Management of Acute Large Bowel Obstruction in Elderly Patients

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Abbreviations

CRC	Colorectal cancer
IBD	Inflammatory bowel disease
LBO	Large bowel obstruction
SBO	Small bowel obstruction

21.1 Pathophysiology of Large Bowel Obstruction in Geriatric Patients

21.1.1 Physiologic Alterations

Conventionally, "elderly" has been defined as a chronological age of 65 years old or older.

Globally, the population is aging and the World Health Organization (WHO) predicts that the number of people aged 60 years or older will rise from 900 million to 2 billion between 2015 and 2050 (moving from 12 to 22% of the total global population) [1].

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Poor nutritional status, chronic diseases, and physiological changes are a key determinant of morbidity and mortality in the elderly subjects [2, 3].

Bowel habit changes are common in elderly patients. Malnutrition and chronic primary constipation are frequent conditions of geriatric subjects and the result of age-related alterations in the gastrointestinal tract and psychological factors. Aging may affect the signal transduction pathways and cellular mechanisms controlling smooth muscle contraction contribute to the development of constipation. In geriatric subjects, the number of neurons in the plexus is reduced, especially in the myenteric plexus. There is also a reduction of the release of acetylcholine and nitric oxide (NO) synthesis that cut the levels of neuronal NO synthase (NOS) [4, 5]. These physiological changes associated with dysphagia, reduced food intake, limited physical activity, and other pathological conditions like endocrine and metabolic disorders, organic colorectal diseases, neurological and psychiatric affections contribute to the development of constipation and represent an important risk factor for LBO [6].

21.1.2 Pathophysiology of LBO

When an obstruction occurs the large bowel functions (water and electrolyte absorption, vitamins synthesis and absorption, bilirubin breakdown) are compromised. LBOs follow a slower course than SBOs. The obstruction of the right colon has a pathophysiological evolution similar to distal small bowel obstruction, the stool is less dense, and the lumen is bigger than descending and sigmoid colon where obstruction's signs and symptoms manifest earlier.

The early stage of LBO starts with gaseous distension of the colon and progressive increase of endoluminal pressure with normal blood electrolytes concentration, on this phase the colon maintains the absorption capacity of fluid and electrolytes. In the cecum, the distension is faster than other colic segments. This difference is associated with the largest diameter and the greater capacity of distension of the cecum with a lower increase of endoluminal pressure. The continence of the ileocecal valve also influences the speed of bowel dilatation, the ileocecal valve is competent in about 75% of subjects, and it leads to a closed-loop LBO without decompression into small bowel. In the 25% of patients with incontinence of ileocecal valve, the distension of small bowel may mimic a SBO with decompression into small bowel and subsequent distension of small intestine.

In the second stage, the partial or complete blockage of digested products in the proximal bowel leads to emesis onset. Frequent emesis and colon progressive distension with isotonic loss of water and electrolytes lead to hemoconcentration, electrolyte disorders (especially hyponatremia), decrease of CVP, and oliguria. Dehydration of as little as 2% of body weight, corresponding to ~3–5% reduction in total body water can result in impairment in physical and cognitive performances in elderly patients.

The colon has the lowest blood flow of abdominal viscera and consequently it develops a faster and earlier damage of the blood flow in the parietal vessel. At first,

the ischemia interests the mucosa. Contemporary blood flow damage and increasing endoluminal pressure can cause perforation and bring to septic peritonitis, especially in intestinal segments with thin walls, like cecum.

A serious and life-threatening complication of LBO is strangulation. Strangulation is more commonly seen in closed-loop obstructions. Without a prompt treatment, the strangulated bowel becomes ischemic and tissue infarction occurs. Tissue infarction progresses to bowel necrosis, and in case of perforation to septic shock [7–10].

21.2 Etiology

LBO etiology can be classified in neoplastic and nonneoplastic pathologies (Table 21.1).

Neoplastic LBO is mostly associated with colorectal cancer (CRC). CRC is the most common cause in elderly patients in about 60% of cases and in approximately 7–29% of cases LBO is the initial presentation of colorectal cancer. Sigmoid colon is the most common site of LBO caused by colorectal cancer [13–17].

Extracolonic malignances can extrinsically compress the bowel resulting in obstruction. Neoplasms can lead to LBO through direct invasion (NET, GIST, gastric, pancreatic, genitourinary cancers), hematogenous, or lymphatic metastasis and intraperitoneal seeding (carcinomatosis) [18].

Diverticulitis and volvulus are the most common nonneoplastic causes of LBOs, respectively in 10% and 10–15% of cases.

Diverticulitis can cause obstruction through fibrosis, adherence, and compression by intramural or extramural abscess [19].

The sigmoid colon is the most common site of colonic volvulus in about 60–75% of all cases of colonic volvulus.

Table 21.1 Causes of LBO in geriatric patients [7, 11, 12]

LBO common cause (>95%)	
Colorectal cancer	60–80%
Volvulus	10–15%
Diverticulitis	10%
LBO uncommon cause (<5%)	
Extra colonic neoplasms	<1%
Adherence	1%
IBD	<1%
Abdominal wall hernia	<1%
Fecal impaction	1%
Intraluminal foreign body	<1%
Enterolith	<1%
Intussusception	<1%
Toxic megacolon	<1%
Ogilvie's syndrome	<1%
Gallstones	<1%
Strictures	<1%
Internal hernia	<1%

Cecal volvulus is responsible for 1% of all adult intestinal obstructions and nearly 25–30% of all cases of colonic volvulus [18–20].

Fecal impact is a common finding in geriatric patients, the absence of any treatment rarely can lead to LBO that is secondary to ischemic pressure necrosis caused by a stercoraceous mass. IBD rarely can cause LBO with adhesions or strictures formation, commonly caused by persistent inflammation [21, 22].

21.3 Evaluation of Large Bowel Obstruction in Geriatric Patients

21.3.1 Geriatric Patient's Assessment

Geriatric patient's physical exam could be difficult to achieve due to comorbidities and psychological diseases of the elderly. The lack of cooperation itself can be an important indication of an underlying medical problem. Comorbidities such as stroke and dementia can result in communication difficulties. Presenting symptoms of geriatric subjects are subtler than youngers. Initially, it is important to recognize the comorbidities, especially psychosocial disorders and specific geriatric conditions such as dementia, falls, or functional disability. Physical examination must include an immediate evaluation of vital signs. Signs of hypovolemic or septic shock must be evaluated (tachycardia, tachypnea, hypotension, obtund or abnormal mental status, cold, clammy extremities, mottled or cyanotic skin, dizziness, weakness, apathy, oliguria, metabolic acidosis, and hyperlactatemia). To identify patients at high risk of mortality due to sepsis qSOFA is used.

Personal history about last defecation, chronic constipation and use of laxatives, abrupt onset of symptoms, previous abdominal surgery, or previous diverticulitis episodes may be diagnostically significant. LBO causes a wide range of uncomfortable symptoms. Typical presentation of LBO includes abdominal pain, distension, nausea, vomiting, and constipation-obstipation. Some symptoms may depend on the location and length of time of the obstruction. Sigmoid volvulus is common in elderly, immobile patients. Volvulus should be suspected in patients with painless and gross abdominal distension.

Pain is usually colicky and poorly localized due to visceral distention of the intestine. Intermittent abdominal pain is typical in the early stage due to increased bowel motility, after this stage the peristalsis reduction leads to a typical continuous pain. LBO's emesis is less frequent than in SBO, it is intermittent and feculent when present.

Abdominal tenderness and distension are the most common signs of LBO. Tenderness is more diffuse than in SBO. Peritonism is associated with bowel ischemia and/or perforation. Distention is marked in LBO with obstipation. An incompetent ileocecal valve producing symptoms similar to the SBO. Bowel sounds can be hyperactive or absent. Abdominal hernias and surgical incision must be examined. Digital rectal examination is important to evaluate active bleeding or the presence of a rectal mass.

Clinical findings of high fever, severe abdominal tenderness, rebound tenderness, severe leukocytosis, suggest possible complications of bowel obstruction with necrosis, bowel perforation, or generalized peritonitis [23–27].

21.3.2 Diagnostic Tests

21.3.2.1 Plain Abdominal Radiography

Abdominal radiography normally is the first diagnostic test in suspected LBO. The examination should include supine and nondependent (upright or left lateral decubitus) radiographs. Abdominal radiographic findings present a diagnostic value in 50–60% of the cases, indifferent in 20–30%, and misleading in 10–20% of patients. The sensitivity and specificity of plain abdominal x-ray for the detection of LBO are respectively of 84% and 72%. Plain radiograph in LBO is potentially useful to evaluate colonic distension, the colon is dilated proximal to the site of obstruction with absence of gas distal to the obstruction (normal colonic caliber ranges from 3 to 8 cm, the colon and the cecum are dilated when the diameter is greater than 6 cm and 9 cm, respectively). Eventual small bowel distension is noted in case of incompetent ileocecal valve. When bowel ischemia or perforation are suspected abdominal x-ray can show intramural gas, pneumoperitoneum, and portal venous gas [28–31] (Fig. 21.1).

21.3.2.2 Contrast Enema

The water-soluble contrast enema usually allows easy distinction between a LBO and colon pseudo-obstruction. Contrast enema can detect the obstruction site and the transition point where colon is dilated. The water-soluble contrast enema sensitivity and specificity are respectively of 96% and 98%. The water-soluble contrast

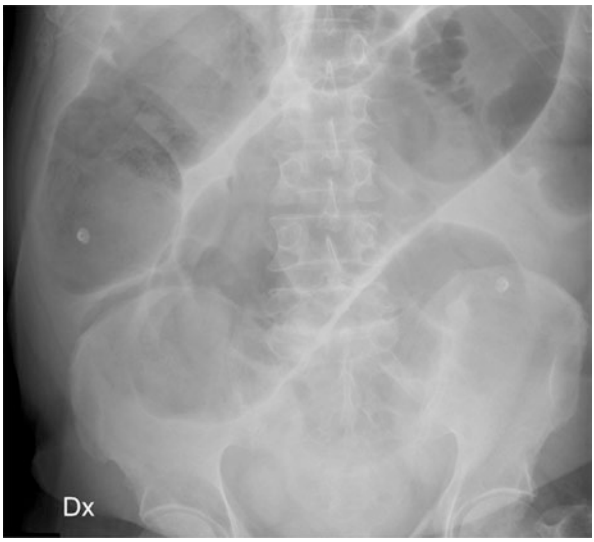

Fig. 21.1 Case courtesy of Emergency Surgery Department, Parma University Hospital, Parma, Italy

material does not cause artifacts on CT scan. In elderly patients, the examination may be an insufficient diagnostic tool due to the difficulty of geriatric patients to be able to rotate on the fluoroscopy table to accomplish the evaluation of the colon [32].

21.3.2.3 Ultrasound

Ultrasound is a noninvasive exam, it can evaluate the obstruction distinguishing mechanical or functional bowel obstruction. Ultrasound and Doppler sonography can detect bowel wall thickness (>4 mm) and perfusion, decreased or absent peristalsis, the presence of free intraperitoneal air and fluid. In conservative treatment, ultrasound is useful to evaluate the progress of LBO [33–35].

21.3.2.4 Computed Tomography Scan

CT with intravenous contrast is the gold standard for the diagnosis of the cause of CT has a superior accuracy than ultrasound and abdominal radiography. CT has a sensitivity and specificity of 96% and 93%, respectively. CT studies intraluminal, mural, and extramural causes of LBO. CT can detect the presence of a mass, signs of inflammation and bowel wall ischemia, or perforation and peritonitis. In colorectal cancers LBO can evaluate the local or regional metastasis. Despite other diagnostic tests abdominal CT can evaluate clinical findings severity and manage the right treatment option [34–36] (Fig. 21.2a, b).

21.3.2.5 Colonoscopy

Colonoscopy in elderly patients can manage diagnosis and treatment. In the absence of clinical, laboratory or radiological signs of bowel necrosis, perforation or peritonitis, diagnostic, and therapeutic colonoscopy is increasing in indications and possibilities. Colonoscopy can lead to a possible diagnosis in case of suspected

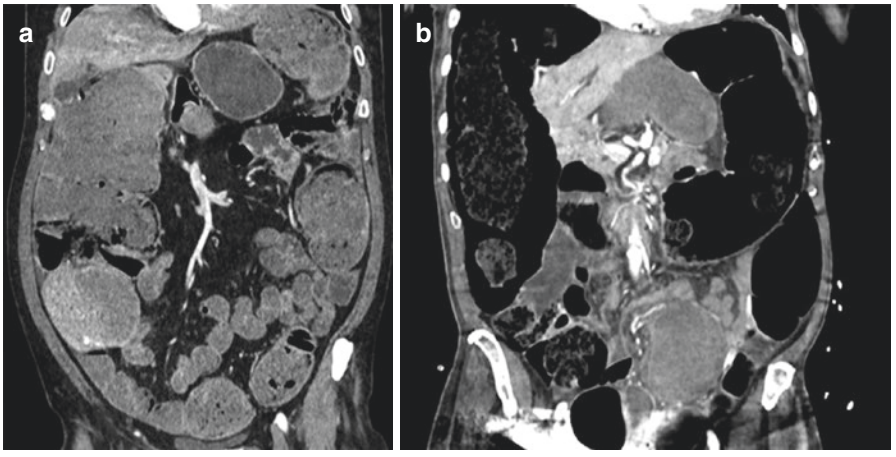

Fig. 21.2 (**a**, **b**) Case of sigmoid volvulus, courtesy of Emergency Surgery Department, Parma University Hospital, Parma, Italy

malignancy, IBD, volvulus, Ogilvie's syndrome, fecal impact or can exclude an unnecessary surgery. When a LBO is suspected carbon dioxide insufflation is preferable to conventional air insufflation due to the faster capacity of the colon to absorption CO2 reducing the risk of bowel ischemia. In elderly patient colonoscopy also can be a definite therapy in 8% of cases avoiding surgery [37, 38].

21.4 Therapy

21.4.1 Initial Management

Initial management must consider the physical status of patients and includes: full blood count, creatinine and electrolytes, liver function tests, amylase, glucose, C-reactive protein (CRP), coagulation profile blood group, ECG, arterial blood gas sample including lactate, placement of urinary catheter, adequate intravenous access, arterial line, CVP monitoring, fluid balance monitoring, vital sign monitoring every 3 h in stable patients, and continuous monitoring of vital signs in critical patients.

Supportive treatment must begin as soon as possible to control symptoms, fluid, and electrolyte loss (hyponatremia) through nasogastric suction, intravenous crystalloids, anti-emetics, and bowel rest. Appropriate preoperative broad-spectrum antibiotics should be considered.

Evaluation of hydration status in geriatric patients is fundamental. Geriatric patients with dehydration and electrolyte disorders are more fragile than youngers. Dehydration is a major predictor of morbidity and mortality causing physical and cognitive impairment with six times greater risk of in-hospital mortality. Dehydration may be a manifestation of disease severity. Iatrogenic overhydration can occur during the management of LBO, especially in renal and/or cardiac insufficiency and it is an independent risk factor for morbidity and mortality in elderly people (congestive heart failure, pulmonary edema, confusion, high blood pressure, and even death).

After appropriate and timely resuscitation, a prompt diagnosis of LBO causes is helpful to reduce delays in treatment. Appropriate preoperative risk assessment for elderly patients is crucial for correct treatment management. It is also important taking account of the patients' wishes and the avoidance of futile surgery. Surgical decision-making for geriatric patients with bowel obstruction is complex due to poor outcomes after emergency surgical intervention and high postoperative complication and mortality rates [39–42].

21.4.2 Nonsurgical Treatment

Conservative treatment should be performed in case of uncomplicated LBO in absence of symptoms and signs of hypovolemic or septic shock or LBO complications (bowel ischemia and necrosis, peritonitis). Conservative management of intestinal obstruction is mandatory in order to avoid unnecessary surgery and unexpected complications due to comorbidities.

The management of LBO with a conservative treatment depends on the etiology and severity of the obstruction. Stable patients with partial or low-grade obstruction resolve with nasogastric tube decompression and supportive measures.

Prompt manual reduction of hernias should always be performed and elective surgery after acute LBO should be considered to prevent new episodes of LBO. Emergency surgery is needed for unsuccessful reductions.

Water-soluble contrast should be initially administrated in LBOs caused by uncomplicated adherences and intussusceptions. Gastrografin can be used for both diagnostic and therapeutic purposes, it is hypertonic and draws fluid from the bowel wall into the lumen, decreasing bowel wall edema and stimulating peristalsis.

Uncomplicated sigmoid colon volvulus benefits of endoscopic decompression and derotation. Nonoperative treatment is successful in 70–91% of cases, with reported complication rates of 2–4.7% in geriatric patients.

In neoplastic obstruction of the colon endoscopic colonic stents have been proposed for palliation or as a bridge to surgery due to a better short-term outcome than emergency surgery.

Diverticular LBO usually is the result of multiple attacks of diverticulitis with marked fibrosis and strictures formation on the colon walls, conservative treatment resolves the obstruction, in the presence of pericolic abscess percutaneous drainage can be performed.

In IBD, colonic obstruction conservative treatment starts with anti-inflammatory medications and high-dose steroids, but fibrotic strictures are often refractory to medical treatment and one or more endoscopic dilatations of strictures are required with a reported success rate between 70% and 90%.

Fecal impaction treatment includes digital manipulation, enema instillation.

Uncomplicated acute colonic pseudo-obstruction is treated with neostigmine or colonoscopic decompression [43–46].

21.4.3 Surgical Treatment

Surgery should be performed only in selected cases. When conservative treatment fails, or complicated LBO is presented with signs of bowel ischemia, perforation, peritonitis, and abdominal sepsis surgery should be considered. The perfect timing to perform nonoperative treatment before surgery is lacking, especially in geriatric patients. A wrong treatment timing can result in deterioration, development of adverse events, and poor outcome. Correct timing for surgery is considered 24–48 h after hospital admission and conservative treatment. Realistic risk prediction and identification of frailty are essential to consider surgery as a treatment option [47, 48].

In presence of sepsis, peritonitis, perforation, and bowel ischemia emergency laparotomy is necessary to control the cause, surgery in elderly patients should be performed following the criteria of damage control surgery to mitigate the negative downstream effects of physiologic insults seen preoperatively. The goal of rapid

source control laparotomy is the restoration of physiologic normality and homeostasis [49].

Abdominal wall hernia surgery with prosthetic repair is the treatment of choice, but in presence of contaminated surgical field (perforation, bowel resections) suture repair is preferred for the risk of mesh infection [50].

Treatment of cecal volvulus involves operative reduction of the twist and cecopexy is preferred in elderly patients instead of right colon resection. After endoscopic decompression and derotation of sigmoid colon, volvulus fail sigmoidopexy should be performed instead of colon resection [51, 52].

Diverticular LBOs in elderly patients should be managed conservatively and surgery should be performed only in case of worsening conditions with Hartmann procedure performed in high-risk patients.

Colorectal cancer bowel obstruction surgery should be performed only after endoscopic dilatation or stenting fail or after clinical stabilization with oncological laparoscopic or laparotomic resection. When emergency laparotomy is required formal resection with or without anastomosis, with or without stoma can be performed. In case of severe clinical conditions in left colon cancer, Hartmann's procedure or loop colostomy should be performed. In right colon cancer right colectomy with terminal ileostomy should be considered as the procedure of choice. Severely unstable patients should be treated with a loop ileostomy [53].

21.5 Conclusion

While nonoperative resolution of LBO in elderly patients is ideal, waiting too long may lead to poor outcomes. In uncomplicated LBOs conservative treatment should be always performed. Complicated LBOs need immediate treatment and damage control surgery is the most recommended treatment to control severe complications of LBO like perforation and sepsis in elderly patients. The goal of this procedure consists of restoring physiologic normality and reduces mortality.

"When treating patients in the later years of life, our focus must shift from maximizing survival to maximizing also the quality of life, dignity, and minimizing suffering." [54].

References

1. World Health Organisation. 10 facts on ageing and the life course. Updated May 2017.
2. Tierney AJ. Undernutrition and elderly hospital patients: a review. J Adv Nurs. 1996;23:228–36.
3. Leslie W, Hankey C. Aging, nutritional status and health. Healthcare (Basel, Switzerland). 2015;3(3):648–58. https://doi.org/10.3390/healthcare3030648.
4. Bitar KN, Patil SB. Aging and gastrointestinal smooth muscle. Mech Ageing Dev. 2004;125:907–10.
5. Grassi M, Petraccia L, Mennuni G, Fontana M, Scarno A, Sabetta S, Fraioli A. Changes, functional disorders, and diseases in the gastrointestinal tract of elderly. Nutrición Hospitalaria. 2011;26(4):659–68.

6. Spinzi GC. Bowel care in the elderly. Dig Dis. 2007;25(2):160–5.
7. Cappell MS, Batke M. Mechanical obstruction of the small bowel and colon. Med Clin North Am. 2008;92(3):575–97, viii. https://doi.org/10.1016/j.mcna.2008.01.003.
8. Welch J. Bowel obstruction: differential diagnosis and clinical management. Philadelphia: Saunders; 1989. p. 59–95.
9. Saegesser F, Chapuis G, Rausis C, Tabrizian M, Sandblom P. Intestinal distension and colonic ischemia: occlusive complications and perforations of Colo-rectal cancers—a clinical application of Laplace's law [in French]. Chirurgie. 1974;100(7):502–16.
10. Cappell MS, Batke M. Mechanical obstruction of the small bowel and colon. Med Clin N Am. 2008;92(3):575–97. https://doi.org/10.1016/j.mcna.2008.01.003.
11. Lopez-Kostner F, Hool GR, Lavery IC. Management and causes of acute large-bowel obstruction. Surg Clin North Am. 1997;77(6):1265–90.
12. Ramanathan S, Ojili V, Vassa R, Nagar A. Large bowel obstruction in the emergency department: imaging spectrum of common and uncommon causes. J Clin Imaging Sci. 2017;7:15. Published 2017 Apr 5. https://doi.org/10.4103/jcis.JCIS_6_17.
13. Taourel P, Kessler N, Lesnik A, Pujol J, Morcos L, Bruel JM. Helical CT of large bowel obstruction. Abdom Imaging. 2003;28(2):267–75.
14. Biondo S, Parés D, Frago R, et al. Large bowel obstruction: predictive factors for postoperative mortality. Dis Colon Rectum. 2004;47(11):1889–97.
15. Sule AZ, Ajibade A. Adult large bowel obstruction: a review of clinical experience. Ann Afr Med. 2011;10(1):45–50.
16. Gore RM, Levine MS. Textbook of gastrointestinal radiology. 3rd ed. Saunders/Elsevier: Philadelphia; 2008.
17. Frago R, Ramirez E, Millan M, Kreisler E, del Valle E, Biondo S. Current management of acute malignant large bowel obstruction: a systematic review. Am J Surg. 2014;207(1):127–38.
18. Hayakawa K, Tanikake M, Yoshida S, Urata Y, Yamamoto E, Morimoto T. Radiological diagnosis of large-bowel obstruction: neoplastic etiology. Emerg Radiol. 2013;20:69–76.
19. Chintapalli KN, Chopra S, Ghiatas AA, Esola CC, Fields SF, Dodd GD. 3rd diverticulitis versus colon cancer: differentiation with helical CT findings. Radiology. 1999;210:429–35.
20. Habre J, Sautot-Vial N, Marcotte C, Benchimol D. Caecal volvulus. Am J Surg. 2008;196:e48–9.
21. Kumar P, Pearce O, Higginson A. Imaging manifestations of faecal impaction and stercoral perforation. Clin Radiol. 2011;66:83–8.
22. Narayanaswamy S, Walsh M. Calcified fecolith—a rare cause of large bowel obstruction. Emerg Radiol. 2007;13:199–200.
23. Catena F, De Simone B, Coccolini F, Di Saverio S, Sartelli M, Ansaloni L. Bowel obstruction: a narrative review for all physicians. World J Emerg Surg. 2019;14:20. https://doi.org/10.1186/s13017-019-0240-7.
24. Bohner H, Yang Q, Franke C, Verreet PR, Ohmann C. Simple data from history and physical examination help to exclude bowel obstruction and to avoid radiographic studies in patients with acute abdominal pain. Eur J Surg. 1998;164:777–84.
25. Laurell H, Hansson LE, Gunnarsson U. Acute abdominal pain among elderly patients. Gerontology. 2006;52(6):339–44. https://doi.org/10.1159/000094982.
26. Pisano M, Zorcolo L, Merli C, et al. 2017 WSES guidelines on colon and rectal cancer emergencies: obstruction and perforation. World J Emerg Surg. 2018;13:36. Published 2018 Aug 13. https://doi.org/10.1186/s13017-018-0192-3.
27. Markogiannakis H, Messaris E, Dardamanis D, et al. Acute mechanical bowel obstruction: clinical presentation, etiology, management and outcome. World J Gastroenterol. 2007;13(3):432–7. https://doi.org/10.3748/wjg.v13.i3.432.
28. Jaffe T, Thompson WM. Large-bowel obstruction in the adult: classic radiographic and CT findings, etiology, and mimics. Radiology. 2015;275(3):651–63. https://doi.org/10.1148/radiol.2015140916.
29. Maglinte DT, Reyes BL, Harmon BH, et al. Reliability and role of plain film radiography and CT in the diagnosis of small-bowel obstruction. AJR Am J Roentgenol. 1996;167(6):1451–5.

30. Frager D, Medwid SW, Baer JW, Mollinelli B, Friedman M. CT of small-bowel obstruction: value in establishing the diagnosis and determining the degree and cause. AJR Am J Roentgenol. 1994;162(1):37–41.
31. Gans SL, Stoker J, Boermeester MA. Plain abdominal radiography in acute abdominal pain; past, present, and future. Int J Gen Med. 2012;5:525–33. https://doi.org/10.2147/IJGM.S17410.
32. Chapman AH, McNamara M, Porter G. The acute contrast enema in suspected large bowel obstruction: value and technique. Clin Radiol. 1992;46(4):273–8.
33. Nicolaou S, Kai B, Ho S, Su J, Ahamed K. Imaging of acute small-bowel obstruction. AJR Am J Roentgenol. 2005;185:1036–44.
34. Godfrey EM, Addley HC, Shaw AS. The use of computed tomography in the detection and characterisation of large bowel obstruction. N Z Med J. 2009;122(1305):57–73.
35. Frager D, Rovno HD, Baer JW, Bashist B, Friedman M. Prospective evaluation of colonic obstruction with computed tomography. Abdom Imaging. 1998;23(2):141–6.
36. Beattie GC, Peters RT, Guy S, Mendelson RM. Computed tomography in the assessment of suspected large bowel obstruction. ANZ J Surg. 2007;77(3):160–5.
37. Sajid MS, Caswell J, Bhatti MI, Sains P, Baig MK, Miles WF. Carbon dioxide insufflation vs conventional air insufflation for colonoscopy: a systematic review and meta-analysis of published randomized controlled trials. Color Dis. 2015;17:111–23. https://doi.org/10.1111/codi.12837.
38. Katsanos KH, Maliouki M, Tatsioni A, et al. The role of colonoscopy in the management of intestinal obstruction: a 20-year retrospective study. BMC Gastroenterol. 2010;10:130. Published 2010 Nov 8. https://doi.org/10.1186/1471-230X-10-130.
39. Phillips PA, Johnston CI, Gray L. Disturbed fluid and electrolyte homeostasis following dehydration in elderly people. Age Ageing. 1993;22(suppl 1):S26–33.
40. Rowat A, Graham C, Dennis M. Dehydration in hospital-admitted stroke patients. Stroke. 2012;43(3):857–9.
41. Besen BA, Gobatto AL, Melro LM, Maciel AT, Park M. Fluid and electrolyte overload in critically ill patients: an overview. World J Crit Care Med. 2015;4(2):116.
42. Speicher PJ, Lagoo-Deenadayalan SA, Galanos AN, Pappas TN, Scarborough JE. Expectations and outcomes in geriatric patients with do-not-resuscitate orders undergoing emergency surgical management of bowel obstruction. JAMA Surg. 2013;148(1):23–8. https://doi.org/10.1001/jamasurg.2013.677.
43. Fitzgibbons RJ Jr, Forse RA. Clinical practice. Groin hernias in adults. N Engl J Med. 2015;372(8):756–63.
44. Bak MP, Boley SJ. Sigmoid volvulus in elderly patients. Am J Surg. 1986;151:71–5.
45. Verstockt B, Van Driessche A, De Man M, van der Spek P, Hendrickx K, Casneuf V, Dobbels P, Van Molhem Y, Vandervoort J. Ten-year survival after endoscopic stent placement as a bridge to surgery in obstructing colon cancer. Gastrointest Endosc. 2018;87(3):705–713.e2. https://doi.org/10.1016/j.gie.2017.05.032. Epub 2017 Jun 1
46. Lee HW, Park SJ, Jeon SR, et al. Long-term outcomes of endoscopic balloon dilation for benign strictures in patients with inflammatory bowel disease. Gut Liver. 2018;12(5):530–6. https://doi.org/10.5009/gnl17396.
47. Anderson I, Eddleston J, Grocott M, et al. The higher risk general surgical patient towards improved care for a Forgotten Group. London: RCS; 2011.
48. Torrance AD, Powell SL, Griffiths EA. Emergency surgery in the elderly: challenges and solutions. Open Access Emerg Med. 2015;7:55–68. Published 2015 Sep 8. https://doi.org/10.2147/OAEM.S68324.
49. Becher RD, Peitzman AB, Sperry JL, et al. Damage control operations in non-trauma patients: defining criteria for the staged rapid source control laparotomy in emergency general surgery. World J Emerg Surg. 2016;11:10. Published 2016 Feb 24. https://doi.org/10.1186/s13017-016-0067-4.
50. Birindelli A, Sartelli M, Di Saverio S, et al. 2017 update of the WSES guidelines for emergency repair of complicated abdominal wall hernias. World J Emerg Surg. 2017;7(12):37.

51. Wai CT, Lau G, Khor CJ. Clinics in diagnostic imaging (105): sigmoid volvulus causing intestinal obstruction, with successful endoscopic decompression. Singap Med J. 2005;46:483–7.
52. Delabrousse E, Sarlième P, Sailley N, Aubry S, Kastler BA. Cecal volvulus: CT findings and correlation with pathophysiology. Emerg Radiol. 2007;14:411–5.
53. Pisano M, Zorcolo L, Merli C, et al. 2017 WSES guidelines on colon and rectal cancer emergencies: obstruction and perforation. World J Emerg Surg. 2018;13:36. Published 2018 Aug 13. https://doi.org/10.1186/s13017-018-0192-3.
54. Zenilman ME. Surgery in the elderly. Curr Probl Surg. 1998;35:99–179.