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Permalink

<https://escholarship.org/uc/item/7948r44r>

ISBN

9781119756750

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Publication Date

2022-06-24

DOI

10.1002/9781119756781.ch37

Peer reviewed

Chapter 37 Small Intestine, Appendix, and Colorectal

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Colon, Small Bowel, and Appendix

- 1) A 21-year-old man is brought by ambulance to the trauma bay after sustaining a gunshot wound to the abdomen. He is alert and oriented with a heart rate of 130 beats/min and blood pressure 95/55 mm Hg. His FAST exam is positive and he is taken urgently for laparotomy. During surgery there is extensive damage to the transverse colon. You notice an expanding hematoma at the base of the transverse mesocolon and suspect an superior mesenteric artery (SMA) injury. As you expose the SMA you find a near- complete transection of the SMA just distal to the middle colic artery. Which of the following is true about this injury?
- a) Ligation at the point of injury would most likely result in loss of significant portions of small bowel
 - b) This is a zone 3 injury, which carries a mortality rate of 40%
 - c) The preferred method of repair involves temporary shunting with a second-look operation
 - d) This patient's greatest mortality risk is due to infection
 - e) Most SMA injuries can be managed successfully with angioembolization

Injuries to the SMA carry significant morbidity and mortality. The incidence of these injuries is unknown, however they generally account for less than 1% of cases at large trauma centers. Most laparotomy deaths for SMA injuries are due to exsanguination, not infection. Review of the literature reveals that those who undergo primary repair have a lower incidence of associated vascular and nonvascular injuries, and have improved survival, compared to those who undergo ligation (and have a higher number of associated injuries). The SMA zones of injury were first described in the 1970s.

Zone of Injury	Anatomic Location	Mortality
Zone 1	Aorta to inferior pancreateo-duodenal artery	Close to 100%
Zone 2	Inferior pancreateo-duodenal artery to middle colic artery	43%
Zone 3	Distal to middle colic artery (25%
Zone 4	Segmental branches	25%

There are no definitive published guidelines for management of these injuries, however there are various options that have been extensively reviewed. Ligation should be considered in unstable patients when bowel ischemia is present. Ligation in zones 1 and 2 carries a significant risk of bowel ischemia, unless sufficient collaterals are present. Ligation in zones 3 and 4 carry a lower risk of ischemia, but the risk may be increased if the patient has significant atherosclerotic disease. In a damage-control setting, shunting can be performed with a planned second-look operation, with later reconstruction with a saphenous vein graft or PTFE. Angioembolization has been successful in managing these injuries recently, although there is significant risk of ischemia and it is advised to only perform angioembolization in hemodynamically stable patients.

Answer: A

Asensio, J.A., Britt, L.D., Borzotta, A., et al. (2001). Multi-institutional experience with the management of superior mesenteric artery injuries. *Journal of the American College of Surgeons*, 193 (4), 354–366. Erratum in *Journal of the American College of Surgeons*, 193 (6), 718.

Phillips B, Reiter S, Murray EP, et al. (2018) Trauma to the Superior Mesenteric Artery and Superior Mesenteric Vein: A Narrative Review of Rare but Lethal Injuries. *World journal of surgery*. 2018;42(3):713-726.

- 2) A 60-year-old woman presents to the trauma bay after being involved in a head-on motor vehicle collision. She is alert, oriented, and complaining of abdominal pain. Her vitals are normal at initial assessment. Bruising is present across her low abdomen and she has tenderness without peritoneal findings. Initial CT scan of the abdomen shows no solid organ injury but a small amount of free fluid in the right paracolic gutter and some mild small bowel wall thickening. Her abdominal pain improves in the trauma bay and she is admitted for observation. Six hours later, you are called to reassess her because her pain has returned. Her vitals remain within normal limits. She is tender in the right hemi-abdomen, but again without peritoneal signs. Her labs have since resulted and show a WBC count of 11,000. Which of the following is the next best course of action?
- a) Repeat CT scan of the abdomen with IV contrast only
 - b) Repeat CT scan of the abdomen with IV and PO contrast
 - c) Continued observation until she develops peritonitis
 - d) Surgical exploration
 - e) Acute abdominal series
- 3) Which of the above patient's signs or symptoms predict, with the greatest accuracy, the presence of blunt small bowel injury?
- a) Tenderness on physical exam
 - b) Free fluid on CT scan
 - c) Bowel wall thickening
 - d) Lower abdominal bruising from seat belt
 - e) Elevated WBC count

Blunt small bowel perforation (SBP) remains a diagnostic challenge to this day, even though our diagnostic capabilities have improved. Rates of small bowel injury range from 5% to 15% of blunt abdominal trauma patients, and perforation occurring in 1%. These injuries are often found incidentally on laparotomy for other intra-abdominal injuries. The presence of abdominal free fluid in the trauma patient, in the absence of solid organ injury or other obvious source of bleeding, should prompt evaluation for small bowel injury.

Another mechanism of small bowel injury in trauma is mesenteric injury resulting from shearing forces that can tear the small bowel loose from its blood supply, which may result in delayed perforation, stricture, and internal hernia from bowel being trapped in the new mesenteric defect.

Blunt abdominal trauma patients can present a diagnostic challenge. Many recommend additional diagnostic/therapeutic intervention by 8 hours after arrival in these patients, as the mortality from blunt SBP increases to 30.8% from 13% in those who receive surgical therapy greater than 8 hours from injury. Repeat CT scans may provide some useful information, however in this patient who has reasonable signs of small bowel injury on her initial scan, will only delay operative intervention. Continued observation in this patient who is high risk is also not the best course of action.

Recent studies show that the most accurate indicator of blunt SBP is the presence of free fluid on abdominal CT. Other signs including tenderness on physical exam, bowel wall thickening, seat belt sign, and elevated WBC count, are less reliable.

2) **Answer: D**

3) **Answer: B**

Fakhry SM, Allawi A, Ferguson PL, et al. Blunt small bowel perforation (SBP): An Eastern Association for the Surgery of Trauma multicenter update 15 years later. *J Trauma Acute Care Surg.* 2019; 86(4):642-650.

- 4) A 38-year-old woman is horseback riding when she is thrown from the horse and lands on a wood pile. She is brought to the hospital for evaluation of rectal pain. She is hemodynamically normal. There is blood present on digital rectal exam and a small external wound is noted that is not bleeding. A CT scan with IV contrast shows evidence of a rectal injury 8 cm above the anal verge that is confirmed on rigid proctoscopy. What procedure should this patient undergo?
- a) Trans-anal repair without fecal diversion
 - b) Trans-anal repair with sigmoid loop colostomy
 - c) Trans-anal repair with end-sigmoid colostomy
 - d) Primary repair, pre-sacral drainage, and sigmoid loop colostomy
 - e) Primary repair, distal limb washout, and sigmoid end colostomy

In the 1970s, Vietnam-era surgeons taking care of combat casualties published the 4 “Ds” of rectal trauma, and advocated for their regular use when dealing with penetrating rectal injuries: direct repair, diversion, distal rectal washout, and presacral drain. Over time, however, this data has been challenged, and current guidelines and the data do not support the use of pre-sacral drainage or distal limb washout. Studies have shown a significantly higher rate of complication in patients who undergo these procedures. Routine diversion with loop colostomy is recommended in those with extraperitoneal injuries to avoid the development of pelvic sepsis. End-colostomy is a surgical option, but the ease of colostomy takedown with a loop colostomy makes it preferred in this setting.

Answer: B

Brown, Carlos V.R. MD; Teixeira, Pedro G. MD; Furay, Elisa MD; et al. (2018) The AAST Contemporary Management of Rectal Injuries Study Group Contemporary management of rectal injuries at Level I trauma centers: The results of an American Association for the Surgery of Trauma multi-institutional study, *Journal of Trauma and Acute Care Surgery*:2018; 84 (2) 225-233

- 5) A 57-year-old man is brought to your trauma bay after sustaining multiple stab wounds to the abdomen. He has a history of asthma but is otherwise healthy. He is tachycardic and hypotensive and is given two units of whole blood in the trauma bay and is transferred urgently to the operating room for exploration. During surgery you encounter a significant splenic laceration with active hemorrhage, a full-thickness descending colon injury involving less than 50% of the circumference of the colon, as well as a serosal tear of the stomach. A splenectomy is successfully performed and the stomach thoroughly examined with no posterior injury identified and no pancreatic injury. At this point, the patient has received another two units of packed red blood cells, and is hemodynamically stable with an arterial pH of 7.34. How should the colon injury be addressed?
- a) Resection, primary anastomosis, diverting transverse loop colostomy
 - b) Resection, primary anastomosis
 - c) Primary repair, diverting transverse loop colostomy
 - d) Primary repair
 - e) Transverse loop colostomy, drain placement

The grade of injury in adult civilian patients with penetrating colon injuries is less important for determining the management of colon injuries than is the risk factors for anastomotic breakdown. Even destructive injuries (>50% of circumference) may be managed without diversion in low-risk patients. For high-risk penetrating colon injuries, (delay >12 hours, shock, associated injuries, transfusion > 6 units of blood, contamination, or left-side colon injuries), colon repair or resection may be still be performed rather than mandatory colostomy. Colostomy may have a role in select patients with other injuries (pancreas). Low-risk patients with penetrating colon injury without signs of shock, significant hemorrhage, severe contamination, or delay to surgical intervention, should preferentially undergo colon repair or resection and anastomosis versus colostomy. In cases of damage-control laparotomy, there is increased risk of anastomotic breakdown, however, colostomy is still not mandatory and clinical judgement is required.

Answer: D

Cullinane, Daniel C. MD; Jawa, Randeep S. MD; et al. Management of penetrating intraperitoneal colon injuries: A meta-analysis and practice management guideline from the Eastern Association for the Surgery of Trauma, *Journal of Trauma and Acute Care Surgery*: March 2019 - Volume 86 - Issue 3 - p 505-515

- 6) An 89-year-old woman is brought to the ED by ambulance from a skilled nursing facility, where she has been recovering from hip replacement surgery, with a chief complaint of constipation for 7 days. She has a past medical history that includes diabetes, dementia, and hypertension. On exam, she is quite distended but nontender to palpation in her abdomen. Plain radiographs of the abdomen are obtained which show significant dilation of the entire colon without air in the sigmoid or rectum, and without free air. In addition to admission, electrolyte replacement and cessation of narcotics, what is the next best step in management?
- a) Rectal tube placement
 - b) Anoscopy
 - c) Placement of an NG tube
 - d) Laparotomy
 - e) Upper GI contrast study
- 7) The above patient is admitted for conservative medical management, cessation of narcotics, and an NG tube but has not had relief of symptoms after 72 hours. What is the next best step to relieve her symptoms?
- a) Decompressive rectal tube placed at bedside
 - b) Subcutaneous neostigmine in a monitored setting
 - c) Colonoscopic decompression
 - d) Exploratory laparotomy and subtotal colectomy
 - e) Loop sigmoid ostomy for colonic pseudo-obstruction

Acute colonic pseudo-obstruction (ACPO), or Ogilvie's syndrome, almost exclusively occurs in hospitalized or immobilized patients. Risk factors include older age, recent major orthopedic procedure, narcotic use, and electrolyte disturbances. Despite the dramatic appearance of the colon on imaging, these patients rarely need surgery. The most serious adverse events of ACPO are ischemia and perforation, with an increased risk in patients with cecal diameters greater than 10 to 12 cm and in those with abdominal distention greater than 6 days. When evaluating these patients, a mechanical obstruction must be ruled out first. This can be done with either rigid proctoscopy or CT scan. CT imaging is not only highly sensitive and specific for detecting mechanical obstruction, but it can also show evidence of ischemia, perforation, and evaluate for extrinsic or intrinsic compression. Water-soluble contrast enema of the rectum and distal colon is another diagnostic option, although CT has largely replaced contrast enema studies. It is worth noting that mechanical obstruction rarely occurs in a patient admitted for unrelated illnesses (i.e., pneumonia, elective non-GI surgery). Rectal tube placement at the bedside rarely is helpful because the right colon is frequently adynamic. After maximal medical management with narcotic avoidance, electrolyte correction, and NG decompression (if needed), the next step is neostigmine administration which is 85-94% effective. Male gender, younger age, postsurgical status, and having electrolyte imbalance are risk factors for nonresponse to neostigmine. Daily administration of polyethylene glycol via nasogastric tube has also been shown to decrease recurrence. Continuous infusion or subcutaneous administration of neostigmine may reduce cardiovascular effects while remaining effective. Traditionally, endoscopic decompression with colonoscopy is second line therapy after failure of medical management and neostigmine. There are no randomized controlled trials of pharmacologic versus endoscopic therapy for ACPO, however two retrospective studies found colonoscopic decompression to be superior to neostigmine. The data is considered limited and the 2020

American Society for Gastrointestinal Endoscopy ACPO guidelines continue to recommend initial pharmacologic therapy.

6) **Answer: C**

7) **Answer: B**

Naveed M, Jamil LH, Fujii-Lau LL, et al. American Society for Gastrointestinal Endoscopy guideline on the role of endoscopy in the management of acute colonic pseudo-obstruction and colonic volvulus. *Gastrointest Endosc.* 2020 Feb;91(2):228-235. doi: 10.1016/j.gie.2019.09.007. Epub 2019 Nov 30. Erratum in: *Gastrointest Endosc.* 2020 Mar;91(3):721.

- 8) A 65-year-old woman with a history of chronic constipation and rheumatoid arthritis, presents with a 12 hour history of severe right lower quadrant abdominal pain, nausea, and vomiting. She takes methotrexate for her arthritis as well as multiple laxatives for constipation. On examination she is distended and has mild lower abdominal tenderness without peritoneal signs. Her labs are normal including WBC count and renal function. A coffee-bean sign is seen on an abdominal plain film taken in the ED. She is taken to surgery, where patchy ischemic bowel is found at the involved segment. What is the best management strategy for this patient?
- a) Detorsion and placement of a venting tube through the abdominal wall
 - b) Detorsion and pexy of the non-ischemic portion of the involved bowel to the abdominal wall
 - c) Resection and diverting ileostomy
 - d) Resection and primary anastomosis
 - e) Detorsion and observing the involved portion of bowel with resection only if it does not appear viable

The figure shows cecal volvulus. Cecal volvulus affects a younger population than sigmoid volvulus, and is also relatively more common in females. Cecal volvulus should be considered a surgical emergency. Decompressive colonoscopy is rarely successful (30%) in cases of cecal volvulus, and should not be performed. The best management of this condition is a right hemicolectomy and primary anastomosis, to remove the mobile portion of bowel. Cecopexy is not favored as the recurrence rate is high, and recurrent volvulus would place the patient at risk for perforation. Cecostomy placement is a relatively easy procedure but is also not recommended for this patient as it is associated with a high risk of complications including missed intestinal ischemia. In the debilitated, frail patient who would not tolerate a resection, these procedures may be considered, with great caution. Detorsion and observation of the bowel (E) is not recommended due to high rate of recurrence without resection. Diverting ileostomy is rarely required for this condition unless hemodynamic instability or significant intra-abdominal contamination is present.

Answer: D

Vogel JD, Feingold DL, Stewart DB, et al. Clinical Practice Guidelines for Colon Volvulus and Acute Colonic Pseudo-Obstruction. *Dis Colon Rectum*. 2016 Jul;59(7):589-600..

Perrot L, Fohlen A, Alves A, Lubrano J. Management of the colonic volvulus in 2016. *J Visc Surg*. 2016 Jun;153(3):183-92.

- 9) You are asked to see a 91-year-old man who is admitted to the internal medicine service from a skilled nursing facility for dehydration and failure to thrive with significant weight loss over the past month. The medicine team tells you that the patient experienced an episode of severe abdominal distension, and plain radiographs showed a “bent inner tube” sign. On exam, he is still distended and has mild tenderness to palpation in the low abdomen. Rectal exam shows no stool in the vault. During colonoscopy, the colon appears viable except for an area of gray mucosa. What is the next step in management?
- a) Open detorsion and sigmoidpexy in the OR
 - b) Sigmoidectomy, primary re-anastomosis
 - c) Continue colonoscopic detorsion and admit for observation
 - d) Sigmoidectomy, end-colostomy
 - e) Percutaneous endoscopic colostomy

Volvulus of the sigmoid colon is the most common presentation of colonic volvulus. It is frequently present in those with significant comorbidities and in the institutionalized, so careful history, examination, and routine blood work are all indicated in the workup of this condition. Sigmoid volvulus can be diagnosed via plain radiographs only in 31%-66% of patients. Contrast enema and CT scan also play a diagnostic role. Endoscopy is first line therapy in the absence of peritonitis. During endoscopic detorsion, if there is evidence of ischemic bowel, sigmoid resection is mandated. Primary re-anastomosis can be established in most cases, however in patients who are significantly immunosuppressed or that have extremely poor nutritional status, it may be safer to perform a colostomy with resection. Percutaneous endoscopic colostomy is a minimally invasive procedure that is reserved only for the poorest of surgical candidates, and it contraindicated if ischemic bowel is present. Sigmoidpexy is generally not recommended as there is a high rate of recurrence. Continuing with the colonoscopy & admission would not be correct given the evidence of full thickness ischemia (gray mucosa).

Answer: D

Vogel JD, Feingold DL, Stewart DB, et al. Clinical practice guidelines for colon volvulus and acute colonic pseudo-obstruction. *Dis Colon Rectum*. 2016;59(7):589-600.

Naveed M, Jamil LH, Fujii-Lau LL, et al. American Society for Gastrointestinal Endoscopy guideline on the role of endoscopy in the management of acute colonic pseudo-obstruction and colonic volvulus. *Gastrointest Endosc*. 2020 Feb;91(2):228-235. doi: 10.1016/j.gie.2019.09.007. Epub 2019 Nov 30. Erratum in: *Gastrointest Endosc*. 2020 Mar;91(3):721.

- 10) A 19-year-old man undergoes an uncomplicated laparoscopic appendectomy for acute appendicitis and is discharged the same day. Final pathology of the appendix shows a 2cm carcinoid tumor at the midportion of the appendix. What do you recommend the patient undergo?
- a) Observation, no further therapy required
 - b) Ileocecectomy
 - c) Right hemicolectomy with lymph node sampling
 - d) Right hemicolectomy, no lymph nodes required
 - e) Octreotide and neoadjuvant chemotherapy, followed by right hemicolectomy

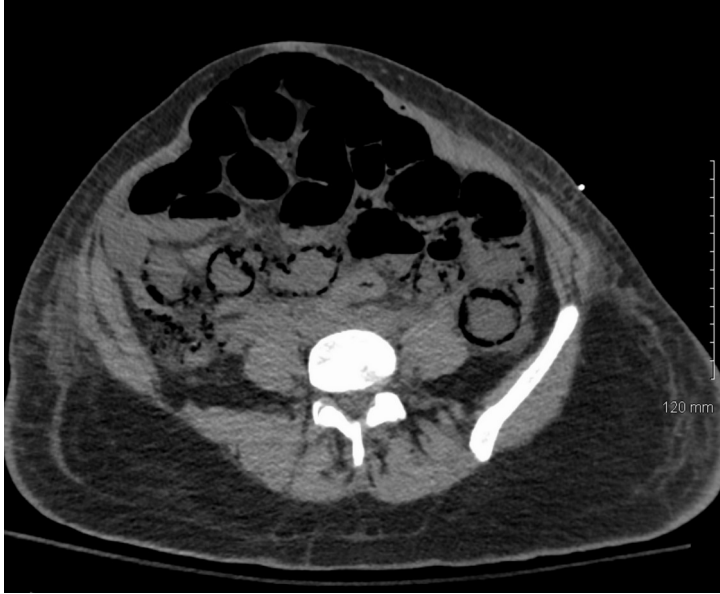
Neuroendocrine tumors, commonly carcinoid tumors, are the most common neoplasm found in the appendix. Prognosis is largely based on size. For tumors less than 1cm, appendectomy is sufficient. For tumors greater than 2cm, or for tumors between 1 and 2 cm in the presence of deep meso-appendiceal invasion (>3 mm), positive or unclear margins, a higher proliferative rate (grade ≥ 2), lymphovascular invasion, and mixed histology (goblet cell adenocarcinoma), a right hemicolectomy with lymph node sampling (oncologic resection) is recommended by the North American Neuroendocrine Tumor Society (NANETS) and the European Neuroendocrine Tumor Society (ENETS). However, this is a controversial area, and others disagree, considering appendectomy alone to be adequate for all tumors <2 cm, even with meso-appendiceal invasion or other adverse histologic features. NCCN guidelines currently recommend appendectomy for T1 tumors (<1cm). For incomplete resection, they recommend reexploration after abdominal imaging and to consider right hemicolectomy based on original tumor size. For T2-T4 lesions, they recommend staging with imaging and to consider right hemicolectomy. The risk of nodal metastases at diagnosis is 0, 7.5, and 33 percent for patients with appendiceal carcinoid <1, 1 to 1.9, and >2cm, respectively. Octreotide and chemotherapy would be treatments for disseminated disease.

Answer: D

Kunz PL, Reidy-Lagunes D, Anthony LB, et al. North American Neuroendocrine Tumor Society. Consensus guidelines for the management and treatment of neuroendocrine tumors. *Pancreas*. 2013 May;42(4):557-77.

Landry, C.S., Woodall, C., Scoggins, C.R., et al. (2008) Analysis of 900 appendiceal carcinoid tumors for a proposed predictive staging system. *Archives of Surgery*, 143 (7), 664–670.

11) A 70-year-old woman with history of COPD and current tobacco use is admitted to the MICU with severe pneumonia, and is intubated for respiratory failure. You are called to evaluate her several hours later for abdominal distension and for an abnormal CT finding. Her vitals are as follows: blood pressure 105/70 mm Hg, HR 105 beats/minute, temp 99 degrees Celsius. Although intubated, she is awake and can interact with you and indicates she is not having abdominal pain. Her abdomen is distended and tympanic, but soft and minimally tender. Her urine output has been 0.5 mL/kg/hr for the past 3 hours and she is not currently on pressors. A representative image from her CT scan is shown. She is on antibiotics for her pneumonia. What is the most appropriate management of her abdominal distension at this time?



- a) Observation
- b) Diagnostic laparoscopy
- c) Exploratory laparotomy with resection of involved bowel
- d) Splanchnic vasodilators
- e) IV fluid resuscitation

Pneumatosis intestinalis is pockets of air in the bowel wall, typically in the submucosal or subserosal layers. Most cases are associated with COPD or an immunocompromised state, such as HIV or after transplantation. Other associated conditions include intestinal ischemia, inflammatory and obstructive conditions of the intestine, and iatrogenic causes including recent endoscopy or jejunostomy placement. If this patient showed peritoneal signs, surgical exploration would be warranted, however she is hemodynamically stable with a relatively benign abdominal exam. Splanchnic vasodilators have no role to play in this condition, regardless of the underlying cause. She does not require further IV fluid resuscitation given her current urine output, and one should try to avoid fluid overload in those with tenuous pulmonary physiology. Risk factors for pathological PI are best defined in a 2013 study by the EAST Pneumatosis Study Group and include hypotension, vasopressor use, peritonitis, lactate >2 mmol/L, and acute renal failure.

Answer: A

Braumann C, Menenakos C, Jacobi CA. Pneumatosis intestinalis - A pitfall for surgeons? Scand J Surg. Published online 2005.

DuBose JJ *et al*; EAST Pneumatosis Study Group. Pneumatosis Intestinalis Predictive Evaluation Study (PIPES): a multicenter epidemiologic study of the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2013 Jul;75(1):15-23.

I'm having a hard time finding the Ferrara article for some reason!

- 12) A 45-year-old man presents to the ED with 2 days of abdominal pain, nausea, and vomiting. He has a history of bloating/burping for several weeks but has not yet sought medical care. He is otherwise healthy and has never had abdominal surgery before. He is tachycardic and normotensive in the ED. A CT is performed which shows dilated loops of small bowel with a clear transition point. There are no abnormalities in the mesentery or other abdominal organs. You proceed to the operating room and perform an exploratory laparotomy. The cause of the obstruction is identified as a 6 cm extraluminal mass in the distal jejunum. The proximal bowel is dilated but appears viable. What is the recommended surgical procedure?
- a) Small bowel resection with peri-tumor margins proximally and distally, with reanastomosis
 - b) Small bowel resection with 10 cm margins proximally and distally, with regional lymphadenectomy, and reanastomosis
 - c) Small bowel resection to uninvolved small bowel proximally and distally, with reanastomosis
 - d) Small bowel resection to uninvolved small bowel proximally and distally, with regional lymphadenectomy and reanastomosis
 - e) Biopsy the mass and wait for pathologic diagnosis to proceed

Small bowel neoplasms are a rare but important cause of primary small bowel obstruction. The characteristics of this mass are most consistent with a gastrointestinal stromal tumor (GIST). These masses are commonly exophytic, and therefore cause obstruction when they have reached significant size. Adenocarcinomas and leiomyomas grow intra-luminally and present earlier with obstructive symptoms. Biopsy of GISTs is not recommended, as tumor rupture portends a higher rate of peritoneal recurrence. There is no recommended margin length for resection. The goal is to resect to normal-appearing bowel on both sides, avoiding both an unnecessary long resection, as well as a peri-tumoral resection. Routine lymphadenectomy is unnecessary because the rate of nodal metastases is rare (1.1% to 3.4% of cases). Prognosis after resection is largely based on tumor size and mitotic rate.

Answer: C

Bamboato ZM, DeMatteo RP. Updates on the Management of Gastrointestinal Stromal Tumors. Surg Oncol Clin N Am. 2012;21(2):301-316.

Eisenberg BL, Pipas JM. Gastrointestinal Stromal Tumor-Background, Pathology, Treatment. Hematol Oncol Clin North Am. Published online 2012.

- 13) A 31-year-old man with history of ulcerative colitis and an episode of otitis media treated with amoxicillin, is admitted to the hospital for management of an acute flare of his colitis, with abdominal pain and bloody diarrhea. He is on adalimumab for maintenance of his disease, and is started on a course of prednisone while inpatient. His symptoms temporarily improve, but he develops watery diarrhea and worsening pain on hospital day 3. You are consulted for evaluation of his pain. His vitals on evaluation are temperature 38.0°C, heart rate 110 beats/minute, and blood pressure 130/68 mm Hg. On exam he is distended, with mild tenderness to palpation throughout. His WBC count is 24,000/mm³ and his creatinine is 2.1 mg/dL, an increase from 0.9 mg/dL. A plain radiograph is obtained which shows dilated large bowel from the cecum to the sigmoid colon, with a transverse colon diameter of 8 cm. The next best step in management is:
- Colonoscopy to evaluate for colonic ischemia
 - Exploratory laparotomy, diverting loop ileostomy, and colonic lavage
 - Exploratory laparotomy, segmental resection of any abnormal appearing colon, and primary anastomosis
 - Exploratory laparotomy, subtotal colectomy, end-ileostomy
 - Exploratory laparotomy, subtotal colectomy, ileorectal anastomosis

Clostridium difficile (*C difficile*) colitis has increased in incidence and severity over the past 20 years. Severe *C difficile* colitis is defined as WBC >15,000 cells/mm³, albumin <3 g/dL, and/or a creatinine level >1.5 times the premorbid level). The initial treatment for severe disease is oral vancomycin, with IV metronidazole often being added in the setting of ileus. Fecal transplants do not have a defined role for severe disease at this time, but are effective in treating recurrent mild to moderate bouts of recurrent *C difficile* colitis.

Toxic megacolon is a feared complication of severe *C difficile* colitis. The most widely used criteria for clinical diagnosis are

- Radiographic evidence of colonic distension (>6 cm)
- Plus three of the following: Fever >38 degrees Celsius, HR>120 bpm, neutrophilic leukocytosis >10,500/mL, and anemia
- Plus at least one of the following: dehydration, altered mental status, electrolyte disturbances, hypotension

The recommended procedure for *C difficile* colitis is subtotal colectomy. Removal of only grossly abnormal colon is not recommended, as there may be severe mucosal and submucosal disease not visible to the surgeon. Death rates are higher in those who receive partial colectomy, presumably due to residual disease as the ongoing source of sepsis. Reanastomosis should not be performed due to ongoing inflammation and risk of dehiscence.

Diverting loop ileostomy with colonic lavage with high volume polyethylene glycol-based solution and postoperative antegrade colonic vancomycin treatment through the ileostomy, has been described as a colon-preserving procedure. In one study, preservation of the colon was achieved in 93% of patients. To this date, however, there have been no randomized controlled study to validate this approach.

Answer: D

Koss, K., Clark, M.A., Sanders, D.S., et al. (2006) The outcome of surgery in fulminant *Clostridium difficile* colitis. *Colorectal Disease*, 8 (2), 149–154.

Neal, M.D., Alverdy, J.C., Hall, D.E., et al. (2011) Diverting loop ileostomy and colonic lavage: an alternative to total abdominal colectomy for the treatment of severe, complicated *Clostridium difficile* associated disease. *Annals of Surgery*, 254 (3), 423–429.

Sartelli M, Di Bella S, McFarland LV, et al. 2019 update of the WSES guidelines for management of *Clostridioides (Clostridium) difficile* infection in surgical patients. *World J Emerg Surg*. 2019 Feb 28;14:8. doi: 10.1186/s13017-019-0228-3. PMID: 30858872; PMCID: PMC6394026.

- 14) A 64-year-old obese man who has never had a colonoscopy before presents to the ED with left lower quadrant pain for three days. He has poorly-controlled diabetes, hypertension, and a history of a myocardial infarction 5 years prior. He is febrile to 38.4°C and his heart rate is 110 beats/minute, and his abdomen is tender to percussion in the left lower quadrant. His WBC count is 16,000/mm³. Abdominal CT imaging shows a thickened sigmoid with a 5 cm abscess, and free fluid in the pelvis without air. The next step in management should be:
- a) Resuscitation, IV antibiotics, and emergent colonoscopy to look for malignancy
 - b) Resuscitation, IV antibiotics, and consultation to IR for percutaneous drainage
 - c) Laparoscopic exploration & lavage, with drain placement
 - d) Exploration with sigmoidectomy and colorectal anastomosis
 - e) Exploration with sigmoidectomy and descending end colostomy (Hartmann's procedure)

Complicated diverticulitis often requires intervention, whether it be percutaneous drainage or a surgical procedure. Hinchey I is defined as colonic inflammation with associated pericolic abscess; stage II includes inflammation with pelvic abscess; stage III is purulent peritonitis; stage IV is feculent peritonitis. This patient has Hinchey III diverticular disease, as evidenced by the large abscess with free fluid. Percutaneous drainage is not viable in a patient with a ruptured abscess with free fluid. Laparoscopic lavage and drain placement is a newer procedure that has frequently been performed in an attempt to save the patient from getting an ostomy, which carries its own morbidity. It is generally recommended to perform this in patients who are able to tolerate prolonged infection, since up to 25% of patients will not have persistent or recurrent infection after the procedure. Frail, septic patients, as well as those with major comorbidities like this patient, are not good candidates for lavage. Colorectal anastomosis can be performed in these patients depending on surgeon comfort and patient factors, however it is recommended to also perform proximal fecal diversion.

Answer: E

Sartelli M, Catena F, Ansaloni L, et al. WSES Guidelines for the management of acute left sided colonic diverticulitis in the emergency setting. *World J Emerg Surg.* 2016;11(1):1-15.

Biffi WL, Moore FA, Moore EE. What is the current role of laparoscopic lavage in perforated diverticulitis? *J Trauma Acute Care Surg.* Published online 2017.

- 15) A 92-year-old woman with a history of urinary and fecal incontinence and severe COPD with supplemental oxygen requirement, is brought to the ED via ambulance from her nursing home, with complaint of a protruding mass from the anus. She is bedbound and malnourished. The staff there did not know how long the mass had been protruding. On exam you see a 5 cm mass with concentric rings protruding from the anus. It is firm to the touch and the edges are dusky in appearance. Attempted reduction of the mass in the ED is unsuccessful due to pain. You transfer her to the operating room for reduction under sedation. If unsuccessful, what is the next best step in management?
- a) Perineal rectosigmoidectomy (Altemeier procedure)
 - b) Mucosal proctectomy
 - c) Laparoscopic rectopexy
 - d) Laparoscopic rectopexy and sigmoidectomy
 - e) Open rectopexy and sigmoidectomy

Rectal prolapse is a circumferential full-thickness intussusception of the rectum out of the anus. It affects women more commonly than men, and has a higher prevalence in the institutionalized patient and those with neurological disorders. It is associated with pelvic floor dysfunction, but treatment of rectal prolapse does not treat the underlying pelvic floor abnormalities, and associated symptoms are therefore not resolved once the prolapse is treated. Prolonged prolapse can lead to congestion of the exposed rectum, which can make reduction impossible. To assist, applying topical osmotic agents (granulated sugar) can decrease the edema to facilitate reduction. If monitored sedation does not allow reduction, then general anesthesia may allow reduction.

Irreducible rectal prolapse is uncommon, but if it occurs, emergent surgical removal of the affected bowel is warranted. There are open and laparoscopic abdominal options, as well as perineal procedures. The Altemeier procedure is a perianal rectosigmoidectomy that can be done under local anesthesia, and is useful in the patient who would not be able to tolerate an abdominal surgery. This patient, who is severely debilitated, bedbound, and with severe lung disease, would not be able to tolerate a laparoscopic procedure, and an open abdominal procedure would be highly morbid for her. A mucosal proctectomy can be performed if there is prolapse of the mucosa only, which is not applicable in this case. If able to tolerate, abdominal procedures have the lowest recurrence rate, especially when combined with resection of the redundant colon.

Answer: A

Bordeianou L, Hicks CW, Kaiser AM, Alavi K, Sudan R, Wise PE. Rectal Prolapse: An Overview of Clinical Features, Diagnosis, and Patient-Specific Management Strategies. *J Gastrointest Surg.* 2014;18(5):1059-1069.

- 16) A 24-year-old man presents to the ED complaining of rectal pain for two days. He states he is otherwise healthy and takes no medications. He has normal vital signs, but appears uncomfortable in the gurney. His abdomen is nontender, and on rectal exam, you palpate a smooth foreign body high in the rectum, which is later confirmed on plain x-ray of the abdomen. There is no free air seen. Attempted extraction with IV pain medication and mild sedation is unsuccessful in the ED. You take him to the operating room, where conscious sedation is achieved with the assistance of anesthesia. The object is removed after multiple difficult attempts. Rigid proctoscopy after the procedure reveals rectal lacerations with minor bleeding. The patient remains hemodynamically normal. What is the next step in management?
- a) Admit the patient for serial abdominal exams, and repeat rigid proctoscopy prior to discharge
 - b) Operative exploration to evaluate for perforation
 - c) Rectal contrast study
 - d) Upright chest x-ray
 - e) Flexible sigmoidoscopy with hemostatic treatments to the bleeding mucosa

Rectal foreign bodies do not commonly need surgical consultation, as they are often removed by emergency room providers with the assistance of sedation and local anesthesia, which includes pudendal nerve block, perianal block, and/or spinal anesthesia. Other non-operative methods of retrieval include using forceps to grasp the object, palpation of the left iliac fossa from above to facilitate downward movement of the object, and the use of a Foley catheter inserted past the object and inflated, to break the vacuum seal above the object and allow easier passage. If nonoperative methods are unsuccessful, laparotomy is warranted, to either “milk” the object down the rectum internally, or to perform a colotomy for object extraction. After object removal, rigid proctoscopy or flexible sigmoidoscopy is mandated to evaluate for transmural injury, as well as imaging to document the presence or absence of free air (answer d). If a transmural injury is present, management of the injury follows that of other penetrating rectal trauma, based on location of injury and presence of fecal contamination. Rectal lacerations can occur from foreign bodies or iatrogenically during the removal process. Most bleeding from these lacerations resolves spontaneously without the need for intervention. Rectal contrast studies are not required if the patient remains hemodynamically stable and asymptomatic. There is no need to repeat a rigid proctoscopy prior to discharge, if the patient does not otherwise show signs of perforation.

Answer: D

Goldberg JE, Steele SR. Rectal Foreign Bodies. *Surg Clin North Am.* 2010;90(1):173-184.

Lake JP, Essani R, Petrone P, Kaiser AM, Asensio J, Beart RW. Management of retained colorectal foreign bodies: Predictors of operative intervention. *Dis Colon Rectum.* 2004;47(10):1694-1698.

- 17) A 55-year-old woman who is receiving chemotherapy for leukemia, presents to the ED complaining of right lower quadrant pain and bloody bowel movements. Her last chemotherapy session was 14 days ago; her next session was scheduled for today. Her vitals are T 38.2° C and pulse 105 beats/minute. She is tender in the right lower quadrant with mild guarding. Her WBC is $0.8/\text{mm}^3$ with 30% neutrophils. What is the most appropriate next step in management?
- a) Colonoscopy to evaluate the source of her bleeding
 - b) IV fluid resuscitation, *C difficile* testing, start oral vancomycin
 - c) Abdominal x-ray
 - d) CT abdomen/pelvis
 - e) Urgent exploratory laparotomy for ischemic colon

Neutropenic enterocolitis, or typhlitis, is a well-described complication arising in immunosuppressed patients, including those with HIV, those receiving chemotherapy, and those status-post organ transplant. The pathophysiology is unclear. It typically affects the right colon; left-sided involvement is rare. The most common presenting symptoms are right-sided abdominal pain, fever, neutropenia, with or without peritonitis. It is a clinical diagnosis, but an important step in the diagnostic workup is the abdominal CT scan, which can evaluate both the extent of the disease as well as for indications to operate. Surgical exploration in these cases is reserved for those with perforation, uncontrolled sepsis, refractory bleeding despite correction of cytopenias and coagulopathy, or development of another indication for surgery (i.e. appendicitis). Abdominal imaging will typically show bowel wall edema and thickening of the terminal ileum and ascending colon. Colonoscopy in these patients is risky and can cause perforation easily. Testing for other infectious sources should be performed, but abdominal cross-sectional imaging should be prioritized.

Answer: D

Cloutier RL. Neutropenic enterocolitis. *Hematol Oncol Clin North Am.* 2010;24(3):577-584.

Rodrigues FG, Dasilva G, Wexner SD. Neutropenic enterocolitis. *World J Gastroenterol.* 2017 Jan 7;23(1):42–47.

Xia R, Zhang X. Neutropenic enterocolitis: A clinico-pathological review. *World J Gastrointest Pathophysiol.* Published online 2019.

- 18) A 52-year-old man presents to the emergency room complaining of bright red blood per rectum for 2 days. His vital signs are normal in the ED and his hematocrit is 32%. Nasogastric lavage in the ED shows bilious output. He is resuscitated and admitted. Colonoscopy shows sigmoid diverticulosis with stigmata of recent hemorrhage, but no obvious source. He continues to have intermittent bloody bowel movements requiring multiple transfusions, but has remained hemodynamically normal during his stay. What is the next step in management?
- a) Mesenteric angiography
 - b) Tagged red blood cell scan
 - c) Sigmoid resection
 - d) Subtotal colectomy
 - e) Catheter-directed heparin to reveal the source

Lower GI bleeding should first be managed with aggressive resuscitation and correction of coagulopathy as needed. Nearly 15% of lower GI bleeding is caused by an upper GI source, therefore expeditious gastric lavage is important. The recommended procedure for unlocalized lower GI bleeding is a subtotal colectomy, and should only be performed if the patient is *in extremis* or if attempted localization through multiple avenues does not reveal a source. Segmental colectomy is not recommended for unlocalized lower GI bleeding as it carries significant risk of recurrent bleeding.

In hemodynamically normal patients, colonoscopy is the preferred procedure as it can also provide therapeutic intervention. If colonoscopy is unsuccessful, nuclear RBC scanning and angiography can be utilized. Angiography requires the offending vessel to be actively bleeding at the time of the procedure, and cannot detect very slow bleeds (less than 0.5 mL/min). Tagged RBC studies can detect bleeding as low as 0.1 mL/min, and if positive, can localize the bleeding area of colon so a segmental resection or localized angiography can be performed if needed. For this patient, his rate of bleeding is unlikely to be fast enough to be detected by angiography, so tagged RBC is a reasonable option to attempt localization. Catheter-directed heparin is a newer method to detect bleeds that are difficult to localize, however it should only be attempted in a setting with significant resources, and it needs to be studied more before its place in the algorithm of lower GI bleeding is solidified.

Answer: B

- 19) A 30-year-old man with von Willebrand disease presents with four days of right lower quadrant abdominal pain. He is febrile but normotensive with a pulse of 89 beats/minute. He is tender to palpation with guarding, and has a WBC count of 16000/mm³. An abdominal CT scan shows no visualized appendix, but a 4 cm fluid collection with a radiopaque object near the edge. What is the next step in management?
- a) Laparoscopic drainage of the abscess, drain placement, interval appendectomy in 6 weeks
 - b) Percutaneous drainage of abscess, interval appendectomy in 6 weeks
 - c) Percutaneous drainage of abscess, no follow up if feeling well at 2 weeks
 - d) IV broad spectrum antibiotics and inpatient observation
 - e) Percutaneous drainage of abscess, colonoscopy prior to appendectomy in 6 weeks

There is a plethora of conflicting literature comparing medical therapy alone to surgical therapy for appendicitis. With the emergence of percutaneous drainage techniques, the options for managing appendicitis can be confusing. Data supporting antibiotic treatment for appendicitis must be taken with caution, since most studies exclude septic patients and patients with perforation. The recently completed CODA trial is the largest randomized controlled trial in the United States, comparing 10 days of antibiotic therapy with appendectomy in patients with confirmed appendicitis. Non-operative management failed in 29% of those in the antibiotics group, including 41% with an appendicolith and 25% without. Complication rates are higher in those with fecoliths, so in this population appendectomy is encouraged once feasible. In this case, percutaneous drainage should be pursued due to the fluid collection. Operative drainage can be considered if this fails. Intravenous antibiotics are unlikely to resolve an abscess of this size. He has no risk factors for colon cancer that would mandate colonoscopy prior to interval appendectomy.

Answer: B

The CODA Collaborative. A Randomized Trial Comparing Antibiotics with Appendectomy for Appendicitis. *N Engl J Med.* 2020;383(20):1907-1919.

Varadhan KK, Humes DJ, Neal KR, Lobo DN. Antibiotic therapy versus appendectomy for acute appendicitis: A meta-analysis. *World J Surg.* 2010;34(2):199-209.

- 20) You are consulted to evaluate a 75-year-old man who is recovering in the ICU from an abdominal aortic aneurysm repair. He complains of left-sided abdominal pain that has now generalized, anorexia, and bloody bowel movements for the past 24 hours. The pain has been worsening and is now severe. His temperature is 39 degrees C and his pulse is 110 beats/minute, but he has a normal blood pressure. He has peritonitis on exam. What is the next step in management?
- a) Mesenteric angiogram
 - b) Flexible sigmoidoscopy to confirm diagnosis prior to treatment
 - c) Exploration, segmental resection, end-colostomy
 - d) Exploration, segmental resection, primary anastomosis
 - e) Diagnostic laparoscopy

This patient has ischemic colitis, which complicates about 2% of all abdominal aortic aneurysm repairs. Other etiologies of ischemic colitis include hypovolemia due to sepsis or cardiac failure, atherosclerosis, vasculitis, and emboli. Most mild-to-moderate cases can be treated with IV fluid resuscitation and antibiotics. If the patient fails to improve with medical management, or develops signs of sepsis or perforation, laparotomy is warranted. Angiogram is not recommended in this as it is time consuming and the patient shows convincing signs of bowel ischemia with a reasonable cause. Sigmoidoscopy is not indicated in this case as it will not change management, but should be performed in mild-to-moderate cases to confirm diagnosis. Diagnostic laparoscopy is not typically performed in the management of ischemic colitis. Primary anastomosis can be performed in patients who have appropriate physiology, but should be avoided in those who have a prosthetic aortic graft, as an anastomotic leak risks graft contamination.

Answer: C

Steele SR. Ischemic Colitis Complicating Major Vascular Surgery. *Surg Clin North Am.* 2007;87(5):1099-1114. doi:10.1016/j.suc.2007.07.007

Sun MY, Maykel JA. Ischemic colitis. *Clin Colon Rectal Surg.* 2007;20(1):5-12.

- 21) Two months ago, a 42-year-old man presented to the emergency department with a 3-day history of right lower quadrant pain. He had no significant medical or family history. At that time he had rebound tenderness in the right lower quadrant of the abdomen. His initial white blood count was 15,000/mm³. A CT scan of the abdomen obtained by the emergency department at the initial admission demonstrated a dilated appendix with abscess and a surrounding inflammatory mass. The patient was started on intravenous antibiotics, and his symptoms markedly improved over 36 hours; he was discharged on oral antibiotics. He now presents for a follow-up visit and is asymptomatic. Which of the following is the best next step in his care?
- a) No further observation
 - b) Abdominal MRI
 - c) Interval appendectomy
 - d) Screening colonoscopy at age 50
 - e) Carcinoembryonic antigen (CEA) level

Most studies that have reported an increased risk of neoplasm in patients having initial complicated appendicitis or who undergo interval appendectomy indicate that an age of 40 years or older is a risk factor for neoplastic disease. Although most tumors found at interval appendectomy are low-grade, the increased incidence of neoplasm may have clinical significance. Surgeons should consider interval appendectomy after successful conservative management in adult patients, especially those aged 40 years or older. When the patient chooses not to undergo surgery after successful initial conservative treatment, serial follow-up with imaging studies such as might be a better option than ceasing further observation or follow-up. Lesions found at interval appendectomy include adenomas, polyps, neuroendocrine tumors, goblet cell carcinoids, and mucinous adenocarcinoma and mucinous neoplasms, CEA testing would not detect the presence of most of these tumor types.

Answer: C

References

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- 2) Son J, Park YJ, Lee SR, et al. Increased Risk of Neoplasms in Adult Patients Undergoing Interval Appendectomy. *Ann Coloproctol.* 2020 Jan 31.
- 3) Siddharthan RV, Byrne RM, Dewey E, et al. Appendiceal cancer masked as inflammatory appendicitis in the elderly, not an uncommon presentation (Surveillance Epidemiology and End Results (SEER)-Medicare Analysis). *J Surg Oncol.* 2019 Sep;120(4):736–739

22) A 32-year-old woman in her third trimester of pregnancy presents with internal hemorrhoids that have prolapsed out of the anal canal, these cannot be reduced with gentle manual pressure. What is the best therapy?

- a) Hemorrhoidectomy
- b) Infrared coagulation
- c) Rubber band ligation
- d) Phlebotonics
- e) Topical nifedipine

This patient has grade III or IV internal hemorrhoids. Hemorrhoidectomy should typically be offered to patients whose symptoms result from external hemorrhoids or combined internal and external hemorrhoids with prolapse (grades III–IV). Infrared coagulation is typically an office-based procedure that involves the direct application of infrared light resulting in protein necrosis within the hemorrhoid. This is most commonly used for grade I and II hemorrhoids. A Cochrane review evaluated the efficacy of rubber band ligation (RBL) with respect to grade of hemorrhoids and found that excisional hemorrhoidectomy was superior to RBL for grade III hemorrhoids. Phlebotonics are a heterogeneous class of drugs used to treat both acute and chronic hemorrhoidal disease. While useful for medical management of symptoms of pruritis, bleeding and other chronic symptoms, they do not have a defined role in prolapsed internal hemorrhoids. Topical nifedipine has been described as a treatment for anal fissure, but does not have a defined role for hemorrhoids.

Answer: A.

References

Davis BR, Lee-Kong SA, Migaly J, et al. The American Society of Colon and Rectal Surgeons Clinical Practice Guidelines for the Management of Hemorrhoids. *Dis Colon Rectum*. 2018 Mar;61(3):284–292.