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Intraabdominal Infections in Older Adults

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**KEYWORDS**
- Acute abdomen • Atypical presentation • Intraabdominal infection
- Geriatric surgery • Frailty • Surgical outcomes

**KEY POINTS**
- Intraabdominal infections may be confined, localized, or diffuse.
- Compared with younger patients, elderly patients with intraabdominal infection tend to present in delayed or atypical fashion and have a narrow therapeutic window, both of which are associated with significantly increased morbidity and mortality.
- Treatment of intraabdominal infections is based on source control and judicious use of antibiotics. In elderly patients, this requires a balanced approach, taking into consideration the invasiveness and inherent risk of a procedure as well as its efficacy for producing the desired outcomes.
- Multimodal and aggressive preventative management of geriatric syndromes and collateral damage of diagnostic and therapeutic interventions decreases the risk of adverse outcomes in geriatric acute-surgery patients.

**GENERAL PRINCIPLES**

Intraabdominal infections are a leading cause of illness in the elderly population.\textsuperscript{1} The pillars of treatment of any intraabdominal infection are antibiotics and source control (drainage or removal of the infecting agent when possible). To appropriately choose and direct therapy, it is helpful to classify intraabdominal infections according to their anatomic extent and recognize the patterns of presentation typical for each category. Perhaps most important, it is important to recognize the unique presentation of intraabdominal infections in the elderly patient and understand the outcomes of available management options in the geriatric population.

**Anatomic Classification**

Intraabdominal infections can be broadly classified as localized or diffuse. Localized infections may be solely confined to an organ or hollow viscus (eg, uncomplicated...
cholecystitis or *Clostridium difficile* colitis), producing localized symptoms. Additionally, these localized infections may create systemic effects (eg, severe cholangitis or fulminant *C difficile* colitis) or, with rupture or progression of local infection, may create a colocalized abscess. Diffuse intraabdominal infections, on the other hand, extend throughout the peritoneal cavity. Peritonitis may be primary, as in the case of spontaneous bacterial peritonitis; secondary, as in the case of perforated appendicitis or diverticulitis with diffuse peritoneal purulence or spillage of enteric contents; or tertiary, which represents incompletely eradicated or recurrent secondary peritonitis. Elderly patients are especially susceptible to tertiary peritonitis due to their decreased physiologic reserve and prevalence of malnutrition. Whereas primary and secondary peritonitis are predominantly associated with normal enteric flora (*Escherichia coli*, *Bacteroides fragilis*, and *Streptococcus* species), the pathogens responsible for tertiary peritonitis include frequently resistant nosocomial and opportunistic organisms such as *Pseudomonas aeruginosa*, multidrug-resistant *Klebsiella* and *Enterobacter*, and *Candida* species.2

**Clinical Evaluation**

The constellation of symptoms and signs that herald an intraabdominal infection in a young, healthy patient (ie, abdominal pain, guarding, rebound, fever, and leukocytosis, with or without hemodynamic changes such as tachycardia) are often absent or atypical in elderly patients. In patients with a decreased range of verbal expression due to dementia, aphasia, or other cognitive impairments, history may be difficult to obtain. Delirium and worsening cognitive function may be related to systemic effects of infection and/or decreased end-organ perfusion. Due to physiologic alterations associated with aging, abdominal pain may be vague and elusive, manifesting as social withdrawal, irritability, and disinterest in food or activity. The tachycardia common in children and young adults with intraabdominal infections may be absent in older patients, especially those on beta blockers. Because of changes in the immune system associated with advanced age and frailty, fever and leukocytosis may not develop. In fact, hypothermia and leukopenia are equally if not more ominous signs of intraabdominal infection in older patients (See Norman DC: Clinical Features of Infection in Older Adults, in this issue.) Given the altered presentation, sepsis diagnosis can be late and the resultant hypotension can be sudden and profound. In addition to abdominal infections, due to the multiple chronic conditions encountered in this population, acute abdominal infections in the elderly person may be overshadowed or coexist with significant distracting diagnoses, including urinary tract infection and acute coronary syndrome.3 In summary, an inability to rely on obvious physiologic derangements is a hallmark in the geriatric population and is often associated with delays in diagnosis and treatment. Although this phenomenon is widely reported and well known to the geriatrician, the atypical presentation cannot be overemphasized and should be promulgated to surgeons, both established and in training, to reinforce this well-established fact.

The abdominal examination in the elderly patient with a suspected intraabdominal infection deserves particular mention. Because of connective tissue and immune changes associated with age, peritonitis in older patients who have insufficient skeletal muscle mass and inability to mount an appropriate inflammatory response does not produce the classic physical signs of involuntary guarding, rebound tenderness, and abdominal rigidity in response to peritoneal irritation characteristic of younger patients. Pain out of proportion to physical examination findings (ie, severe abdominal pain in the absence of objective physical examination signs of peritonitis) usually indicates intestinal ischemia associated with vascular inflow or outflow occlusion due to arterial thromboembolic events, mesenteric venous thrombosis, or mechanical factors
such as volvulus and closed-loop obstruction. These alterations in elderly patients create a tenderness that may be subtle and diffuse, rather than focal and specific, even if a process is confined to a specific organ. Pain may also be referred, such as the right shoulder and scapular pain classically associated with acute biliary processes. Abdominal distension should be further classified according to the presence of tympani or dullness to percussion, indicating the presence of intraluminal or free air, or ascites or free fluid, respectively. Finally, the rectal examination is an essential component of the abdominal examination in any patient but especially so in the elderly person. The presence or absence of gross blood, indicating intestinal hemorrhage or mucosal ischemia; tenderness or fluctuance of the anal canal, indicating a perianal or perirectal abscess; an obstructing mass in the anal lumen or peritoneal reflection, indicating possible malignancy; or mere fecal impaction, a common and treatable finding among elderly patients, are all important observations.

Management Options

Intraabdominal infections frequently require multimodal therapy, as indicated previously. With the exception of contained intraabdominal abscesses limited to less than 3 to 4 cm in diameter, antibiotics alone are unlikely to be sufficient without source control. Conversely, source control alone cannot address the systemic response to infection or bacteremia that may ensue. The choice of initial antibiotics should be based on guidelines for empirical therapy coupled with local antibiotic susceptibility profiles. Piperacillin-tazobactam, or a fluoroquinolone plus metronidazole, are recommended choices in advanced age and high-risk infections. Carbapenems and third-generation cephalosporins, the latter in combination with metronidazole, are also acceptable choices but may be less cost-effective. Empirical therapy against methicillin-resistant Staphylococcus aureus (MRSA) with vancomycin is recommended in patients known or suspected to be colonized with MRSA who acquire an intraabdominal infection in the nosocomial setting. The duration of antibiotic therapy for established infection in which source control has been achieved should be limited to 7 days, given that longer durations of therapy have not been shown to demonstrate improved outcomes. In fact, emerging evidence suggests that courses as short as 4 days may be equivalent. In many instances, including organ-confined disease (eg, acute appendicitis without evidence of generalized peritonitis or perforation, or acute cholecystitis) and intraoperative spillage of enteric contents, antibiotic therapy should be limited to less than or equal to 24 hours.

Options for source control vary in invasiveness and may be definitively therapeutic or temporizing. Surgical approaches offer the option of definitive management and include laparotomy and laparoscopy. Laparoscopy has a proven record of safety in elderly patients and, in many circumstances, produces outcomes favorable to open surgery. However, it requires general anesthesia and has some relative contraindications, including hypertension and pulmonary compromise, that may limit its applicability in select cases. Abdominal surgery under local, epidural, or spinal anesthesia is another a potential option for the treatment of localized disease in high-operative risk patients. Although not standard therapy, these anesthetic modalities can and have been used to perform appendectomy, sigmoid colon resection, and ileostomy or colostomy procedures.

In addition to surgery, percutaneous interventions guided by ultrasound, fluoroscopy, or computed tomography may be suitable for controlling the source of infection while avoiding the morbidity and mortality associated with more invasive surgical approaches. Percutaneous drainage may be considered a temporizing measure, as in the case of a cholecystostomy tube used to manage a patient with acute calculous...
cholecystitis who may or may not be a future candidate for cholecystectomy. Post-cholecystostomy patients with gallstones should be managed according to a patient-centered approach, taking into account their specific operative risks, goals of care, and clinical variables such as the presence or absence of continued cystic duct obstruction on repeat cholangiography. In certain instances, a cholecystostomy tube for life may be considered the best available option. In contrast, patients with acalculous cholecystitis who are not operative candidates are well served by cholecystostomy tube decompression followed by simple removal of the tube after recovery. Additional therapeutic interventions include percutaneous abscess drainage, for example for perforated appendicitis or complicated diverticulitis, which carries a success rate as high as 90% in combination with antibiotics.4

In choosing the right intervention, one should adhere to the principles of shared decision-making and patient-centered care. Whenever possible, knowledge of patient’s preferences, goals, and values should inform therapeutic choices so that these are concordant with patient wishes. Patients who prioritize comfort-directed measures above those with curative intent may nonetheless benefit from multimodal therapy, including minimally invasive interventional techniques, to palliate the significant pain and discomfort associated with intraabdominal infections.

**Important Considerations**

Interventions for intraabdominal infections for elderly patients need to be taken in the context of 3 specific issues: the age of the patient, frailty, and the increasing invasiveness of intervention. Age alone is not a simple predictor of whether or not someone will tolerate and intraabdominal infection and its treatment. However, in multiple studies, age has been shown to increase risk of complications and mortality in surgical patients, with nonagenarians especially at risk. Thus, when treating patients of advanced age, one must be cognizant of the impact age has on both 30-day and 1-year mortality in the oldest of the old.

In contrast to age, frailty seems to be the most prominent risk factor for morbidity and mortality related to infections and subsequent interventional and surgical treatment of those infections. Multiple studies have now documented that frailty confers a marked risk of complications related to intraabdominal surgical intervention.14–16 One would ideally perform a detailed individualized risk assessment of the patient to guide the decision-making and discussion about alternatives of treatment based on a physical phenotype (weakness, exhaustion, somatic shrinking, slow walking speed, and low physical activity) and deficit accumulation index approach based on the research, which clearly demonstrates that frailty confers a marked increase in surgical risk of mortality and morbidity.16–18 Unfortunately, intraabdominal infections do not often present with the luxury of time to perform classic frailty assessments. Decisions regarding intervention are time-sensitive in the setting of rapid and progressive decline. However, there are multiple tools, such as the Edmonton Frail Scale, Risk Analysis Index, and Rockwood Clinical Frailty Scale, that can be rapidly performed and provide a guide for risk compared with a nonfrail individual and inform the shared decision-making process.19,20 At a minimum, surgical intervention in the setting of a major intraabdominal infection should prompt a preintervention discussion to include a complication rate of approximately 40% to 50%. Although this figure may seem high, multiple investigators across multiple settings have documented significant morbidity associated with major elective operations on abdominal organs of the intraperitoneal cavity.

Regarding the invasiveness of intervention, a systematic thought process of advancing invasiveness of intervention should be entertained with each patient that is based on increasing levels of intervention to achieve the optimal outcome. The first
and obvious step is to start with antibiotics because this should be the cornerstone of
treatment. Antibiotics can be used as treatment in and of itself or in conjunction with
invasive intervention. Consideration for antibiotic treatment alone in particular condi-
tions that were once considered obvious surgical conditions should be considered,
especially in the elderly frail patient (see later discussion on appendicitis). Source con-
trol of the infection to eradicate the infection and prevent progression is well recog-
nized to accompany antibiotic treatment. Because source control is the primary
goal of any invasive treatment of intraabdominal infection, percutaneous drainage re-
mains an attractive option for treating the elderly frail patient because it removes the
infectious source without major physiologic insult. In patients with a localized process
and coexistent abscess (appendicitis or diverticulitis with abscess), the ability to treat
the abscess and convert definitive treatment to an elective setting is attractive. Should
surgical intervention be needed, one must give thought immediately to laparoscopic
intervention, which has been shown to have markedly reduced physiologic insult
compared with standard laparotomy.\textsuperscript{15,21--23} Although one should lean toward the
least invasive intervention for source control, in certain situations, maximal interven-
tion in the form of open laparotomy is often necessary to rapidly obtain source control
and eradicate the infectious process.

Structured communication techniques and time-limited trials are strategies for
improving the patient-centeredness and goal-concordance of treatment of acute
intraabdominal processes in the elderly, frail, or chronically ill.\textsuperscript{24,25} Structured commu-
nunication involves (1) clarifying the patient’s decisional capacity, expectations, and
understanding regarding the situation, treatment options, and overall prognosis; (2)
identifying the patient’s priorities and goals; (3) determining the fears, worries, and
health states that the patient would find unacceptable; (4) recommending a course
of action that is best aligned with patient goals and wishes; (5) identifying objective
markers and time points to evaluate for improvement or deterioration (time-limited
trial); and (6) affirming one’s commitment to the patient’s well-being.\textsuperscript{24} In a time-
limited trial of therapy, patients who fail to improve according to the selected
parameters within the predetermined time period for evaluation should be managed
according to the paradigm of “changing hopes,” whereby a transition is made from
resuscitative and life-saving treatment toward comfort-directed measures.\textsuperscript{25}

SPECIFIC CONDITIONS

Intraabdominal infections may be associated with both hollow and solid organs. This
section reviews the presentation, management options, and potential complications
associated with infection arising from the various anatomic locations and organ sys-
tems within the abdomen.

\textbf{Biliary Tract}

Cholecystitis and cholangitis are common problems in the elderly person, with acute
cholecystitis representing the leading cause (32\%) of acute abdomen among the
elderly population in a recent analysis from Finland, where the incidence of biliary tract
disease may well be lower than that in the United States.\textsuperscript{26} Acute cholecystitis often
occurs in isolation but may also occur in the setting of hospitalization or decompensa-
tion due to other causes. Acute cholecystitis after a period of decreased oral intake
or physiologic stress is well-described and illustrated by the recent finding of a higher
than expected rate of acute cholecystitis among hip fracture patients, with a 2-month
incidence of approximately 0.75\%.\textsuperscript{27} Clinical history and examination revealing right-
upper quadrant tenderness, fever or hypothermia, leukocytosis or leukopenia, and
gallstones on ultrasound are sufficient to establish the diagnosis of acute cholecystitis, regardless of the presence of gallbladder wall thickening and pericholecystic fluid, which are less specific. Liver enzymes and bilirubin are normal in uncomplicated cholecystitis and, if elevated, may represent biliary obstruction or hepatocellular injury associated with severe inflammation extending to the liver parenchyma surrounding the gallbladder. Patients should be treated with intravenous fluids, nothing by mouth, and early antibiotics. For lower risk patients with uncomplicated disease and early presentation, cefazolin and metronidazole or ampicillin-sulbactam provide adequate coverage. Higher risk patients with more severe presentations warrant piperacillin-tazobactam or a quinolone plus metronidazole.\textsuperscript{2} Multiple studies, albeit many with a high risk of bias, document the risks associated with delayed definitive treatment of acute cholecystitis in elderly patients. In fact, a recent study of more than 4000 subjects using the National Surgical Quality Improvement Program database found that early laparoscopic cholecystectomy, within 24 hours of admission, was associated with shorter postoperative stay and no increase in postoperative complications or conversion to open cholecystectomy compared with delayed cholecystectomy in elderly patients with significant comorbidities.\textsuperscript{28} This suggests that delays in definitive management, whether due to delays in diagnosis or systematic delays introduced by the perceived need for preoperative risk stratification and optimization, or other factors, may be detrimental to older patients.

Cholangitis, which may be due to obstructing biliary stone disease, malignancy, or benign strictures, has a presentation similar to that of acute cholecystitis, with the addition of increased markers of biliary obstruction (ie, jaundice or hyperbilirubinemia, elevated alkaline phosphatase, and elevated gamma-glutamyl transferase). Severe cholangitis, indicating systemic involvement, includes the triad of cholangitis, as well as hypotension and mental status change. Early antibiotics, urgent biliary decompression via endoscopic retrograde pancreatography (ERCP), and monitoring in a high-acuity level of care are indicated for severe cholangitis. If ERCP is unsuccessful, percutaneous transhepatic cholangiography with external decompression of the biliary tract is an alternative. Because elderly patients with biliary stone disease have a high risk of recurrent complications (more than 40% in patients treated noninvasively), and because these recurrent complications are often accompanied by high morbidity and mortality, cholecystectomy should be recommended to elderly patients during the index presentation. Patients who are not operative candidates should undergo ERCP with sphincterotomy as an alternative.\textsuperscript{29}

**Stomach and Duodenum**

Although perforated peptic ulcer has decreased in incidence since the advent of therapy suppressing gastric acid production and targeted against *Helicobacter pylori*, it is still an important cause of acute abdomen. This is especially so among older patients, who have increased risk factors, including pharmacologic interruption of mucosal barrier protection associated with nonsteroidal anti-inflammatory drugs, corticosteroids, and other treatments. Elderly patients may lack the precise history of sudden onset intense upper abdominal pain, are more likely to have a delayed presentation, and have high mortality (34%–44%) associated with perforated peptic ulcer, especially when presenting with shock.\textsuperscript{30,31}

Up to half of perforated gastric and duodenal ulcers self-seal with omentum or surrounding viscera.\textsuperscript{32} This provides a justification for the observed success of nonoperative management in up to 73% of patients.\textsuperscript{33} Patients without shock and with evidence of sealed perforation on a water-soluble contrast study can be treated supportively with a low (<5%) risk of intraabdominal abscess and reperforation.\textsuperscript{34} Supportive treatment
includes rapid resuscitation, prompt surgical evaluation, and early antibiotics. The choice of antibiotics is dictated by knowledge of the microbiology of the condition rather than high-level empirical evidence. Gastric juice, in normal circumstances, consists primarily of gram-positive cocci and fungi, whereas under conditions of acid suppression or malignancy is enriched for total organisms, including enteric. Empirical antifungal therapy is not indicated except in nosocomial settings or when documented infection is established. When source control is achieved expeditiously, either surgically or by self-sealing, and diffuse peritonitis does not exist, therapy need not extend beyond 24 hours. In addition, all patients should be tested for *H pylori* infection and treatment should be directed accordingly. Patients who do not meet criteria for nonoperative intervention should undergo prompt operation. Gastric ulcers should be biopsied or excised to rule out malignancy. Ulcers less than 10 mm in diameter can be safely managed laparoscopically with omental patch repair. Definitive acid-reducing procedures should be performed only in highly select patients.

An important percentage of intraabdominal infections associated with proximal gastrointestinal tract perforation in the elderly population are iatrogenic. Due to the prevalence of dysphagia in the setting of acute and chronic neurologic deterioration caused by cerebrovascular accident and neurodegenerative disorders, and acute and chronic serious illness accompanied by the inability to meet nutritional needs through oral intake, the elderly patient is frequently subjected to placement of gastrostomy tubes for enteral nutrition. Although the evidence-based indications for feeding gastrostomy tube placement are actually quite restrictive, health care system realities drive local practice patterns in complex ways. For instance, up to one-third of long-term care residents with advanced cognitive impairment have feeding tubes, despite any demonstrated benefit in preventing aspiration pneumonia or prolonging life.

Unfortunately, the burdens associated with feeding gastrostomy tubes are significant, including diarrhea, increased rate of pressure ulcer formation, and multiple complications culminating in intraabdominal infection. Chief among these is leakage of gastric contents, sometimes admixed with tube feeds, into the abdominal cavity, producing peritonitis. Early mild leakage associated with the procedure and an insufficiently tightened retention ring or external bolster may be managed by placing the gastrostomy tube to gravity, and initiating bowel rest and antibiotic therapy with consideration of antifungal coverage, until symptoms resolve. Severe leakage, often associated with complete traumatic dislodgment of the tube by the patient or staff during the course of moving or transferring the patient, can only be successfully addressed by prompt laparotomy, lavage of the peritoneal cavity, appropriate antibiotic therapy (gram-positive or mixed flora coverage if the patient had acid suppressive therapy, with or without antifungal coverage), gastrorrhaphy, and resiting of the gastrostomy tube in a new location.

Other gastrostomy tube complications, namely acute tube migration and the more chronic buried bumper syndrome, result when outward traction along the tube produces displacement of the internal balloon or deformable dome (bumper) of the gastrostomy tube into the abdominal wall. This can occur if the external bolster is excessively tightened against the skin, causing the internal balloon or bolster to exert pressure necrosis on the gastric mucosa, eventually pulling the internal bolster into the gastrocutaneous tract. Instillation of feeds directly into the abdominal wall may produce a collection initially mistaken for, and subsequently developing into, an abscess. These abscesses are notoriously difficult to manage but should be done so aggressively, with early antibiotics, incision and drainage, interruption of feeds, placement of the gastrostomy tube to gravity drainage, and potentially resiting of the tube to a remote location to allow for local healing to take place. Finally, abdominal wall
hematomas occurring on tube placement can become secondarily infected and produce an abscess. This is managed in the same way as those associated with buried bumper syndrome.40–42

Small Bowel

Small bowel obstruction and ischemia can produce intraabdominal infection when treatment delays or failures result in intestinal necrosis and perforation, or as complications of initial surgical treatment. Secondary and tertiary peritonitis, in these circumstances, should be managed according the general principles outlined above. Goal-directed resuscitation and early antibiotics (piperacillin-tazobactam or a carbapenem, or metronidazole plus a third-generation cephalosporin or a quinolone) should be initiated; source control should be achieved percutaneously, if possible. Diffuse peritonitis mandates emergency surgical intervention if the probable outcomes are consistent with the patient’s previously expressed goals and wishes.2,43,44

Appendix

Acute appendicitis is an important cause of intraabdominal infection in the elderly person, accounting for up to 28% of cases and constituting the diagnosis in 10% to 15% of emergency operations in this age group.45–48 A true intestinal diverticulum, the appendix is subject to luminal obstruction from fecalith (20%–40%), lymphoid hyperplasia, or malignancy, all of which contribute to bacterial overproliferation,
overdistension, venous congestion, mucosal ischemia, and, eventually, necrosis and perforation. Elderly patients are at especially high risk of perforation, with rates of this complication as high as 50% in several recent studies.\textsuperscript{49, 50} The morbidity and mortality of appendicitis in the elderly patient are as high as 15% and 40%, respectively, likely reflective of a combination of delayed diagnosis and underlying pathophysiologic factors.\textsuperscript{51}

The gold standard for treatment of acute appendicitis in the elderly patient is appendectomy, open or laparoscopically, to the extent the patient can tolerate the required pneumoperitoneum.\textsuperscript{52} Management decisions should be made on an individualized basis taking into account each patient’s operative risk, the risks of nonoperative treatment, and overall goals. Although recent interest has grown in the nonoperative management of acute appendicitis, randomized controlled trials comparing antibiotics alone to antibiotics with surgery have failed to demonstrate noninferiority of antibiotics alone in the elderly population.\textsuperscript{53–55} Importantly, none of these studies have targeted enrollment of elderly subjects who may have a different risk profile for nonresolution or recurrence based on underlying causal factors such as malignancy. Indeed, elderly patients with perforated appendicitis who are treated nonoperatively should be referred for colonoscopy 4 to 6 weeks after the index event, due to the relatively high incidence of cecal or appendiceal cancer in this age group. A high index of suspicion for malignancy should be also maintained in elderly patients with uncomplicated appendicitis who undergo appendectomy. Postoperative surveillance is recommended if screening is not up-to-date or if any risk factors for malignancy exist, such as unexplained anemia or weight loss.

Colon

More than one-third of elderly patients with intraabdominal sepsis will be found to have a colonic source.\textsuperscript{45} The most important causes are diverticulitis, infectious colitis, and ischemia and subsequent perforation in the setting of obstruction due to malignancy or volvulus. Diverticulitis may be uncomplicated or complicated. Complicated diverticulitis represents local inflammation associated with bacterial overproliferation in a diverticulum and can be treated with oral antibiotics, although the exact role of antibiotics in uncomplicated diverticulitis is not well-defined.\textsuperscript{56} Complicated diverticulitis, on the other hand, results from diverticular perforations that may result in contained abscesses or diffuse peritonitis. Because of the increased prevalence of diverticulosis, as well as age-related connective tissue changes in the bowel wall that predispose to perforation, older patients are more likely than younger patients to have complicated diverticulitis with diffuse peritonitis. Unfortunately, the mortality rate is also excessive compared with younger patients (17% vs 6%).\textsuperscript{45, 57, 58}

Treatment of complicated diverticulitis depends on the overall condition of the patient and the extent of disease. Stable patients with focal abdominal examination findings, and pericolic or mesenteric abscesses on cross-sectional imaging (Hinchey stage I disease), should be treated with intravenous fluids, bowel rest, and early broad-spectrum antibiotics (piperacillin-tazobactam or metronidazole plus a quinolone). For patients with walled-off pelvic or retroperitoneal abscesses (Hinchey stage II disease), image-guided percutaneous abscess drainage should be added to the treatment armamentarium. After recovery, decisions about elective surgery should be made on a case-by-case basis, taking into account the risk of recurrence, the risks of surgery, and the patient’s goals and preferences.\textsuperscript{59}

For patients with diffuse peritonitis, shock, or evidence of free air and fluid on radiographic imaging, emergent surgical intervention is required for source control. The goals of the operation are not only to drain and lavage the peritoneal cavity of purulent
(Hinchey stage III) or feculent (Hinchey stage IV) spillage but also to remove the focus of infection and prevent recurrent attacks. The question of whether to undertake a definitive resection in the acutely ill patient with Hinchey stage III disease, with either a primary anastomosis or an end colostomy (Hartmann procedure), is the subject of ongoing controversy in the surgical literature. Although the appeal of minimally invasive laparoscopic lavage and drainage is clear and small studies in the elderly population have been promising, current evidence does not convincingly support its superiority compared with sigmoidectomy, and it may even contribute to worse outcomes.61,62 These patients are at high risk of ongoing secondary and tertiary peritonitis and undiagnosed malignancy, and should be managed according to the general principles previously outlined.

Sigmoid volvulus, obstructing masses, and mesenteric ischemia can lead to intra-abdominal infection through the final common pathway of necrosis and perforation, or through direct extension of a tumor into the peritoneal cavity in the case of malignancy. In the elderly patient with obstructing carcinomas of the cancer and rectum, proximal perforation is more likely.63,64 Given the poor long-term survival associated with perforated colon cancer in the elderly patient, early palliative care and excellent communication with patients and families about expected outcomes, goals, and priorities are of paramount importance in formulating treatment plans that are concordant with patient’s values and preferences.24,65

**Clostridium difficile Infection**

Despite being preventable, *C difficile*–associated diarrhea or infection (CDI) is an increasingly prevalent problem that disproportionately affects the elderly population (See White MB, Rajagopalan S, Yoshikawa T: Infectious Diarrhea: Norovirus and Clostridium Difficile in Older Adults, in this issue.) It is the most common infectious cause of acute diarrhea in both inpatient and outpatient health care settings, carries a high morbidity and mortality, and its economic costs are estimated at $500 million annually in the United States. The spore-forming anaerobic gram-positive bacillus produces a toxin that causes pseudomembranous colitis. Although asymptomatic carriage and mild infection can occur, the most dreaded consequence is the toxic megacolon seen in severe disease, which can lead to full-thickness colonic ischemia and perforation along with septic shock due to the systemic inflammatory response.66

CDI should be suspected in any elderly patient presenting with diarrhea, though it is important to note that CDI may present with obstipation as well, particularly in severe disease with toxic megacolon. Abdominal cramping or pain and leukocytosis should raise the index of suspicion, although any 1 or more of these features may be absent in the elderly population. Mild and moderate disease is defined as diarrhea and cramping without criteria of severe illness, which include abdominal distension and tenderness, leukocytosis (white blood cell [WBC] count >15,000 cells/mm$^3$), and hypoalbuminemia (albumin <3 g/dL). Complicated CDI is defined by any of the following criteria: WBC greater than 35,000 cells/mm$^3$ or less than 2000 cells/mm$^3$, lactate greater than 2.2 mmol/L, admission to the intensive care unit, hypotension with or without vasopressor support, fever greater than 38.5°C (to which hypothermia should be added for the elderly), ileus or abdominal distension, mental status changes, and end-organ failure.67 The cornerstones of medical management of CDI include discontinuation of initial antibiotics if possible, and early therapy with appropriate antibiotics according to the severity of illness. Metronidazole for mild-moderate disease should be given intravenously if patient has vomiting, ileus, or other reason to suspect
that absorption of the drug and delivery to the colonic lumen via the enterohepatic circulation will not be optimal; with the addition of vancomycin 500 mg orally every 6 hours for severe disease; as well as vancomycin enemas in patients with ileus.66

Surgical consultation should be requested early in the course of illness (ie, for mild-moderate disease) so that decisions regarding operative management can be made proactively. Diffuse peritonitis, metabolic acidosis, and signs of septic shock, including refractory hypotension, altered mental status, and end-organ dysfunction, unfortunately portend a mortality rate in excess of 50%, even with emergency surgical intervention. Although subtotal colectomy has been the standard treatment, recent success with loop ileostomy and antegrade colonic lavage, which can be performed laparoscopically, has resulted in success with substantially less morbidity and mortality.68 Nevertheless, this approach remains untested in prospective randomized fashion.

**Solid Organs: Pancreas, Spleen, and Liver**

Most infectious complications of the abdomen in the elderly population occur in the hollow viscus organs described previously. However, the solid organs of the abdomen are also susceptible to infection. Specific and notable patterns of infection are seen, although at a rate far less than for other intraabdominal structures. For the pancreas, infection occurs secondarily in the setting of necrotizing pancreatitis. Infection is more common in younger patients than the elderly adult but when present in the elderly patient the mortality rate approaches 30%. Because the primary cause of death in these patients is systemic sepsis, adjunctive invasive treatment is directed at establishing source control. Dogmatic surgical approaches for infected necrotizing pancreatitis, including early debridement and wide drainage, have generally evolved into a step-up approach using percutaneous and minimally invasive techniques in a progressively more invasive algorithmic fashion until source control is established.69,70 Early and aggressive nutritional support has been associated with improved outcomes and is likely to be especially beneficial in elderly patients who may already be nutritionally depleted.71,72 Although controversial, prophylactic antibiotic administration with beta-lactams in the setting of necrotizing pancreatitis in the elderly patient seems reasonable based on current data.73,74

Liver infections in the elderly patient in the form of pyogenic liver abscess are rare but a well-described entity. These infections previously carrying a high mortality have now become treatable based on the advent of high-quality computed tomographic imaging and accurate percutaneous aspiration and drainage, allowing for minimally invasive treatment. Most liver infections were from a biliary source.75 Splenic bacterial infections are rare. It should be recognized that either congenital or acquired asplenia (previous surgery or infiltrative diseases), leading to splenic nonfunction that predisposes the patient to infection of encapsulated bacteria.76

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