more frequently (4 out of 7 patients, 57.1%) within the first 3 days than did lower (4 out of 11 patients, 36.4%) or transpapillar GIH. (0 out of 3) GIH. Three out of 6 patients (50%) with partial technical success had rebleeding caused by tumor, infection and iatrogenic respectively.

### Clinical success rate

We found an overall 30-day clinical success rate of 61.9% (13 out of 21 patients, 95% CI= 38.4%, 81.9%) (Table 3). In our study, rebleeding 4-30 days post embolization occurred in 2 out of 13 patients but the bleeding sources were unclear. Clinical success was encountered in 3 out of 7 patients (42.9%) with UGIH, in 7 out of 11 patients (63.3%) with LGIH, and in all patients with transpapillar hemorrhage.

### Complete clinical success rate

The complete clinical success rate was 42.9% (9 in 21 patients). Long term recurrent GIH occurred in 2 patients at day 38 and 210. In patient #7 with

**TABLE 3.** Comparison of clinical outcomes between 3 groups of patient.

Outcome	UGIH (n=7)	LGIH (n=11)	Transpapillar H (n=3)	p-value
0-3 days clinical success	3/7 (43%)	7/11 (64%)	3/3 (100%)	0.33
30 days clinical success	3/7 (43%)	7/11 (64%)	3/3 (100%)	0.33
In-hospital mortality	3/7 (43%)	3/11 (27%)	0/3 (0%)	0.45

underlying unresectable gastrointestinal stromal tumor (GIST) presented with rebleeding, a second angiography with Gelfoam embolization was performed resulting in decreased vascularity of the mass. In patient #15, angiodysplasia was demonstrated by a histopathological examination from a right half colectomy. Post operation, the patient experienced several self-limited rebleedings.

### Complications

The complication rate was 9.5% (2 out of 21 patients), both from bowel ischemia. One case of ischemic bowel was improved after conservative treatment. In the other case the disease progressed requiring the patient to undergo surgery with a successful result.

### In-hospital mortality

The overall in-hospital mortality rate was 9 out of 21 patients (42.9%) (Table 3). However, only 6 died from GIH (6/21, 28.6%, 95% CI= 11.3%, 52.2%). The remainder of 3 patients died from sepsis. UGIH had a higher mortality rate (3 out of 7 patients, 42.9%) than LGIH (3 out of 11 patients, 27.3%), or transpapillar hemorrhage (0 out of 3 patients, 0.0%). In 2 cases of bleeding from the LGI tract at the first episode, the patients presented by UGIH in the second episode.

## DISCUSSION

Some articles<sup>10,11</sup> have reported technical success rates of 80-95%, 30-day failure rates of 0-42%, and complication rates which is bowel ischemia of 7-21% which results are similar to our study. Even though this series showed a high technical success rate (100%) and low morbidity rate, there was an early rebleeding rate of up to 38.1% that was completely attributed to recurrent upper GIH (4 of 7 patients, 57.1%) and a high in-hospital mortality rate (42.9%).

### Technical success rate

Our study showed a 100% technical success rate. Recently, the development of microcatheter and guide wire systems permits a superselective catheterization of most distal targeted arteries. However, the techniques are limited by vessel tortuosity, bowel peristalsis, vessel-wall reactivity and also vasospasms.<sup>13</sup> Selective injection from a more proximal position may demonstrate the bleeding site or through an adjacent artery. Whenever contrast material leakage appears, main trunk arteriographs should be studied again to determine the safe point for embolization. In 6 of 21 patients (28.6%) with partial technical success, bleeding was due to tumor and infection (2 patients each), iatrogenic and ulcer (1 patient each). A tumor with numerous neovascularity and a diffuse nature of bleeding in the infectious process might explain the cause of technical difficulty in achieving complete technical success.

### Complication rate

To prevent bowel ischemia, we should deliver the embolic material at the proper place until a slow flow or minimal reflux of contrast medium proximally is seen. In this series, the complication rate of bowel ischemia was 9.5% (2 of 21 patients). No other complication was found. The first case of ischemic bowel, Gelfoam was infused at the vasa recta of the distal jejunum. Four days post embolization, the patient developed ischemic jejunitis confirmed by capsule endoscopy. However, the patient improved after conservative treatment. In the second patient, Gelfoam was also used for embolization at the vasa recta of the distal jejunum. Segmental resection of the jejunum with end to end anastomosis was performed post embolization and was confirmed to be bowel gangrene by pathology. The cause of bowel gangrene in these two complicated cases was probably because the embolization sites were too distal so the collateral blood supply could not enter into the ischemic bowel segment.

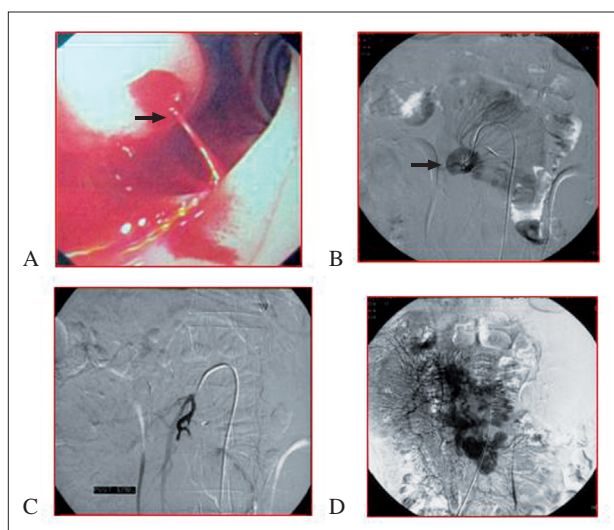
Gordon RL et al<sup>13</sup> have reported that polyvinyl alcohol (PVA) particles and platinum microcoils are a safe and curative treatments with a lower complication rate. However, they preferred to use a coil for embolization because it is radiopaque and PVA is less tightly controlled than coils. In our study, we used PVA in 3 patients with LGIH and achieved 100% technical success. Even though early rebleeding occurred in 1 patient, no complications in those 3 patients were found.

In our study we used glue in 1 case of transpapillar hemorrhage due to iatrogenic (post-surgery) with complete technical success and no complication. Although we successfully treated one case of GIH with glue, we usually did not use this technique because of the high risk of bowel infarction and stenotic complications.<sup>14</sup>

### Early rebleeding

The early failure rate was 38.1% (8 out of 21 patients). Rebleeding in the upper GIH seemed to recur more frequently (4 out of 7 patients, 57.1%) within the first 3 days than did the lower (4 out of 11 patients, 36.4%) or transpapillar (0 out of 3) GIH. The upper GIH is clearly the highest risk for early failure. Early recanalization post embolization when using absorbable gelatin sponge could be responsible for recurrence. However, our study showed 41.2% (7 of 17 patients) rebleeding after occlusion with absorbable gelatin sponge, while a failure rate of 50% (1 of 2 patients) was observed with permanent occlusive material (PVA). However, the majority of embolic material used was absorbable gelatin sponge and polyvinyl alcohol was used only in 2 cases that may be limited to assess this matter.

Recanalization through the numerous collaterals in the duodenal blood supply may explain early rebleeding in upper GIH after technical success. Post embolization inflammatory or ischemic reaction may trigger vasodilation of the intramural collaterals. This problem could be prevented by occluding the gastroduodenal artery with a liquid embolic agent, such as glue, or by using a superselective approach to occlude the bleeding intramural artery.<sup>14</sup> Synchronous embolization of the pancreaticoduodenal arcades is also recommended.<sup>2</sup>



**Fig 1.** Case #5; A 40-year-old male with history of alcoholic cirrhosis and esophageal varices grade III-IV presenting with LGIH.

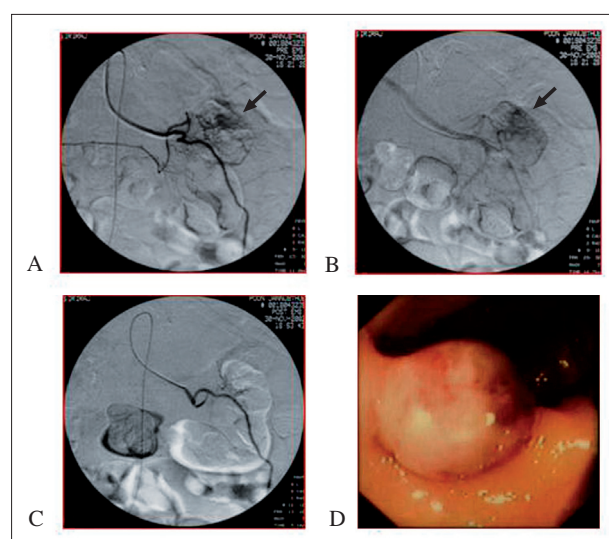
(A) Esophagogastroduodenoscopy showed intermittent active bleeding from 3<sup>rd</sup> part duodenum (arrow).

(B) Inferior (IPD) angiography showed ring-shaped contrast extravasation (arrow).

(C) Post Gelfoam and Ivalon 350-500 micron embolization pancreaticoduodenal (IPD) showed totally occluded IPD artery without evidence of extravasation.

(D) Late venous phase showed mesenteric varices.

**Note:** The patient died from massive bleeding 6 days after embolization.



**Fig 2.** Case #1; A 65-year-old female presented with LGIH.

(A, B) The inferior mesenteric angiography showed tumor blush in early and late arterial phases at splenic flexure of colon supplied by left branch of middle colic artery (arrow).

(C) Post Gelfoam embolization showed completed technical success.

(D) Colonoscopy demonstrated polyp at the same area.

The patient underwent polypectomy due to rebleeding 2 days after embolization. Pathology was tubular adenoma.

**Note:** The patient died 44 days after embolization due to sepsis.

Moreover, we should realize that clinical factors might have an important role in early failure of embolization in upper GIH. In patients with peptic ulcer disease, the definite treatment should be gastric acid suppression. The combination of gastric acid suppression with medical eradication of *Helicobacter pylori* has been effective in the prevention of rebleeding in most patients.<sup>15</sup> Some authors recommended restricting surgery to under-sewing the bleeding ulcer artery, and circumventing collateral refilling.<sup>16</sup>

Defreyne L, et al<sup>2</sup> proposed that contrast material extravasation could be an additional risk factor for clinical failure. Our study showed a rebleeding rate of only 2/19 cases with contrast extravasation on arteriogram. In contrast to hypervascularity on arteriogram which was the most common finding in rebleeding patients (3 of 8 patients) in our paper. Therefore, we conclude that extravasation of contrast material did not increase the rebleeding rate.

Eight patients with early 3-day rebleeding had a mortality rate of 62.5% (5 of 8 patients). Intervention after embolization was performed on 5 patients including endoscopy, surgery and angiography with or without embolization.

#### Clinical success rate

Rebleeding after 3 days is more likely to be related to clinical factors than to the embolization technique.<sup>2</sup> For patients without early rebleeding, cardiovascular hemodynamic is reestablished promoting endogenous repair of the rupture site by means of thrombus formation.

In our study, rebleeding 4-30 days post embolization occurred in 2 out of 13 patients with unknown specific source. One was a case of cervical spine injury with quadriplegia presented with UGIH. An arteriogram showed contrast extravasation at the gastric fundus supplied by the short gastric artery. Technical success was achieved post embolization but with 6 days rebleeding after embolization. The patient died from sepsis with arrhythmia. Another case of malignant lymphoma with febrile neutropenia presented with LGIH due to an ulcer with a raw surface in the ileocecal area. Embolization yielded a technical success with 9 days rebleeding after embolization but this patient was lost to follow up.

Nowadays, embolization has gained widespread acceptance as the procedure of choice in transpapillary bleeding<sup>17</sup> as in our series which showed completely clinical success in all patients.

#### In-hospital mortality

The overall in-hospital mortality rate was 42.9% (9 of 21 patients). UGIH had a much higher mortality rate (3 of 7 patients, 42.9%) than LGIH (3 of 11 patients, 27.3%), or transpapillary hemorrhage (0 of 3 patients). Rebleeding and the severity of blood loss in the upper GIH were highly correlated with mortality. Because of compromising clinical factors and vascular complexity, we found embolization of the upper GIH to be less effective. Therefore, further studies are required before embolization is accepted as the routine first approach in upper GIH. However, in lower and transpapillary GIH, transarterial embolization should be the first treatment modality because it offers definitive treatment and a safe procedure in a large number of cases.

Limitations of this study were the incomplete availability of data due to retrospective analysis and a small sample size.

## CONCLUSION

Transarterial embolization should be an effective first approach with LGIH and transpapillar bleeding, but is less effective with UGIH. Knowledge of vascular anatomy and embolization technique will increase the success rate and reduce the complication rate. Failure of transarterial embolization does not depend only on the technique but also on the underlying disease and the general condition of the patients prior to embolization. Some diseases need further intervention post embolization to completely cure the primary disease.

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## REFERENCES

1. Millward SF. ACR appropriateness criteria on treatment of acute non-variceal gastrointestinal tract bleeding. *J Am Coll Radio* 2008;5:550-4.
2. Defreyne L, Vanlangenhove P, Vos MD, Pattyn P, Maele GV, Decruyenaere J, et al. Embolization as a first approach with endoscopically unmanageable acute nonvariceal gastrointestinal hemorrhage. *Radiology* 2001;218:739-48.
3. Vreeburg EM, Snel P, de Bruijne JW, Bartelsman JFWM, Rauws EAJ, Tytgat GNJ. Acute upper gastrointestinal bleeding in the Amsterdam area: incidence, diagnosis, and clinical outcome. *Am J Gastroenterol* 1997;92:236-43.
4. Jensen DM. Current management of severe lower gastrointestinal bleeding (editorial). *Gastrointest Endosc* 1995;41:171-3.
5. Rockall TA, Logan RFA, Devlin HB, Northfield TC. Incidence and mortality from acute upper gastrointestinal hemorrhage in the United Kingdom. *BMJ* 1995;311:222-6.
6. Zuckerman GR, Prakash C. Acute lower intestinal bleeding: part I: clinical presentation and diagnosis. *Gastrointest Endosc* 1998;48:606-17.
7. Wagner HE, Stain SC, Gilg M, Gertsch P. Systematic assessment of massive bleeding of the lower part of the gastrointestinal tract. *Surg Gynecol Obstet* 1992;175:445-9.
8. Rahn NH, Tishler JM, Han SY, Russinovich NAE. Diagnostic and interventional angiography in acute gastrointestinal hemorrhage. *Radiology* 1982;143:361-6.
9. Darcy M. Treatment of Lower Gastrointestinal Bleeding: Vasopressin Infusion versus Embolization. *J Vasc Interv Radiol* 2003;14:535-43.
10. Toyoda H, Nakano S, Takeda I, Kumada T, Sugiyama K, Osada T, et al. Transcatheter arterial embolization for massive bleeding from duodenal ulcers not controlled by endoscopic hemostasis. *Endoscopy* 1995;27:304-7.
11. Waugh J, Madan A, Sacharias N, Thomson K. Embolization for major lower gastrointestinal haemorrhage: five year experience. *Australas Radiol* 2004;48:311-7.
12. Drooz AT, Lewis CA, Allen TE, Citron SJ, Cole PE, Freeman NJ, et al. Quality improvement guidelines of percutaneous transcatheter embolization: SCVIR Standards of Practice committee—Society of Cardiovascular and Interventional Radiology. *J Vasc Interv Radiol* 1997;8:889-94.
13. Gordon RL, Ahl KL, Kerlan RK, Wilson MW, LaBerge JM, Sandhu JS, et al. Selective arterial embolization for the control of lower gastrointestinal bleeding. *Am J Surg* 1997;174:24-8.
14. Lang EK. Transcatheter embolization in management of hemorrhage from duodenal ulcer: long-term results and complications. *Radiology* 1992;182:703-7.
15. Graham DY, Hepps KS, Ramirez FC, Lew GM, Saeed ZA. Treatment of *Helicobacter pylori* reduces the rate of rebleeding in peptic ulcer disease. *Scand J Gastroenterol* 1993;28:939-43.
16. Kolkman JJ, Meuwissen SG. A review of treatment for bleeding peptic ulcer: a collaborative task of gastroenterologist and surgeon. *Scand J Gastroenterol* 1996;218:16-25.
17. Salam TA, Lumsden AB, Martin LG, Smith RB III. Nonoperative management of visceral aneurysms and pseudoaneurysms. *Am J Surg* 1992;164:215-9.