Global Alliance for Infections in Surgery

The management of acute appendicitis from a global perspective

ACT NOW

Acute appendicitis is both the most common general surgery emergency presentation, as well as the most common cause of intra-abdominal infection worldwide. Appendicitis is seen in up to 1 in 10 individuals over a lifetime. Most cases present between the ages of 10 and 30 years. There is a slight male predominance among patients presenting before age 30 (male:female ratio approximately 3:2).

Interestingly, the incidence of acute appendicitis varies: it is generally thought to have a low-incidence rate in sub-Saharan Africa and in many regions of Asia and Latin America. This condition once thought to be rare in many regions of the world, appears to be increasing in many urban centers of these regions, perhaps due to changes in life style and diet. However, the true incidence of appendicitis in many areas of the world is unknown due to poor medical record-keeping and unreliable population census.

The natural history of appendicitis has been described in three stages:

- **a normal appendix,**
- **uncomplicated acute appendicitis when the infectious process is limited to appendix**
- **complicated appendicitis when the infectious process is extended to peritoneum**

The high morbidity and occasional mortality associated with acute appendicitis are related to delay in presentation by patients or delay in diagnosis by the clinician. These delays may result in complications like gangrene, perforation, appendiceal mass, and peritonitis.

The evaluation of patients with suspected appendicitis is driven by the goal of identifying all patients presenting with acute appendicitis as early in their clinical course as possible while minimizing the nontherapeutic laparoscopy/laparotomy rate.

The evaluation for appendicitis in nonpregnant adults can be particularly challenging in several populations, including:

- **Women of reproductive age**
- **Elderly and frail (eg, immunosuppressed, multiple comorbidities)**

In women of reproductive age, gynecologic pathologies (eg, pelvic inflammatory disease, adnexal torsion) can mimic appendicitis clinically. Elderly and frail patients can present with nonclassical or nonspecific clinical features.

Diagnosis

Unfortunately, the clinical presentation of appendicitis is often inconsistent. While the clinical diagnosis may be clear in patients presenting with classic signs and symptoms, atypical presentations may result in delay in treatment. Therefore, diagnostic scoring systems have been described with the aim to provide clinical probabilities that a patient has acute appendicitis. The development of these scores may contribute to diagnosis and by easily applicable clinical criteria and simple laboratory tests a score which classifies the probability of diagnosis may be attributed to the patient. In 1986, Alvarado published his own method for the early diagnosis of acute appendicitis. A score of five or six was compatible with the diagnosis of acute appendicitis, a score of seven or eight indicated a probable appendicitis, and a score of nine or ten indicated a very probable appendicitis. The only laboratory tests needed in the initial evaluation for acute appendicitis was a complete blood count to determine if there was shift to the left or increased segmented neutrophils (more than 75%).

The more recently introduced appendicitis inflammatory response (AIR) score incorporated the C-reactive protein value in its design and was developed and validated on a prospective cohort of patients with suspicion of acute appendicitis. It was based on similar values to the Alvarado score, but it also included C-reactive protein as a new variable

Imaging is used mainly to increase the specificity of the diagnostic evaluation for appendicitis and to decrease the negative appendectomy rate.

An abdominal ultrasound focused on the right lower quadrant is the preferred imaging exam in children and pregnant women and is recommended over CT in these populations. In other populations, ultrasound represents an alternative to CT if the last is not readily available.

Advantages of ultrasound include the lack of ionizing radiation and intravenous contrast. Unlike CT ultrasound can be performed at the bedside. However, an important disadvantage is that ultrasound demonstrates lower diagnostic accuracy than CT. The test performance is highly variable and depends on patient-specific (eg, body habitus, discomfort and alertness, appendix location relative to overlying bowel) and operator-specific (eg, experience) variables. Rates of indeterminate exams are high.

Imaging features of acute appendicitis on ultrasound include:

- **Non compressible appendix with double-wall thickness diameter of >6 mm**
- **Focal pain over appendix with compression**
- **Appendicolith**
- **Increased echogenicity of inflamed periappendiceal fat**
- **Fluid in the right lower quadrant**

Proposals of staged algorithmics with a step-up approach with CT performed after an inconclusive or negative US were proposed in the setting of acute appendicitis.

Abdominopelvic CT is recommended as the preferred test in the imaging evaluation of suspected appendicitis in adults. If available, low radiation dose image acquisition protocols should be used as they do not compromise diagnostic accuracy. Intravenous contrast is recommended, although CT without contrast is an acceptable alternative when intravenous contrast is contraindicated.

CT demonstrates higher diagnostic accuracy than ultrasound. CT demonstrates the lowest rates of nondiagnostic tests as the normal appendix is visualized in almost all cases. As CT imaging usually includes the abdomen and pelvis, the exam evaluates for other pathologies should the patient prove to not have appendicitis. The disadvantages of CT are patient exposure to ionizing radiation and iodinated contrast.

The estimated effective radiation dose of abdominopelvic CT is 8 to 10 mSv with standard dose and 2 to 4 mSv with low dose techniques. To put these numbers into context, the effective dose from annual background radiation is 3.1 mSv and from plain abdominal radiography is 0.7 mSv.

Intravenous contrast administration is recommended in CT exams performed for the diagnosis of appendicitis. Contraindications to contrast administration are:

- **Renal insufficiency**
- **History of hypersensitivity reaction to iodinated contrast**

Non contrasted CT is an acceptable alternative if intravenous contrast is contraindicated
The imaging features of acute appendicitis on abdominopelvic CT are:

- **Enlarged appendiceal double-wall thickness (>6 mm)**
- **Appendiceal wall thickening (>2 mm)**
- **Periappendiceal fat stranding**
- **Appendiceal wall enhancement**
- **Appendicolith**

Surgical treatment

Since the first appendectomy was performed by McBurney in 1864, surgical removal of the appendix has been considered the standard of care for acute appendicitis.

Antibiotics alone may be useful to treat patients with early, uncomplicated appendicitis, even if there is a risk of recurrence. Approximately 90% of patients treated with antibiotics are able to avoid surgery during the initial admission. The other 10% that fail to respond to antibiotics require a rescue appendectomy. Recurrence rates of non-operated patients within 1 year are as high as 20-30%. Different risk factors for failure of non-operative management (NOM) have been found including fever at initial presentation, high presenting serum C-reactive protein levels, and an intraluminal fecalith.

Although NOM of acute appendicitis seems desirable in many aspects, it certainly bears some disadvantages. Criticism of NOM mainly centers on the risk of recurrent disease. Although antibiotic therapy can be successful in selected patients with uncomplicated appendicitis, the risk of disease recurrence limits the application of this treatment strategy. The need for additional diagnostic certainty with a CT-proven diagnosis further complicates this approach from a global perspective. Another possible disadvantage of a generally conservative approach could be a significant rise in the use of antibiotics. Depending on the antibiotic regimen used, this might increase resistance towards antibiotics and lead to an even heavier burden of *Clostridium difficile* infections. Although this risk does not seem to outweigh the risks of an operation, it may still be of significance to the general burden of disease.

For all these reasons, appendectomy has remained in international guidelines the gold-standard treatment for acute appendicitis worldwide reserving conservative treatments in selected patients, at the moment.

The advent of laparoscopy has modified the surgical treatment of acute appendicitis in high-income countries. In contrast, in many areas of the world, the challenges posed by the burden of primary healthcare concerns have limited support for development of modern tertiary healthcare facilities, and laparoscopic surgery is practiced in only a few tertiary hospitals. In the last years, several prospective randomized studies, meta-analyses, and systematic critical reviews have been published on the topics of laparoscopic appendectomy.

Laparoscopic appendectomy is safe and effective, but open surgery still confers benefits, in particular with regard to the likelihood of postoperative intra-abdominal abscess. Appendectomy can be performed as open surgery or laparoscopically. Both procedures are routine operations with very low operational risks, and morbidity and mortality are mainly determined by the severity of appendiceal disease itself.

In approximately 10% of patients, a periappendiceal abscess and inflammatory phlegmon is present at diagnosis. This is more frequently encountered in the situation of a delayed diagnosis. Clinical features of complicated appendicitis such as mass and abscess may include fever, tachycardia, palpation of mass, and extension of area of tenderness and rebound. Surgical management varies because a proportion of these cases will evolve into an ileocecal resection or a right-sided hemicolectomy if operated in the acute setting. In recent years, high success rates and low incidences of complications have been reported in patients with appendicitis associated with abscess and/or mass, after conservative management; thus, performing non-surgical treatments, such as antibiotic therapy and percutaneous drainage, during the initial period have been proven to be effective and safe. However, a necessary condition for conservative management of these patients is an easy access to diagnostic and interventional radiology to perform a percutaneous drainage. When percutaneous drainage is not available, surgery is suggested.

Traditionally, an interval appendectomy has been offered to patients who initially underwent a non-operative approach to their appendiceal mass. However, the role of the interval appendectomy has been questioned, and controversy continues whether interval appendectomy is appropriate for adults with an appendiceal abscess. The main debate revolves around the recurrence rate, the complication rate of an interval appendectomy, and the potential for underlying malignancy.

Antibiotic therapy

Antibiotics should be used after a treatable infection has been recognized or if there is a high degree of suspicion of an infection. In the setting of uncomplicated acute appendicitis, single doses have the same impact as multiple doses and post-operative antibiotic therapy is not necessary if source control is adequate.

In the setting of complicated acute appendicitis, a short course of antibiotic therapy (3–5 days) after adequate source control is a reasonable option. The prospective trial by Sawyer et al. demonstrated that in patients with complicated intra-abdominal infections undergoing an adequate source control, the outcomes after approximately 4 days fixed-duration antibiotic therapy were similar to those after a longer course of antibiotics that extended until after the resolution of physiological abnormalities.

Patients who have ongoing signs of peritonitis or systemic illness beyond 5–7 days of antibiotic treatment normally warrant a diagnostic investigation to determine whether additional surgical intervention is necessary to address an ongoing uncontrolled source of infection or antimicrobial treatment failure. The prolonged and inappropriate use of antibiotics appears a key factor in the rapid rise of antimicrobial resistance worldwide over the past decade