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Review article

Abdominal surgical emergencies in the elderly

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The elderly are one of the highest-risk patient populations faced by the emergency physician (EP). Baum et al [1] found that the elderly patient who had abdominal pain created the most time-consuming workup of all emergency department (ED) visitors. Not only is their clinical presentation more challenging and their risk for true emergencies greater than other populations, they often have coexisting diseases that result from or are exacerbated by the acute complaint. In this review the authors outline a stepwise approach to the elderly patient who has an abdominal complaint and address key elements of bedside evaluation, imaging, consultation, treatment, and disposition. The authors also examine common life-threatening surgical diagnoses in the elderly patient: ruptured abdominal aortic aneurysm (AAA), acute mesenteric ischemia (AMI), perforated viscus, bowel obstruction, acute cholecystitis, pancreatitis, appendicitis, and diverticulitis.

The definition of “elderly” is changing rapidly. Although many authors use the age of 65 years as a cutoff, this number is arbitrary and might be considered to be unnecessarily low as the longevity and general health of the population improves. While some medical literature identifies subgroups within the elderly population (eg, the “old” and the “very

old"), it might be more useful for the EP to consider the overall health status of each individual patient in the evaluation of acute abdominal pain.

Pitfalls to diagnosis and management

Challenging clinical presentation

Symptoms and signs in older patients are frequently milder and less specific than in younger adults. An accurate history is more difficult to obtain in older patients for several reasons, including fear of loss of independence, dementia, cerebrovascular disease, depression, decreased auditory function, language barriers, and decreased mentation from a variety of other causes including the use of opiates and benzodiazepines, fever, electrolyte abnormalities, and alcohol. Fourteen percent of elderly patients who present to the ED suffer from alcoholism [2] . Jones et al [3] showed that elderly patients were less likely to receive analgesics for long-bone fractures than younger patients, which might reflect a relative inability of elderly patients to perceive or express pain compared with their younger counterparts; alternatively, it might reflect a reluctance on the part of EPs to medicate older patients.

Although arguably the most important symptom in any patient presenting with an abdominal surgical emergency is that of pain, elderly patients might present with no pain at all, and they might have complaints that are seemingly unrelated to the underlying pathology. An elderly patient who has a ruptured AAA, for example, might only complain of the urge to defecate. An elderly patient who has appendicitis might present with the chief complaint of increased falling.

The physical examination is also altered in the elderly. There might be suppression of tachycardia caused by the chronic use of negative chronotropic medications or intrinsic cardiac disease. There might also be an impaired or absent febrile response [4] . Cooper [5] found that the elderly are four times more likely to be hypothermic in response to an abdominal process. Abdominal tenderness might be more difficult to localize because of changes in the nervous system affecting pain perception and laxity of the abdominal wall musculature, which reduces the presence of rebound and guarding. Finally, laboratory tests are more commonly normal. Parker [6] found that the average white blood cell (WBC) count in elderly patients who have a surgical abdomen was only 12,400 cells/mm^3.

Higher risk profile

Surgical emergencies of the abdomen are more common in the elderly than in any other population, so the threshold for surgical consultation should be low. Bulgiosi et al [7] reported on the final diagnoses of 127 patients over age 65 who presented to the ED with acute nontraumatic abdominal pain (Table 1). Forty-two percent of these patients required

surgery. Van Geloven [8] reported on patients over age 80 who presented to the ED with abdominal pain and found that 27% required surgery, with an overall mortality of 17% that increased to 34% among those who required operative intervention.

Table 1. Final diagnoses of elderly patients who had abdominal pain in the ED

Abbreviations: MI, myocardial infarction; UTI, urinary tract infection.*Data from* Bugliosi TF, Meloy TD, Vukov LF. Acute abdominal pain in the elderly. Ann Emerg Med 1990;19(12):1383–6.

Etiology	**N**	**%**
Indeterminate	30	23
Biliary colic or cholecystitis	16	12
Small bowel obstruction	15	12
Gastritis	10	8
Perforated viscus	9	7
Diverticulitis	8	6
Appendicitis	5	4
Incarcerated hernia	5	4
Renal colic	5	4
Pancreatitis	3	2
UTI	3	2
Constipation	3	2
Sigmoid volvulus	2	2
Abscess	2	2
Aortic aneurysm	1	1
Mesenteric ischemia	1	1
MI	1	1
Pulmonary embolus (PE)	1	1

Vascular emergencies (mesenteric ischemia, AAA rupture, aortic dissection) occur almost exclusively in patients over age 50. Diverticular disease is seen in more than 30% of patients over age 60, and by the ninth decade of life this figure increases to 50% [9] . The incidence of gallstones also rises with age from 8% in patients younger than age 40 to 50% in patients in the eighth decade of life. Bowel obstruction becomes more common with age and is the cause of 12% to 25% of surgical abdominal emergencies in the elderly [10] .

Elderly patients are also more likely to present with complications of abdominal surgical conditions. They are three times more likely to have a perforated appendix at surgery compared with the general population. Likewise, complications of acute cholecystitis are far more common in the elderly. Morrow [11] found that 40% of acutely ill elderly patients who had cholecystitis had concomitant empyema of the gallbladder, gangrenous cholecystitis, free perforation, or subphrenic or hepatic abscess.

Coexisting medical conditions

Two critical issues should be considered when evaluating an elderly patient who has an acute abdomen and coexisting medical conditions.

The first is the possibility that the abdominal pain is an atypical presentation of a nonsurgical condition. Inferior wall myocardial infarction (MI), pulmonary embolus (PE), pneumonia, and diabetic ketoacidosis are examples of nonsurgical emergencies that might present as abdominal pain. Some of these will be obvious (eg, a vesicular rash in a dermatome in the case of herpes zoster), but others such as MI and PE can be more subtle. ECG, pulse oximetry, and chest radiographs might not be diagnostic, but their liberal use as screening tests is appropriate.

Secondly, the EP should consider what unique interventions must be made when concomitant medical conditions such as coagulopathy, renal failure, chronic pulmonary disease, or coronary artery disease are present. In one of the largest series of acute abdominal pain in the elderly, Fenyo [12] found that at least 65% of patients had at least one complicating condition in addition to their abdominal pain. The presence of coexisting disease influences outcome strongly and is likely more important than age as a negative prognostic indicator. Escarce [13] found a 400% increase in mortality for cholecystectomy in elderly patients who had more than three additional medical conditions compared with patients who had no concomitant disease. Moreover, in the Acute Physiology and Chronic Health Evaluation III (APACHE III) scoring system, which predicts outcome in critically ill patients, age alone accounts for only 3% of total explanatory power, whereas acute physiologic parameters account for 86% [14] .

Interacting with the elderly patient and assessing decision-making capacity

In a session focusing on surgery in the elderly patient at the 1995 Clinical Congress of the American College of Surgeons, a number of unique facts about the elderly patient were outlined. Research has shown that how physicians communicate with older patients can have a profound influence on clinical outcomes. Most elderly patients have some degree of hearing loss, so important conversations should occur in a quiet room. The EP should sit close to the patient and speak in a strong voice, describing the plan slowly and deliberately. Unhurried interactions decrease the fear and apprehension experienced by the elderly patient [15] .

To obtain consent for emergency investigations or surgery, physicians must first determine the elderly patient's decision-making capacity (not “competency,” which has a more specific legal definition). The capacity to make decisions about medical care implies:

- Knowledge of the options
- Awareness of the consequences of each option
- Appreciation of the personal costs and benefits of options in relation to relatively stable values and preferences

To determine whether or not the third criterion is present, the physician can simply ask the patient for the rationale of the choice being made [16] .

If the patient is deemed to be incapable of decision-making, a reasonable attempt should be made to find family members, locate an advanced directive, or identify the patient's power-of-attorney. Occasionally there are several next of kin who must be consulted and a consensus achieved. When no advance directive or family is available, the physicians involved must make the decisions. Little has been written regarding the ethics of treatment of the elderly demented patient who has an abdominal surgical emergency. A recent survey in Ireland asked physicians to comment on a case scenario of an elderly demented patient presenting with a presumed sigmoid volvulus. Sixty-five percent of respondents felt that surgical therapy would be inappropriate and 26% said that any intervention would be inappropriate. More physicians would recommend surgical intervention at the request of relatives. An advance directive not to treat would be respected by 70% despite a relative's wishes. These figures might have been considerably different if the survey was conducted in the United States, but they are nonetheless revealing of physicians' attitudes in these cases [17] .

Approach to the elderly patient who has abdominal pain

Resuscitative phase and vitals signs

The initial approach to the elderly patient who has abdominal pain begins with the standard priorities of airway, breathing, and circulation. Diagnostic information can be gathered during the initial resuscitation. Significant tachycardia and hypotension are indicators that shock might be present. Diagnoses to consider in patients who have abdominal pain and shock include gangrenous bowel, mesenteric ischemia, AAA rupture, sepsis, gastrointestinal (GI) hemorrhage, severe pancreatitis, cholangitis, perforated viscus, MI, and PE.

The full differential for tachycardia should be considered because it includes several diagnoses often overlooked in the elderly such as alcohol withdrawal and drug intoxication. Tachypnea might be a compensatory response to metabolic acidosis from gangrenous viscera or sepsis, hypoxemia from pneumonia or PE, or simply a

catecholamine-induced reaction to pain. Altered mental status should trigger a broad differential diagnosis that includes sepsis, shock, drug intoxication (especially opiates and alcohol), hypoglycemia, fever, hypoxia, hypercarbia, metabolic acidosis, intracranial hemorrhage, dehydration, and electrolyte emergencies. Mental confusion has been reported to develop in 30% of elderly patients who have acute mesenteric ischemia [18] . The elderly are less likely to mount an appropriate febrile response, so every effort should be made to measure temperature accurately, preferably by rectal thermometer.

History

Despite being more difficult, the importance of patient history in the elderly patient who has abdominal pain should not be underemphasized. Duration of pain less than 48 hours with no previous episodes is concerning and should increase suspicion for a vascular emergency or a perforated viscus. Pain that reaches maximum intensity immediately at onset is suggestive of abdominal and extra-abdominal vascular emergencies such as aortic rupture and dissection, mesenteric ischemia, PE, and MI. Recent syncope or near-syncope should similarly alert the EP to the possibility of vascular emergencies or GI hemorrhage. A history of previous abdominal surgery is important because of its association with obstruction.

Past medical history assumes a central role in the elderly, and a history of cardiovascular conditions such as coronary artery disease, peripheral vascular disease, and atrial fibrillation should be specifically sought. Because of their prevalence in the elderly population, the EP should also inquire directly about the use of the use of antiplatelet and anticoagulant medications.

Physical examination

Several elements of the physical examination should be highlighted. For example, skin examination assumes a special importance because the elderly have a higher incidence of herpes zoster and, more importantly, abdominal or flank ecchymoses might indicate underlying retroperitoneal hemorrhage with a ruptured or leaking AAA. Palpation of the aorta and auscultation for bruits are mandatory. A careful evaluation for the presence of hernias is especially important in the elderly—ventral, umbilical, inguinal, femoral, and obturator sites should be considered. If an elderly patient who has altered mental status or cognitive deficits will not relax the abdomen when asked, one should not assume that they are being irascible—he or she might well harbor peritonitis, despite the level of comfort described. Lastly, the value of serial examinations must be emphasized. This is common practice with respect to suspected appendicitis and has improved the diagnostic accuracy of appendicitis in patients whose presentations were atypical [19] .

Plain radiographs and ancillary testing

Pulse oximetry and 12-lead ECG should be considered mandatory. Plain abdominal radiographs can be diagnostic by revealing free air, bowel obstruction, volvulus, or a dilated calcified aorta, obviating the need for more advanced imaging. Although some authors argue against the routine use of plain films in the evaluation of abdominal pain citing their poor diagnostic utility overall [20] [21] , such studies have not looked specifically at the elderly population. The authors recommend a low threshold for plain films in the evaluation of the elderly patient who has abdominal pain. Table 2 describes important findings on plain abdominal films. Despite limitations of the WBC, a complete blood count, serum chemistries, blood urea nitrogen, creatinine, and, in selected cases, serum lipase, liver enzymes, and prothrombin time should be obtained during the initial evaluation. Urinalysis is also indicated.

Table 2. Plain film findings in the elderly patient who has abdominal pain

Finding	Appearance	Associations
Pneumoperitoneum	Air seen under diaphragms on upright chest or overlying right lobe of liver on left lateral decubitus films	Most commonly associated with bowel perforation, although other causes exist
Peritoneal fluid	Medial displacement of colon separated from flank stripes by fluid density on flat plate	Ascites or hemorrhage
Adynamic ileus	Dilatation of entire intestinal tract including stomach	Multiple causes including trauma, infection (intra- and extra-abdominal), metabolic disease, and medications (eg, narcotics)
Sentinel loop	Single distended loop of small bowel containing an air–fluid level	Represents localized ileus associated with localized inflammatory process such as cholecystitis, appendicitis, or pancreatitis
Small bowel obstruction	Dilated loops of small bowel (distinguished by valvulae conniventes, thin, transverse linear densities that extend completely across diameter of bowel) with air–fluid levels	Can be associated with other serious pathology such as incarcerated hernia, appendicitis, or mesenteric ischemia
Large bowel obstruction	Dilated loops, usually more peripheral in the abdomen, (distinguished by haustra—short, thick indentations that do not completely cross bowel and are less	Can be associated with diverticultis and malignancy

Table 2. Plain film findings in the elderly patient who has abdominal pain

	frequently spaced than valvulae conniventes)	
Cecal volvulus	Usually found in middle or upper abdomen to the left; often kidney-shaped	–
Sigmoid volvulus	Dilated loop of colon arising from left side of pelvis and projecting obliquely upward toward right side of abdomen	–
Early ischemic bowel findings	Might resemble mechanical obstruction with dilated loops and air–fluid levels	–
Later ischemic bowel findings	Might resemble adynamic ileus; thumbprinting (edema of bowel wall with convex identations of lumen) and pneumatosis intestinalis (linear or mottled gas pattern in bowel wall)	–
Gallbladder emergency findings	Ring of air outlining gallbladder	Emphysematous cholecystitis
	Air in biliary tree combined with signs of small bowel obstruction, possibly with visible calculus in pelvis	Gallstone ileus
Abdominal aortic aneurysm	Usually appears left of midline on supine film and anterior to spine in lateral projection; calcification in wall of aneurysm is variable	Ruptured or leaking AAA might reveal loss of psoas shadows or large soft tissue mass

Advanced imaging studies

During the initial assessment, which can include basic laboratory and imaging studies, the elderly patient who has abdominal pain can usually be classified into one of five general categories:

1. Specific examination or laboratory findings (eg, presence of peritoneal signs or a markedly elevated serum lipase)
2. Bowel obstruction
3. Vascular emergency
4. Nonspecific abdominal pain
5. Nonabdominal emergencies

Although further studies can be obtained for patients in the first three categories, surgical consultation should not be delayed for the purpose of making a definitive diagnosis. This is especially true when signs of hemodynamic instability or diffuse peritonitis are present or when a vascular emergency is suspected. In stable patients who have nonspecific abdominal pain, further evaluation and advanced imaging studies can be undertaken before consultation.

When the bedside evaluation has been completed, three advanced imaging studies that can further narrow the differential diagnosis can be used: ultrasound (US), CT, and angiography. US is the ideal study to assess the biliary tree. A bedside US is also the test of choice in the unstable patient who has a suspected ruptured AAA. CT is indicated in patients who have suspected appendicitis and in patients who have suspected AAA who are hemodynamically stable. CT is also indicated in cases of bowel obstruction and pancreatitis when signs of sepsis are present to detect the presence of complications such as infarction and necrosis. Furthermore, CT is the modality of choice in the elderly patient who has undifferentiated, nonspecific abdominal pain. Although angiography is the study of choice in patients who have symptoms that are highly suspicious of mesenteric ischemia such as intractable pain, pain out of proportion to examination, signs of sepsis, and a history of atrial fibrillation, CT might also be helpful in these patients.

Surgical consultation

As with advanced imaging, the timing of ED surgical consultation depends primarily on the suspected diagnosis and patient stability. Immediate surgical consultation is appropriate for unstable patients who have a suspected intra-abdominal surgical emergency. It is also indicated in the setting of diffuse peritonitis, suspected mesenteric ischemia, symptomatic AAA, perforated viscus, incarcerated hernia, and volvulus. If available, a vascular surgeon should be contacted immediately when AAA is suspected. Stable elderly patients who have less severe disease can undergo initial laboratory and radiographic evaluation before consultation.

Analgesia

Although many surgeons prefer to assess the patient before the administration of analgesia, its delay prolongs suffering and might impair the surgeon's evaluation [22] . As already noted, the elderly are at higher risk for inadequate analgesia, and the EP must make every effort to avoid the practice of oligoanalgesia [3] . Fentanyl is an excellent choice for use in the elderly—it does not cause histamine release, so it is more hemodynamically stable than other opiates. Although analgesia does not typically interfere with the abdominal examination [23] [24] , the short-acting nature of fentanyl does allow for more accurate symptom reassessments. For instance, in elderly patients who have mesenteric ischemia, ongoing pain might be the only sign of impaired perfusion when physical examination and CT are still normal. Long-acting opiates might therefore

delay the EP's decision to pursue this diagnosis. Fentanyl can be titrated safely in small doses of 25 to 50µg intravenously (IV), virtually eliminating the risk of chest muscle rigidity seen with high doses. Respiratory depression with fentanyl is dose-related, and patients should be monitored during titration.

Antibiotics

Antibiotics are indicated for multiple types of intra-abdominal pathology including appendicitis, cholecystitis, diverticulitis, perforated viscus, and severe pancreatitis. Pathogens include gram-negative and anaerobic bacteria. Nontoxic patients can receive a second-generation cephalosporin, whereas ill-appearing patients should receive broader coverage with a fourth-generation penicillin or a third-generation cephalosporin plus metronidazole. Penicillin-allergic patients can receive an aminoglycoside and metronidazole. The use of antibiotics for suspected ischemic bowel remains controversial. It should also be noted that the administration of antibiotics might, with time, obscure the presence of physical signs that would otherwise mandate immediate surgical intervention.

Disposition

Although one study demonstrated that the use of CT in the ED can safely reduce the number of hospital admissions for adult patients who have acute abdominal pain [25] , no study has looked specifically at this practice in the elderly population. The 2% false-negative rate that was observed might have been significantly higher in older patients, and the higher mortality and complication rates in the elderly also need to be considered. It therefore remains common practice to admit the vast majority of elderly patients who have abdominal pain. If no clear surgical emergency has been identified, a decision to admit the patient to a medical rather than a surgical service might be appropriate; however, it is recommended that surgical consultation be made and that the EP personally speak with a surgeon before transfer of the patient from the ED. The inpatient level of care should be based primarily on the nature and severity of comorbidities rather than the patient's age.

In the elderly patient who has a normal laboratory and radiographic evaluation, a benign physical examination, and resolution of pain, discharge with close follow-up care can be considered; however, such plans should be made cautiously and in consultation with the patient's primary physician and family. Caution should also always be exercised when elderly patients suddenly insist that all symptoms have disappeared—they might be frightened of the prospect of an operation, admission, or loss of autonomy.

Abdominal vascular emergencies

Ruptured and symptomatic AAA

Epidemiology

AAAs are rare before age 50, but they are found in 2% to 4% of the population older than age 50 with a reported prevalence of 5% to 10% in elderly men [26] . Risk factors include hypertension, coronary artery disease, peripheral vascular disease, and first-degree relatives who have aneurysms. Ruptured AAA is a common and preventable cause of death, accounting for 2% of all deaths in men over age 60 [27] . Heikkinen et al [28] found that the incidence of ruptured AAA in patients older than age 65 is 35.5/100,000 (compared with 440/100,000 for AMI), a figure that is expected to increase by 50% in the next two decades as the population ages. Mortality from ruptured AAA is extremely high, ranging from 77% to 88% [28] [29] [30] .

Presentation

Because ruptured AAA is almost exclusively a disease of patients over age 50, there are few studies that examine variations in presentation by age group. The classic triad of hypotension, back pain, and a pulsatile abdominal mass is present in only half of patients [31] . Atypical presentations are relatively common and include epigastric pain that radiates to the back, groin, or testes. As with subarachnoid hemorrhage, the pain might be severe, then resolve. Transient improvement in symptoms is fairly common, but it will be followed by hemodynamic deterioration if diagnosis and treatment are delayed [32] . Syncope followed by normalization of vital signs sometimes occurs because rupture might be initially contained within the retroperitoneum, thus limiting blood loss. Hypotension occurs in half to two thirds of patients, but it is a late finding that predicts a worse outcome [33] . The key is to consider ruptured AAA before the development of hypotension. It is important to note that the patient who has a ruptured AAA might occasionally have symptoms for several days or even weeks before seeking medical attention [34] .

In the physical examination of patients who have suspected AAA, the only maneuver of demonstrated value is abdominal palpation to detect abnormal widening of the aortic pulsation. Palpation of AAA appears to be safe and has not been reported to precipitate rupture [35] [36] . Despite the sometimes limited value of the physical assessment, there can be other clues to diagnosis.

The walls of AAAs are often lined with thrombus, which can embolize and occlude distal vessels. Large emboli can lodge in major vessels such as the iliac, femoral, or popliteal arteries, causing acute painful lower extremity ischemia with absent distal pulses. Rarely, the aneurysm thromboses, rendering the lower extremities acutely ischemic. Patients might also have complications caused by mechanical impingement on adjacent structures such as the ureters. Finally, an AAA might rupture into the GI tract (aortoenteric fistula), causing massive rectal bleeding. More often, however, rupture occurs into the vena cava

without leaking externally, and the signs and symptoms of a large arteriovenous fistula with high output failure dominate the clinical picture. In the latter case, the abdominal examination might also reveal a loud, continuous bruit.

Diagnosis

A high clinical suspicion for ruptured AAA is all that is necessary for the EP to initiate immediate surgical consultation. Delay of surgical intervention caused by the acquisition of confirmatory diagnostic tests is the biggest pitfall in the ED management of AAA. There are certain instances, however, when radiographic studies are appropriate. Bedside studies might be helpful in confirming the diagnosis. In addition, identification of a symptomatic AAA that has not yet ruptured is vital because perioperative cardiovascular morbidity is lower if repair is deferred until the underlying cardiac issues are addressed [36] .

US is 100% sensitive for detecting AAA provided that entire aorta is visualized [37] . Although US cannot definitively distinguish between asymptomatic and symptomatic aneurysms, its availability at the bedside in the unstable or potentially unstable patient makes it the modality of choice in the ED. In cases in which US is not available, a bedside abdominal radiograph can assist in the diagnosis, revealing calcification of an aneurysm, a soft tissue mass, or the loss of one or both psoas outlines [38] .

CT is also nearly 100% accurate in identifying AAA and any associated retroperitoneal hemorrhage associated with rupture. CT might be indicated in hemodynamically stable patients when it is unclear whether an AAA identified on US is the cause of symptoms or if alternative diagnoses appear to be more likely. In addition, CT can be useful in stable patients who have known AAA because it provides better anatomic detail for the surgeons as they plan their operative intervention. IV contrast is not essential in emergency situations because acute hemorrhage is well visualized on unenhanced scans [39] [40] . Nonetheless, hemodynamically unstable patients who have clinical features of ruptured AAA should never be transported to the CT scanner but should instead proceed directly to the operating room.

Because CT cannot exclude aneurysm rupture with 100% certainty, patients who have AAA and a lingering suspicion of rupture should proceed to surgery or undergo MRI [41] , depending on their condition and the preference of the consulting surgeon. Angiography is helpful in establishing the diagnosis of aortic dissection, but it has no role in the emergent evaluation of the suspected ruptured AAA.

ED management

Although the patient who has a ruptured AAA can present with hypovolemic shock, exsanguination is the exception rather than the rule because of clotting and the

tamponade effect of bleeding into the retroperitoneum. As long as the patient is conscious and has adequate peripheral perfusion, euvolemic resuscitation should be deferred until the patient has been transported to the operating room. Increasing blood pressure without control of the aneurysm might lead to loss of retroperitoneal tamponade with further bleeding, profound hypotension, and death [42] . To maintain adequate cerebral and myocardial perfusion, a target blood pressure of 90 to 100 mm Hg systolic has been suggested, but it might vary in individual patients [43] . Normal saline is the initial fluid of choice, and at least 10 units of blood should be made available because patients who have ruptured AAAs have large transfusion requirements [44] .

Prognosis

Ruptured AAA is uniformly fatal unless treated surgically. Age alone cannot be used to justify withholding definitive operative intervention. In a series of 258 patients admitted for AAA, the mortality among patients over the age of 80 was not significantly different from that among younger patients (51% versus 48%) [45] [46] ; however, surgery might not be appropriate or reasonable when a patient's life expectancy is extremely short and the patient's quality of life is poor because of underlying illness [47] .

AMI

Classification and epidemiology

AMI encompasses four conditions: arterial embolism (50%), arterial thrombosis (15%), nonocclusive mesenteric ischemia (20%), and venous thrombosis (15%) [48] . Acute mesenteric ischemia is an intra-abdominal catastrophe that is almost as lethal today as it was 50 years ago, with a mortality rate ranging from 59% to 93% in various series [49] . The superior mesenteric artery, which originates from the ventral surface of the abdominal aorta at a 45° angle, is the vessel most commonly implicated. This vessel supplies the distal duodenum, jejunum, ileum, and colon to the splenic flexure. The larger celiac artery, which supplies the stomach and duodenum, is rarely affected by ischemic events.

The median age of patients presenting with mesenteric arterial emboli is 70 years. Embolism occurs in an older subset of patients than thrombosis (74 versus 63 years) and is more often associated with atrial fibrillation (50% versus 11%) [50] . Causes of nonocclusive AMI include low-flow states (eg, cardiogenic shock, pancreatitis, sepsis, hypovolemia), mechanical obstruction (eg, strangulated hernia, adhesive bands, intussusception), trauma, dissection, medications (eg, vasoconstrictive agents), and previous aortic surgery. Nonocclusive AMI is also seen after dialysis [51] .

Presentation

The classic presentation of AMI consists of acute abdominal pain and GI emptying occurring in the presence of heart disease. Many types of cardiovascular disease are associated with AMI including cardiomyopathy, valvular disease, and generalized atherosclerosis. Atrial fibrillation, the associated condition that most clinicians are familiar with, is present in less than 50% of patients [50] . Although abdominal pain is typically described by the patient as severe, the abdomen usually is soft, flat, and nontender early in the disease course before the parietal peritoneum is involved.

In a 10-year review of AMI cases at the Mayo Clinic, Park et al documented the relatively high frequency of nausea (44%), vomiting (35%), and diarrhea (35%) [50] . The prevalence of these symptoms should make the EP extremely cautious about making the diagnosis of gastroenteritis in the elderly, especially when it is accompanied by sustained abdominal pain. It should be noted that heme-occult positive stools occur in only 25% of patients.

Intestinal necrosis can develop as early as 10 to 12 hours after the onset of pain. As necrosis develops, abdominal findings become more prominent. The presence of rebound tenderness or guarding is strong evidence for bowel necrosis. Fever, rectal bleeding, hematemesis, increasing abdominal distention, and shock are other ominous signs occurring later in the disease course. Mental confusion has been reported to develop in 30% of elderly patients who have AMI [52] .

Diagnosis

The importance of rapid diagnosis was highlighted by a report from Madrid on 21 patients who had superior mesenteric artery embolus. In this series 100% of patients had continued intestinal viability if the duration of symptoms was less than 12 hours, in contrast to only 18% if symptoms were present for greater than 24 hours before a diagnosis was established [153] . Neither physical examination nor ancillary studies are adequately sensitive to provide a definitive diagnosis, so emergent surgical consultation is indicated based upon history alone.

The leukocyte count is greater than 10,500 cells/mm^3 in 98% of patients who have a mean of 20,300 cells/mm^3 [50] . Although the lactate level is elevated in nearly 100% of patients who have bowel infarction [53] [54] , it is unclear how useful this test is with ischemic but viable bowel. A normal lactate level does not rule out AMI and should never deter the EP from ordering more definitive studies [55] .

Plain films might reveal ileus, thumbprinting, or intramural air, but these are generally late signs (Fig. 1). Survival mandates that the EP not wait for the development of definite physical signs (peritonitis) or radiologic abnormalities before making a presumptive diagnosis and initiating care. Such waiting would be equivalent to waiting for ischemic but viable bowel to infarct. The dangers of a delayed diagnosis always outweigh the risk of early invasive studies in patients who are suspected of having ischemic bowel, which

is illustrated by the fact that patients who have AMI and normal abdominal radiographs have a mortality rate of 29%, whereas patients who have abnormal plain radiographs, indicating later-stage disease, have a mortality rate of 78% [50] .

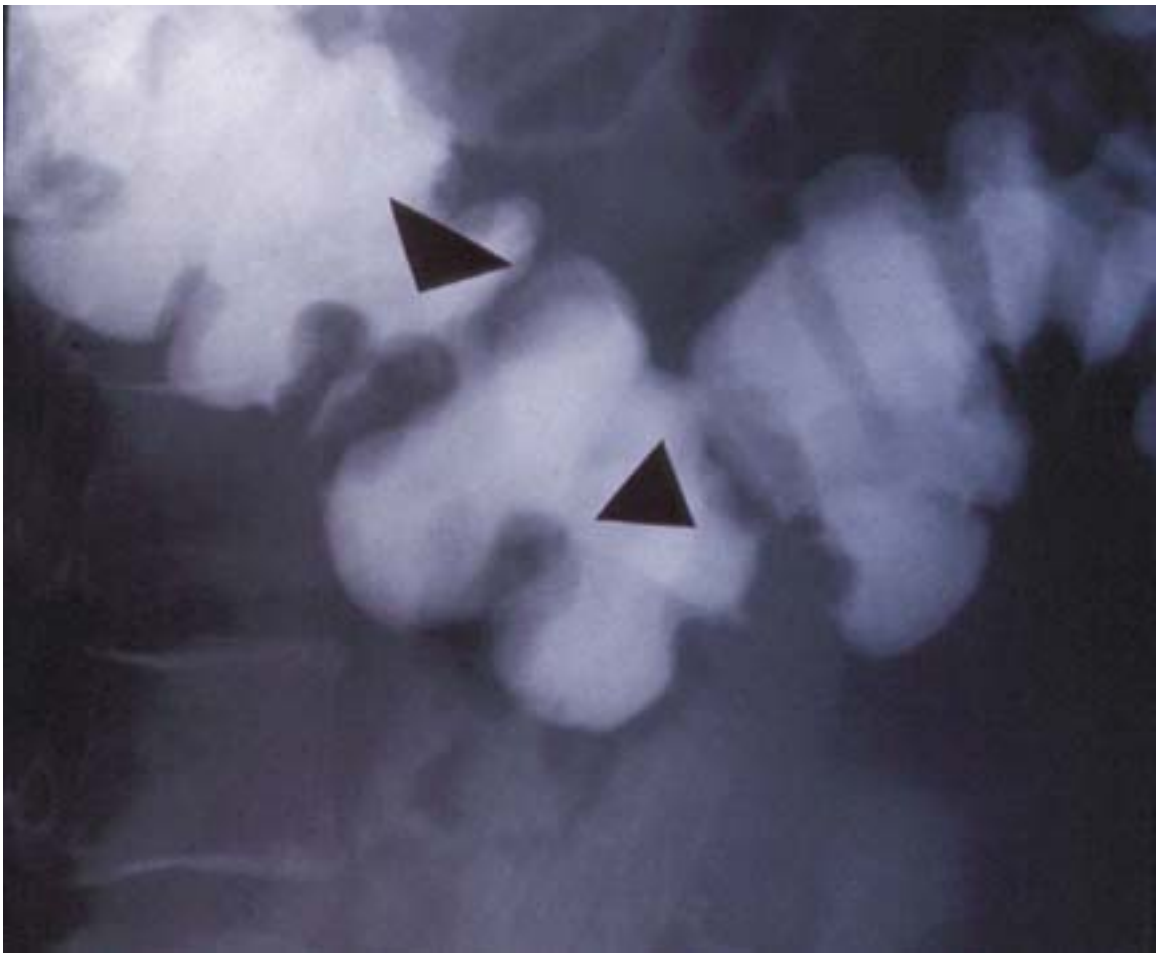

Fig. 1. Thumbprinting in patient who had superior mesenteric vein (SMV) thrombosis and bowel ischemia.

Although it is not considered to be the gold standard, patients will often undergo CT early in their diagnostic evaluation. CT might reveal various abnormalities including arterial or venous thrombosis, intramural gas (Fig. 2), portal venous gas, focal lack of bowel wall enhancement, and liver or splenic infarcts. Each of these findings in isolation has a specificity of more than 95% but a sensitivity of less than 30%. The combined sensitivity of these signs is 64% with a specificity of 92% [56] . Klein et al report a slightly better sensitivity of 82% [57] .

Fig. 2. Pneumatosis intestinalis. CT shows intramural gas in bowel wall caused by bowel infarction from superior mesenteric artery embolus.

Angiography remains the gold standard imaging modality. Angiography allows for identification of the site and type of occlusion and evaluation of the splanchnic circulation, thus facilitating plans for prompt revascularization. Additionally, angiography provides a definitive diagnosis in cases of nonocclusive mesenteric ischemia.

Although EPs are often reluctant to contact an interventional radiologist, angiography is appropriate in the vasculopathic patient who has severe, unremitting abdominal pain of sudden onset in the absence of peritoneal signs or an alternative diagnosis [58] . If the patient has a history of venous thromboembolism, CT might be performed first because its sensitivity for mesenteric vein thrombosis is higher. It is also important to note that the utility of angiography is limited in the setting of shock or vasopressor therapy [59] . In these instances, diagnosis during laparotomy is preferred.

Exploratory laparotomy or laparoscopy remains the gold standard for the determination of bowel viability. Bowel viability is assessed by inspection, palpation, hand-held Doppler scan examination, and with IV injection of fluorescein [50] .

ED management

When AMI is suspected, resuscitation and replacement of fluid losses should precede any diagnostic studies. There are several pitfalls in the resuscitation of these patients. The use of vasopressors for shock before adequate volume resuscitation will only worsen ischemia. Digoxin also acts as a direct splanchnic vasoconstrictor and should also be avoided. Broad-spectrum antibiotics are commonly administered to patients who have suspected mesenteric ischemia, although no randomized prospective clinical studies support their use.

In addition to its diagnostic role, angiography can be used therapeutically. For example, infusion of papaverine through the angiography catheter directly into the superior mesenteric artery reduces or eliminates vasoconstriction. Papaverine is a potent inhibitor of phosphodiesterase, the enzyme necessary for degradation of cyclic adenosine monophosphate (cAMP). Increased cAMP levels cause vascular smooth muscle relaxation and relief of vasoconstriction. Because cAMP is almost completely metabolized by the liver by first-pass metabolism, few (if any) systemic effects are noted during its use. Use of papaverine in nonocclusive and occlusive forms of mesenteric ischemia has improved survival substantially [60] , and preoperative angiography is believed to improve outcome [61] ; however, if a patient starts to manifest signs of shock while undergoing angiography, the use intra-arterial vasodilators such as papaverine is contraindicated because these agents might precipitate a further drop in blood pressure.

Although catheter-infused vasodilators and thrombolytic agents have been used in selected cases, the definitive treatment of superior mesenteric artery embolus remains arteriotomy and surgical embolectomy of the superior mesenteric artery. “Second-look” explorations within 24 to 72 hours after the initial laparotomy are also commonly performed to re-assess for progression of bowel ischemia and necrosis.

Prognosis

The 30-day mortality from AMI in one large series was 32%, with a worse prognosis in the subset of patients who had nonocclusive disease. Multiorgan failure was the most frequent cause of death [50] .

The mean duration of pain before hospital admission for patients who have mesenteric vein thrombosis (MVT) is longer than with other forms of AMI, often lasting up to several days or even 1 month before a diagnosis is made [62] . Most patients present with fever and abdominal tenderness.

Contrast-enhanced CT is diagnostic for MVT in more than 90% of cases [63] [64] . Common findings include a visible thrombus within the superior mesenteric vein, thickening of the bowel wall, and collateralization of blood flow. CT is also preferred over angiography in suspected cases of MVT because of the absence of therapeutic benefit from angiography in this condition.

Treatment of MVT hinges largely on the presence or absence of peritoneal signs.In the absence of peritoneal signs, some patients can be managed adequately with anticoagulation and careful clinical observation. In patients who have signs of peritonitis, laparotomy is indicated and segments of nonviable bowel are resected. Surgery is then followed by prompt anticoagulation [65] . The mortality rate of MVT is lower than that encountered in other forms of mesenteric ischemia, varying from 2% to 50%.

GI and biliary tract emergencies

Bowel perforation

Epidemiology and etiology

Bowel perforation occurs in all age groups but is more common and more lethal in the elderly. The overall mortality rates for bowel perforation are less than 10% in the general population [66] , but in the elderly this rate rises to 30% [67] . For all patients, a delay in diagnosis of more than 12 hours doubles the mortality, and after 24 hours mortality increases eight-fold. Tolerance to this delay is inversely proportional to age [68] . Patients over age 65 are also more likely to have a prolonged stay in the hospital [69] [70] .

The most common cause of bowel perforations is peptic ulcer disease (50%). The average age of a patient who has a perforated gastroduodenal ulcer has increased from 41 to 62 years over the last 50 years, which has been attributed to the increased incidence of *Helicobacter pylori* in the elderly and the more frequent use of nonsteroidal anti-inflammatory drugs (NSAIDs) [71] . Colonic diverticular or neoplastic perforations are also responsible for a large number of cases, with the large bowel being the most common site [72] .

Presentation

The classic presentation of perforated viscus is sudden onset of sharp, severe abdominal pain. The patient typically lies motionless but in obvious distress. Tachypnea and tachycardia are early findings. Hypotension and fever develop 4 to 6 hours into the illness. Examination in young, immunocompetent patients typically reveals diffuse peritonitis with a characteristic “board-like” abdomen. In elderly patients who have bowel perforation, the symptoms and signs are often minimal or even seemingly unrelated [73] . Elderly patients might present with nonspecific complaints and findings such as confusion, restlessness, abdominal distention, or a fall. In patients suffering from

dementia, there might be no complaints at all [73] [74] [75] . As a result, these patients are at extremely high risk for delayed or missed diagnosis and death [76] .

Diagnosis

The diagnosis of bowel perforation centers on the identification of free intraperitoneal air on imaging studies. The upright chest radiograph (CXR) reveals pneumoperitoneum in approximately 70% of cases [77] . The location of the perforation affects the likelihood of detecting pneumoperitoneum. The finding of free air is more likely in gastroduodenal perforations (69%) than with those of the distal small or large bowel (30% and 37%, respectively). In patients who are unable to tolerate an upright CXR, a left lateral decubitus film can be used. If the upright CXR does not demonstrate free subdiaphragmatic air, three simple maneuvers might be diagnostic and obviate the need for CT, which might result in diagnostic delay. First, an upright lateral CXR can be obtained, which is significantly more sensitive for pneumoperitoneum than the more commonly ordered posteroanterior view [78] . In addition, the upright CXR can be repeated after the patient has been sitting upright for 10 minutes. Another useful technique is to insert a nasogastric tube and inject 50 mL of air or water-soluble contrast. The sensitivity of CT scan for pneumoperitoneum approaches 100%. Although CT is excellent at detecting free air, it is less sensitive for determining the presence or location of the perforation (65%) [79] .

ED management

The three critical interventions in the treatment of acute peptic ulcer perforation are antibiotics, nasogastric tube suction, and surgical repair. Antibiotic selection is directed primarily at *Escherichia coli* and *Bacteroides fragilis*. Fourth-generation penicillins or a third-generation cephalosporin plus metronidazole are alternatives to the once-popular “triple” regimen of ampicillin, an aminoglycoside, and metronidazole or clindamycin. Aminoglycosides are significantly more nephrotoxic than third-generation cephalosporins, are inefficient in the low pH level of the infected peritoneum, and are no longer the initial antibiotics of choice in the treatment of intra-abdominal infection [80] .

Enterococcus, which is frequently isolated in peritonitis, is usually clinically insignificant in the setting of bowel perforation except for its role as a cofactor for *B fragilis* in the formation of abscesses. Thus, ampicillin is not required as long as anaerobes are covered adequately with metronidazole or clindamycin [81] .

Although the nonoperative management of perforated peptic ulcer was shown in a randomized, controlled trial to have identical mortality to surgical treatment, patients over age 70 were less likely to respond to conservative treatment [82] . When surgery is pursued, elderly patients are more likely to receive an omental patch repair rather than

definitive gastrectomy or vagotomy [83] . Laparoscopic surgery for perforated peptic ulcer has failed to show a significant advantage over open technique [84] .

Biliary tract disease

Epidemiology

Biliary tract disease is the most common surgical cause of acute abdominal pain in the elderly and accounts for approximately one third of all abdominal operations in this population. The incidence of acute cholecystitis in elderly patients who have abdominal pain ranges from 12% to 23% [85] . The elderly are also more likely than their younger counterparts to present with serious complications such as gangrenous cholecystitis, emphysematous cholecystitis, and gallbladder perforation. Septic complications increase in parallel to increases in age [86] . One large series of elderly patients who had acute surgical disease of the biliary tract consisted of uncomplicated cholecystitis (80%), gangrenous cholecystitis (7%), empyema of the gallbladder (6%), gallbladder perforation (3%), and emphysematous cholecystitis (0.5%) [87] .

Presentation and diagnosis

The initial challenge in assessing patients who have biliary tract disease is distinguishing between biliary colic and cholecystitis. The presentation of acute cholecystitis in the elderly is commonly subtle. Parker et al found that 56% of patients over age 65 were afebrile on presentation, 84% had neither localized epigastric nor right upper quadrant abdominal pain, and 5% had no pain whatsoever [88] . The abdominal examination is also unreliable. Murphy's sign in the elderly has a sensitivity of 48% [89] , compared with a sensitivity of more than 90% in the general population. Mild jaundice is present in 20% of all patients and in 40% of the elderly. The jaundice is often subtle, with bilirubin concentrations of less than 4 mg/dL [90] . Bilirubin concentrations above this level suggest the possibility of common duct stones.

Charcot's triad, consisting of right upper quadrant pain, jaundice, and fever, is associated with acute cholangitis. The additional features of mental confusion and hypotension (Reynold's pentad) are more common in late and severe presentations, which are typical in the elderly.

Although US is the imaging modality of choice for biliary disease, there remains a role for the radionuclide (HIDA) scan for patients who have a negative US examination and a high clinical likelihood for acute cholecystitis. The elderly are predisposed to acalculous cholecystitis, which is not as readily identified on US (67% sensitivity) as is calculous cholecystitis [91] . A negative HIDA scan might thus be useful in excluding cholecystitis. HIDA produces a substantial number of false-positive results in acalculous disease. CT is not as sensitive as US for the detection of acute cholecystitis, but it is an important tool in

septic patients to rule out suspected complications such as emphysematous cholecystitis or gallbladder perforation.

ED management

Treatment for acute cholecystitis and its complications begins with fluid resuscitation, analgesia, antimicrobial therapy, and surgical consultation. Analgesics for biliary pain include NSAIDs and opiates. Although recent studies have found a comparable efficacy between the two groups [92] [93] , opiates might be safer in elderly patients because the lack of renal and GI mucosal effects. A second-generation antibiotic is ideal for mild cholecystitis, but patients who have significant signs of sepsis should receive a fourth-generation penicillin or a third-generation cephalosporin plus clindamycin or metronidazole.

Elderly patients who require emergency cholecystectomy tend to do poorly when compared with their younger cohort. The reported mortality rate for emergency cholecystectomy in elderly patients older ranges from 4% to 12% [94] [95] [96] [97] . The decision to perform laparoscopic versus open cholecystectomy is surgeon-dependent. At the authors' institution, the majority of elderly patients are started with laparoscopic cholecystectomy then converted intraoperatively to open procedures when necessary. Recent studies in elderly patients have shown that laparoscopy results in shorter hospital stays by approximately 4 days, but morbidity and mortality results are conflicting [98] [99] . Patients who have obstructive jaundice should undergo laparoscopic duct exploration or have an endoscopic retrograde cholangiopancreatography procedure with a sphincterotomy.

Acute pancreatitis

Acute pancreatitis (AP) is a potentially fatal disease with a mortality of 5% to 10%. The incidence and mortality rate of AP increases considerably with age [100] , with a reported mortality rate of 19% in patients over age 70 [101] . Furthermore, in patients over age 80 the incidence of necrotizing AP and death are markedly higher [102] . Older individuals suffer more often from gallstone-related AP, whereas alcohol-induced pancreatitis occurs in a minority of cases [103] .

Serum lipase is at least equally sensitive and is more specific than serum amylase in AP; however, it is particularly important to note that mild elevations of amylase in the elderly patient might be indicative of a more sinister process such as mesenteric ischemia or bowel perforation. A CT scan is sometimes indicated in the older patient in the setting of suspected AP. CT might identify an alternate surgical diagnosis in patients in whom there is no elevation or only mild elevation of pancreatic enzymes. When signs consistent with sepsis are present, CT also might identify pancreatic necrosis, which places patients at risk for deterioration. Patients who have extensive hemorrhage and necrosis should

receive prophylactic antibiotics and be admitted to an intensive care setting. Surgical intervention might also be required in these cases, so surgical consultation from the ED is advisable.

Specific treatment for most cases of AP is still lacking. Supportive care includes IV fluids (using vital signs and urine output to judge the adequacy of volume replacement), parenteral analgesia with opiates, and bowel rest. Ionized calcium and magnesium levels should be checked before initiating replacement therapy. If the magnesium level is low, its replacement will frequently raise the calcium level. If there is true hypocalcemia, treatment with calcium gluconate is appropriate.

Bowel obstruction

Epidemiology

Bowel obstruction is one of the most common causes of abdominal pain in the elderly (12–25%) [10] [104] and is second only to biliary disease as an indication for emergency abdominal surgery in this age group. The etiology of small bowel obstruction (SBO) is predominantly surgical adhesions (50–70%) followed by incarcerated hernias (15%) and neoplasms (15%). Hernias are extremely important to recognize in the elderly because this group has a high rate of strangulation and bowel infarction. Obturator hernia is a rare cause of obstruction that typically occurs in emaciated elderly women who have significant concomitant medical illness but no previous abdominal surgery. Gallstone ileus is rare in the general population but accounts for as many as 25% of nonstrangulated SBOs in patients over the age of 65 [105] .

Overall, large bowel obstruction (LBO) is much less common than SBO; however, proportionately more cases of LBO are seen in the elderly because its most common underlying causes, diverticulitis and carcinoma, increase in incidence with age. Sigmoid and cecal volvuluses account for a minority of cases of LBO but are more likely to require emergent surgical intervention.

Presentation

The key question to answer from a management perspective when evaluating an elderly patient who has bowel obstruction is whether or not strangulation or closed-loop obstruction is present. These types of obstruction require immediate surgical intervention, whereas a simple obstruction can be treated with nasogastric tube decompression and inpatient observation after surgical consultation. There are various historical and physical examination findings that help differentiate between the two.

The typical symptoms of bowel obstruction include crampy abdominal pain followed by constipation, obstipation, and vomiting; however, patients might present with diarrhea because hyperperistalsis distal to the obstruction evacuates all remaining stool. With

prolonged obstruction, the cramping pain subsides as distention of the bowel begins to inhibit motility. Closed-loop obstructions and volvulus are associated with a sudden onset of severe, unremitting abdominal pain, and a change in the description of the pain from intermittent and colicky to constant and severe might signal strangulation or perforation.

The presence of fever and signs of shock, particularly when they are unresponsive to volume repletion, suggest the presence of strangulated bowel. Likewise, abdominal tenderness with guarding or other evidence of peritonitis suggests the presence of a strangulated obstruction and necessitates emergent surgical consult. Closed-loop obstructions can also present with pain out of proportion to the physical findings, much like that of acute mesenteric ischemia. In the setting of bowel obstruction, occult rectal bleeding suggests the presence of mucosal ulceration, which might be the result of intestinal ischemia. The presence of a tender mass at the inguinal femoral triangle or in the abdominal midline strongly suggests hernia as the cause of obstruction; associated erythema is ominous for strangulated bowel. Physical examination alone cannot completely exclude strangulation [106] .

Plain films demonstrate the presence of SBO in 60% to 75% of cases, with a specificity of 50% to 60% [107] [108] . Plain film findings suggestive of a complete bowel obstruction include abnormal gaseous distension and differential air–fluid levels (two levels at different heights seen in the same loop of intestine) [109] [110] . Volvulus appears on plain abdominal films as dilated colon that arises from the left lower quadrant and is directed toward the right side (sigmoid volvulus) or originates from the right lower quadrant and is directed toward the left side (cecal volvulus) [111] .

CT is a superior test to diagnose and exclude high-grade or complete obstruction. It has a sensitivity of 82% to 100% [112] [113] and a specificity of 70% to 94% [114] . Another benefit of CT is its ability to determine the location and cause of obstruction. CT can detect a hernia that was not detected on examination. It might also detect acute appendicitis, which might present as acute bowel obstruction in up to 45% of elderly patients [115] , and CT is helpful in identifying this process. CT can also identify whether or not bowel is strangulated with a sensitivity of 83% to 100% and a specificity of 61% to 93% [116] [117] . When there is any suggestion of strangulation in an elderly patient who has a bowel obstruction, CT and surgical consultation should be obtained from the ED.

ED management

Early surgical intervention in acute SBO has long been recognized as an important factor in preventing morbidity and mortality. Although patients who have nonspecific bowel obstructions are sometimes admitted to medical services, there is recent evidence that suggests that these patients might experience additional delays when surgery becomes necessary, thus resulting in a higher mortality [118] . In the event that the patient is admitted for observation into a medical service, surgical consultation should be obtained before admission.

The conservative management of adhesive obstruction with IV fluids, nasogastric suction, and bowel rest remains controversial. Most patients who have the diagnosis of bowel obstruction receive an initial trial of such nonoperative therapy unless there is suspicion of bowel strangulation; however, the optimal duration of this trial is not clear [119] [120] [121] .

With sigmoid volvulus, treatment depends on whether or not there is evidence of strangulation. For nonstrangulated volvulus, detorsion by sigmoidoscopy and rectal tube application is usually effective as an initial therapy; however, emergency or elective sigmoid resection is the most effective definitive treatment [122] . Cecal volvulus is treated surgically.

Appendicitis

Epidemiology

Appendicitis is a frequent disease in the elderly, accounting for 5% of all abdominal surgical emergencies in this population. While 7% of individuals in the general population will develop appendicitis in their lifetime, 10% of cases occur in persons over the age of 60 [123] . The prognosis of uncomplicated appendicitis is comparable between young and old patients, but perforation and concomitant diseases worsen the situation appreciably. The elderly have a high rate of complications, usually as a result of perforation, which occurs at a rate of 53% to 89% [124] [125] . Lee [123] found that aged patients have a greater rate of mortality than younger adults (2.3% versus 0.2%). Fifty percent of deaths related to appendicitis occur in persons over the age of 65 [126] . These numbers give the EP reason to be especially aggressive in pursuing this diagnosis in older patients who have abdominal pain. While some authors have speculated that the higher rates of perforation in the elderly result from age-related changes in immune defenses, mesenteric blood supply, and weakening of the appendiceal tissue, it equally likely that it is a result of delayed diagnosis and surgery.

Presentation

Only 20% of elderly patients who have appendicitis present with the classic symptoms and findings of anorexia, fever, right lower quadrant pain, and an elevated WBC count [127] . As in all age groups, appendicitis in the elderly demonstrates a wide variation in its presentation, both in the localization and description of pain and the associated symptoms [128] [129] [130] [131] . Moreover, in the elderly patient atypical presentations are more likely and more subtle. An improvement of pain, especially when accompanied by an alteration of vitals signs, should alert the EP to the possibility of rupture. Because elderly patients might have a diminished response to peritoneal irritation, there is a possibility that the patient might paradoxically appear to have improved.

On physical examination, vital signs are often normal. The elderly have an age-related inability to mount a fever or leukocytosis [132] . Only one third of elderly patients have a fever on presentation [123] , so a rectal temperature should be obtained, which can detect a mild temperature elevation more reliably than an oral or axillary temperature. Rectal examination adds little additional information in the diagnosis of appendicitis.

Because there is a higher rate of urinary tract infection (UTI) in the elderly, the EP is cautioned that appendicitis can masquerade as UTI when inflammation adjacent to the ureter produces the finding of hematuria or pyuria. If urine results are equivocal or the patient has abdominal pain that appears to be inconsistent with UTI, it is wise to obtain further imaging studies to rule out a surgical diagnosis.

Diagnosis

Although plain abdominal films are often useful in the elderly patient, a finding of ileus or bowel obstruction might further delay the diagnosis when these findings occur as a result of underlying appendicitis [127] . As noted previously, 45% of patients over the age of 70 who have appendicitis present with an acute bowel obstruction [115] .

CT of the abdomen and pelvis with oral and IV contrast is 98% sensitive in the diagnosis of acute appendicitis [133] . Although the use of CT as a confirmatory test before operation has doubled in the past decade, no improvement in outcome has been demonstrated with this practice [134] ; however, Balthazar [135] showed that the use of CT resulted in a substantial decrease in the negative appendectomy rate (4%) compared with previously published reports (15–20%) without incurring an increase in the rate of perforation.

ED management

When appendicitis is diagnosed or suspected, prompt surgical consultation is the main goal of the EP. Antibiotic prophylaxis covering gut flora is indicated because evidence suggests that it decreases postoperative complications [136] . A second-generation cephalosporin is commonly employed. There is no difference in the rate of postoperative intra-abdominal abscesses between laparoscopic and open appendectomy for **perforated appendicitis**; however, wound infections and ileus are less common after laparoscopic appendectomy. The conversion of laparoscopic to open appendectomy for **perforated appendicitis** is associated with increased postoperative morbidity [137] .

Diverticulitis
Epidemiology and classification

There is an increase in the prevalence of colonic diverticular disease with advancing age [138] . The incidence is at least 50% in persons over the age of 70 and more than 80% in

patients over the age of 85 [139] . Explanations for this include incidence a low-fiber diet, lack of physical exercise, and increased longevity. While there is a high percentage of elderly patients who have diverticula, only about 20% suffer from one of the complications, including diverticulitis, obstruction, hemorrhage, and perforation.

Because virtually all cases of diverticulitis involve some degree of perforation of the bowel wall, confusion arises surrounding the term “perforated diverticulitis,” which is best reserved for cases in which a peridiverticular abscess has ruptured into the peritoneal cavity, causing purulent peritonitis. The scheme devised by Hinchey et al [140] is useful for classifying the severity of the inflammatory complications of diverticular disease. Stage I patients have small, confined pericolonic abscesses, whereas patients who have stage II disease have larger collections. Stage III patients have generalized suppurative peritonitis, and fecal peritonitis is categorized as stage IV. Eighty-five percent of cases of diverticulitis occur in the sigmoid and descending colon.

Presentation

The abdominal pain of diverticulitis usually begins in the hypogastrium then localizes to the left lower quadrant. The majority of patients have left lower quadrant pain (93–100%), fever (57–100%), and leukocytosis (69–83%) [141] . There might also be alterations in bowel habits with diarrhea occurring more frequently than constipation. Up to one quarter of patients who have diverticulitis have hemepositive stools. Dysuria and urinary frequency and urgency might occur if the affected colonic segment lies close to the urinary bladder. Afferent visceral nerves from the inflamed colon, by way of the sacral plexus, might also carry referred pain to the penis, scrotum, or suprapubic region, which might produce intense pain associated with nausea and vomiting.

Differential diagnosis

In addition to carcinoma and appendicitis, the differential diagnosis of diverticulitis includes small bowel obstruction, incarcerated hernia, acute mesenteric ischemia, cystitis, leaking AAA, epididymitis, prostatitis, and kidney stones. In elderly women the differential diagnosis includes ovarian cysts and tumors [142] .

Complications

There are four primary complications of diverticulitis: (1) abscess, (2) free perforation with purulent or fecal peritonitis, (3) fistula, and (4) obstruction. Free perforation occurs more commonly in elderly and immunosuppressed populations and carries a high rate of mortality (6.1–25.7%) [143] . Generalized peritonitis often results from rupture of a diverticular abscess and presents as an acute surgical abdomen.

Diverticular abscesses can lead to fistula formation between the colon and surrounding structures (colovesical, colovaginal, colocutaneous, coloenteric). This progression occurs in approximately 10% of patients at some time during the disease course. Colovesical fistulas are the most common variety. They occur more commonly in men than in women because the uterus is interposed between the colon and bladder. Fistulae also can form between the colon and any structures with which the diverticula come into contact, including the vagina, skin, small bowel, other diverticula, and, less commonly, the ureter and fallopian tubes. Symptoms associated with a colovesical fistula can include urinary frequency, dysuria, pyuria, and the classic symptoms of pneumaturia and fecaluria.

Intestinal obstruction is an uncommon complication of diverticular disease and occurs in approximately 2% of cases. SBO, which is more frequent than colonic obstruction, occurs when loops of bowel are entangled in the peridiverticular adhesions that result from recurrent episodes of inflammation. Partial colonic obstruction can occur during an attack of acute diverticulitis because of the relative luminal narrowing resulting from pericolic inflammation or compression by an abscess. Although complete colonic obstruction is unusual, recurrent attacks of acute diverticulitis, which might be subclinical, can initiate progressive fibrosis and stricturing of the colonic wall.

Diagnostic imaging

Evidence-based guidelines for the management of sigmoid diverticulitis indicate that no imaging studies are necessary when the diagnosis is clear-cut [145] ; however, more liberal use of plain abdominal films is warranted in elderly patients because of their predilection for free perforation and obstruction. CT should be reserved for cases in which the diagnosis is uncertain or when clinical deterioration occurs [144] [145] [146] . When performed with oral and IV contrast (but not by the rectum because of the risk of iatrogenic perforation), CT has a sensitivity of 69% to 95% and a specificity of 75% to 100% for diverticulitis [147] . The two most frequent signs of diverticulitis are bowel wall thickening (96%) and fat stranding (95%) [148] . CT also detects complications including free air (16%), abscesses (4%), and phlegmons (4%). The most specific signs are wall thickening, free fluid, and diverticula [148] .

US might have a role in diagnostic evaluation and is especially useful to rule out the presence of AAA. Characteristic sonographic findings in diverticulitis include hypoechoic bowel wall thickening, visualization of diverticula or abscesses, and hyperechogenicity surrounding the bowel wall, implying active inflammation. One prospective study reported the sensitivity and specificity of US to be 84% and 93%, respectively [149] .

ED management

When the diagnosis of diverticulitis can be made confidently by clinical examination, it is reasonable to begin empiric treatment immediately. Patients who have mild symptoms who can tolerate oral fluids can be treated on an outpatient basis with a liquid diet and a 7- to 10-day course of oral antibiotics. Several antibiotic regimens have been recommended including amoxicillin/clavulanic acid, sulfamethoxazole/trimethoprim, and metronidazole, or a quinolone with metronidazole. Resolution of symptoms should occur within 2 to 3 days, and close follow-up care and re-examination must occur within this time frame [146] [150] . Lack of improvement with medical management might indicate a peridiverticular abscess.

If the patient is unable to tolerate oral fluids or pain is severe enough to require narcotic analgesia, admission to the hospital is appropriate. Admission is also appropriate in “very old” patients (> 85 years), patients who have significant comorbid illness or signs of sepsis, or when adequate home support or outpatient follow-up care is not available [151] . Inpatient therapy consists of IV antibiotics to cover gram-negative and anaerobic organisms and bowel rest.

Most patients hospitalized with acute diverticulitis respond to conservative medical therapy, with a minority (15–30%) requiring surgery or other intervention. In patients who have large peridiverticular abscesses (> 5 cm), the use of CT-guided percutaneous drainage as the initial therapeutic maneuver in conjunction with adequate antibiotic coverage has been reported to be effective [153] . Nevertheless, the presence of generalized peritonitis, uncontrolled sepsis, visceral perforation, and acute clinical deterioration are indications for laparotomy and emergency colonic resection. Laparoscopic resection can also be considered in elderly patients [152] .

Summary

The evaluation of abdominal pain can be considerably more challenging in elderly patients. A higher likelihood of life-threatening pathology combined with a myriad of diagnostic pitfalls in this population mandate a more cautious approach with greater use of diagnostic resources and specialist consultation.

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