Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub

https://doi.org/10.64483/202631816

Acute Appendicitis in Adults: Diagnosis, Emergency Assessment, and Management-An Updated Review for Medical Emergency Professionals.

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Abstract

Background: Acute appendicitis is a cause of acute abdominal pain and remains an indication for emergency surgical assessment. Delayed diagnosis can lead to perforation and other complications, whereas overdiagnosis may lead to unnecessary imaging or surgery.

Aim: This review summarizes the clinical assessment, diagnostic investigations, risk stratification, imaging approaches, and treatment options for acute appendicitis in adults.

Methods: The review discusses evidence and recommendations presented in the cited literature and clinical guidelines, focusing on history and physical examination, laboratory testing, clinical scores, imaging modalities, and the choice between antibiotic treatment and appendectomy.

Results: Diagnosis relies on integrating symptom patterns and examination findings with laboratory and imaging results. Migration of pain to the right lower quadrant and localized tenderness support the diagnosis, but no single clinical feature or laboratory marker is sufficient to confirm or exclude appendicitis. Risk scores, including the Appendicitis Inflammatory Response score and Adult Appendicitis Score, help classify patients and guide further assessment. Computed tomography provides high diagnostic accuracy in adults, while ultrasonography is useful as an initial radiation-free test and magnetic resonance imaging is relevant during pregnancy. Appendectomy remains a treatment. Antibiotic-only management may be considered for selected patients with uncomplicated appendicitis, especially in the absence of an appendicolith, after discussion of treatment failure and recurrence risks. Complicated disease requires individualized management, including antibiotics, drainage when appropriate, or surgery.

Conclusion: Accurate assessment requires a structured, risk-based approach that combines clinical findings, laboratory tests, and appropriate imaging. Treatment should reflect disease severity, patient characteristics, and informed patient preferences.

Keywords: Acute appendicitis; diagnosis; clinical assessment; risk stratification; imaging; appendectomy; antibiotic therapy.

Introduction

Abdominal pain is one of the most frequent presenting complaints in emergency department (ED) settings and represents a major challenge in acute clinical assessment. Among patients presenting with abdominal pain, right lower quadrant (RLQ) pain accounts for up to 50% of visits [1–10]. This presentation requires careful evaluation because it may arise from several gastrointestinal, urinary, reproductive, and other abdominal conditions. However, acute appendicitis remains the most common surgical pathology responsible for RLQ pain in the United States and is recognized as the most common abdominal surgical emergency worldwide [3–10]. Its frequent occurrence and potential progression to serious complications make early recognition and appropriate management important priorities in emergency medicine. Acute appendicitis is an inflammatory condition of the vermiform appendix that can affect individuals across

Saudi Journal of Medicine and Public Health (SJMPH) ISSN 2961-4368
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Receive Date: 30 August 2026, Revise Date: 27 October 2026, Accept Date: 7 November 2026

different age groups. The estimated lifetime risk is approximately 9% in males and 7% in females, with the highest incidence occurring between 15 and 30 years of age [4,11]. Although appendicitis is particularly common among young adults, it can also occur in older individuals. The clinical presentation and disease progression may differ between age groups, making accurate assessment important for avoiding diagnostic delays. The condition can progress from uncomplicated inflammation to perforation and other complications when diagnosis and treatment are delayed. Perforation is among the most important complications of acute appendicitis, with reported rates ranging from 16% to 40%. Higher perforation rates have been observed in pediatric and elderly patients [3,5]. The consequences of perforation are reflected in the differences in mortality between uncomplicated and complicated diseases. Among patients without perforation, mortality ranges from 0.07% to 0.7%, whereas it may increase to approximately 8% in patients with perforated appendicitis [3,8,10–12]. These findings demonstrate the clinical importance of identifying patients at risk of complicated diseases and initiating appropriate treatment without unnecessary delay.

The emergency assessment of adults with suspected appendicitis involves integrating the presenting symptoms, clinical examination, and appropriate diagnostic investigations. Timely identification is essential because an accurate diagnosis supports appropriate treatment decisions and helps reduce the risk of progression to perforation and other complications. Emergency clinicians must also consider the possibility of alternative causes of RLQ pain when evaluating patients, particularly when the clinical presentation is not typical. Several advances have occurred in recent years in the diagnostic evaluation and management of adult patients with acute appendicitis. These developments have influenced clinical decision-making and the selection of appropriate management strategies. This review discusses selected updates in the diagnosis and management of acute appendicitis in adults, with particular attention to issues relevant to emergency care. It is not intended to provide an exhaustive review of every aspect of the disease but rather to highlight important clinical questions and developments that support the assessment and management of affected patients.

History and Physical Examination of Appendicitis

The clinical assessment of patients with suspected acute appendicitis begins with a detailed history and physical examination. Abdominal pain is the most frequent presenting symptom, reported in approximately 99% of adult patients in one study. Other commonly reported symptoms include nausea (81.7%), anorexia (72.4%), vomiting (67.7%), fever (44.9%), and chills (27.3%) [3,4,8,13,14]. Although these symptoms frequently accompany appendicitis, their diagnostic value varies. Therefore, clinicians should evaluate the combination, sequence, and location of symptoms rather than relying on an isolated finding. Right lower quadrant (RLQ) pain is one of the most important historical features associated with appendicitis. A systematic review identified RLQ pain as the most frequent symptom, with a positive likelihood ratio (LR+) ranging from 7.31 to 8.46 and a negative likelihood ratio (LR−) ranging from 0 to 0.28 [14]. These findings indicate that the presence of RLQ pain can substantially increase clinical suspicion, while its absence may reduce the likelihood of appendicitis. However, the absence of localized pain does not completely exclude the diagnosis, particularly in patients with atypical presentations. Migration of abdominal pain is another clinically relevant feature. Patients may initially experience poorly localized abdominal discomfort before developing more localized pain in the RLQ. Pain migration demonstrated an LR+ of 3.18 and an LR− of 0.50, supporting its usefulness during clinical assessment [14]. The sequence of symptoms is also important. Pain occurring before vomiting had an LR+ of 2.76, suggesting that the temporal relationship between abdominal pain and gastrointestinal symptoms may help distinguish appendicitis from other causes of abdominal discomfort.

Other historical findings have more limited diagnostic value. The absence of previous similar pain was associated with an LR+ of 1.50 and an LR− of 0.32. Anorexia demonstrated an LR+ of 1.27 and an LR− of 0.64. In contrast, vomiting and nausea showed limited discriminatory value, with likelihood ratios generally close to 1 [14]. This suggests that although nausea, vomiting, and loss of appetite are frequently reported, they should not independently determine the clinical diagnosis. Recent studies have also demonstrated that several commonly discussed symptoms have only moderate sensitivity and specificity. Anorexia has a sensitivity ranging from 58% to 91% and specificity of 37% to 40%. Nausea or vomiting has a sensitivity of 40% to 72% and specificity of 45% to 69%. Diarrhea is less frequently associated with appendicitis, with a sensitivity of 9% to 24% and specificity of 58% to 65% [3,4,8,13–17]. These values demonstrate the limitations of symptom-based diagnosis. In particular, the presence or absence of gastrointestinal symptoms cannot reliably confirm or exclude appendicitis without considering other clinical findings. Physical examination provides additional information for assessing patients with suspected appendicitis. Localized abdominal tenderness, particularly in the RLQ, is an important finding. McBurney's point tenderness is classically associated with appendicitis. McBurney's point is located approximately 3–5 cm from the anterior superior iliac spine (ASIS), along an imaginary line extending from the ASIS toward the umbilicus. Maximum tenderness at this location supports the clinical suspicion of appendiceal

inflammation. Its reported sensitivity ranges from 50% to 96%, while specificity ranges from 75% to 86% [15–17].

Several specific examination maneuvers may also help identify appendiceal irritation. Rovsing's sign is considered positive when palpation of the left lower quadrant produces pain in the RLQ. Its sensitivity ranges from 22% to 68%, and specificity ranges from 58% to 96%. The psoas sign involves eliciting RLQ pain through passive extension of the right hip or flexion of the hip against resistance. This finding may occur when the inflamed appendix lies close to the psoas muscle. Its sensitivity ranges from 13% to 42%, with specificity between 79% and 97% [15–17]. The obturator sign is another examination maneuver used in suspected appendicitis. It is assessed by flexing the patient's right hip and knee, followed by internal rotation of the hip. Reproduction of RLQ pain may indicate irritation of the obturator internus muscle by an inflamed appendix located in the adjacent pelvic region. Although its sensitivity is low at approximately 8%, its specificity reaches 94% [15–17]. Consequently, a positive obturator sign may support the diagnosis, but its absence has limited value in excluding appendicitis. Other abdominal examination findings include rigidity, rebound tenderness, and guarding. Abdominal rigidity has an LR+ of 3.76 and an LR− of 0.82. Rebound tenderness demonstrates an LR+ ranging from 1.10 to 6.30 and an LR− ranging from 0 to 0.86. The psoas sign has an LR+ of 2.38 and an LR− of 0.90 in the reported meta-analysis [14]. These findings may increase clinical suspicion, particularly when they occur alongside localized RLQ tenderness. However, fever and guarding have relatively limited diagnostic reliability, with reported LR+ values of 1.94 and 1.65–1.78, respectively [14]. Therefore, neither the presence nor absence of these findings should be interpreted in isolation.

Clinical assessment requires additional consideration in pregnant and elderly patients because both populations may present with atypical symptoms and examination findings. Acute appendicitis is the most common non-obstetric surgical emergency during pregnancy. However, pregnant patients are less likely to demonstrate the classical clinical presentation [18,19]. As pregnancy progresses, enlargement of the uterus causes anatomical changes that alter the relationship between the appendix and the abdominal wall. The appendix may also become displaced in a cephalad direction. Consequently, the location of pain may shift from the RLQ toward the right flank or right upper quadrant, particularly during the late second and third trimesters [18,19]. These anatomical changes make reliance on classical RLQ pain less appropriate when evaluating pregnant patients. Elderly patients also represent a population in whom appendicitis may be difficult to recognize. Complicated appendicitis and perforation are more frequent in this group, with reported perforation rates ranging from 18% to 70% [12]. Furthermore, elderly patients are less likely to present with fever or typical RLQ pain and may not develop clear signs of peritonitis, even when perforation has occurred [12,20,21]. Several physiological factors may contribute to this atypical presentation, including lower baseline body temperature, reduced thermoregulatory responses, diminished pain perception associated with loss of spinal afferent innervation, and decreased abdominal wall musculature [12,20,21]. These factors may reduce the visibility of classical inflammatory and peritoneal signs during examination and contribute to delayed diagnosis. Overall, no single historical symptom or physical examination finding can reliably exclude acute appendicitis. RLQ pain, migration of abdominal pain, McBurney's point tenderness, Rovsing's sign, psoas sign, and obturator sign are among the findings that support the diagnosis. Nevertheless, their diagnostic performance varies, and negative findings should not provide false reassurance. Particular attention is required when assessing pregnant and elderly patients because anatomical and physiological changes may produce atypical presentations. A systematic assessment combining symptom history, abdominal examination, and appropriate diagnostic investigations remains essential for identifying adults with suspected appendicitis and reducing the risk of delayed recognition and complications.

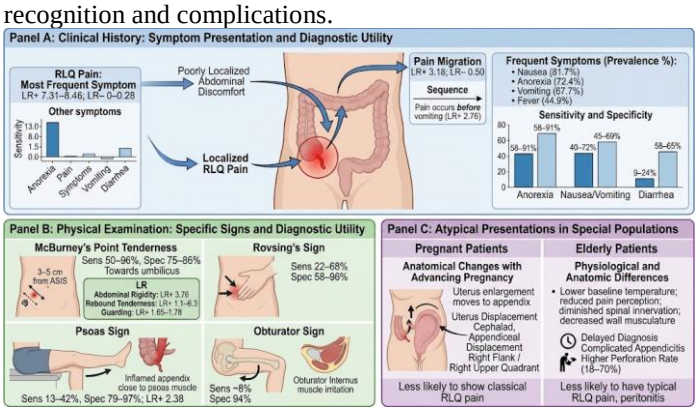


Figure-1: Appendicitis.

Laboratory Testing Utility

Laboratory investigations are an important component of the diagnostic evaluation of patients presenting with suspected acute appendicitis. Although the diagnosis is primarily based on clinical assessment and appropriate imaging, laboratory findings provide additional information about the presence and extent of the inflammatory response. Most clinical guidelines recommend obtaining a complete blood count (CBC) and serum chemistry tests. Pregnancy testing is also recommended in women of reproductive age because pregnancy may influence the differential diagnosis, choice of

imaging investigations, and subsequent management [3,9,10]. The white blood cell count (WBC) and differential count are among the most frequently requested laboratory investigations. More than 70% of patients with acute appendicitis demonstrate leukocytosis accompanied by neutrophil predominance. Reported sensitivity exceeds 83% for leukocytosis and 85% for neutrophil predominance [16,22–26]. These abnormalities reflect the systemic inflammatory response associated with appendiceal inflammation. However, their diagnostic performance varies according to disease severity and the timing of laboratory assessment. Significant leukocytosis, particularly a WBC count greater than 15×10^9/L, and marked neutrophilic predominance are more frequently observed in patients with perforated appendicitis [22–26]. Therefore, these findings may provide additional information when evaluating patients with suspected complicated disease. C-reactive protein (CRP) is another commonly investigated inflammatory marker. It is an acute-phase reactant produced in response to inflammatory stimulation. Studies have reported a sensitivity exceeding 75% for diagnosing appendicitis when CRP is elevated above a threshold of 1.7 mg/dL [22]. Nevertheless, the specificity of individual inflammatory markers is relatively poor. Reported specificity values for WBC, neutrophil predominance, and CRP generally range from 25% to 63% [23,24]. A study published in 2006 reported specificity values of 31.9% for elevated WBC, 33.1% for increased neutrophil percentage, and 26.1% for elevated CRP [23]. These results demonstrate that inflammatory markers may support the diagnosis but cannot independently distinguish appendicitis from other inflammatory or infectious conditions.

The diagnostic value of laboratory testing improves when multiple inflammatory markers are interpreted together. Combining WBC, neutrophil percentage, and CRP provides greater diagnostic sensitivity than relying on any individual parameter. Some studies have reported sensitivity exceeding 95% when all three markers are elevated [4,23,24,27]. This combined approach may strengthen clinical suspicion and support decisions regarding further diagnostic investigations. However, elevated values do not establish appendicitis conclusively because similar abnormalities may occur in other abdominal and systemic inflammatory conditions. The timing of laboratory testing in relation to symptom onset is also important when interpreting results. Leukocytosis generally develops within the first 12 hours following the onset of symptoms. In contrast, CRP usually begins to increase within 12–24 hours and reaches its peak concentration within approximately 48 hours [3,4,23,24,27]. Consequently, patients evaluated early in the disease course may have normal or minimally elevated CRP despite having acute appendicitis. Similarly, inflammatory markers may change as the disease progresses. A normal result obtained during the early stages should therefore be interpreted alongside the patient's symptoms, physical examination, and clinical progression. Furthermore, no universally established CRP threshold can definitively confirm or exclude acute appendicitis. Urinalysis may also be considered when evaluating patients with lower abdominal pain, particularly when urinary tract infection (UTI) is included in the differential diagnosis. However, interpretation requires caution because urinary abnormalities may occur in patients with appendicitis. Approximately 40% of patients with appendicitis may demonstrate leukocytes in their urine [28]. This finding may result in diagnostic confusion, particularly when urinary leukocytes are interpreted without considering the patient's clinical presentation. Therefore, urinalysis should be requested when symptoms suggest a urinary tract condition, and the diagnosis of UTI should not be established solely on the basis of leukocyturia. The presence of urinary leukocytes does not independently exclude appendicitis.

Overall, laboratory testing contributes to the assessment of suspected acute appendicitis by identifying inflammatory changes, supporting clinical risk assessment, and helping evaluate alternative diagnoses. Nevertheless, WBC, neutrophil percentage, and CRP should not be used individually to exclude appendicitis. A combination of normal WBC, normal neutrophil distribution, and normal CRP makes the diagnosis less likely, but does not completely eliminate the possibility. Laboratory findings should always be interpreted in conjunction with the clinical history, physical examination, and appropriate imaging investigations. This integrated approach reduces dependence on individual test results and supports more accurate emergency department decision-making.

Diagnostic Utility of Risk Stratification Tools

Clinical risk stratification tools are used to estimate the probability of acute appendicitis in patients presenting with abdominal pain and to guide decisions regarding further diagnostic evaluation, imaging, observation, and surgical consultation. These scoring systems combine clinical symptoms, physical examination findings, and laboratory parameters into standardized numerical assessments. Their primary purpose is to support clinical judgment, identify patients at low risk who may not require immediate imaging, and distinguish intermediate-risk patients who need additional investigation from those with a high probability of appendicitis. Several scoring systems have been developed and evaluated in adults, including the original Alvarado score, the modified Alvarado score, the Appendicitis Inflammatory Response (AIR) score, the Adult Appendicitis Score (AAS), and the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score [3,9,25,26,29–36]. The Alvarado

score, introduced in 1986, is among the most widely recognized clinical prediction tools for acute appendicitis. It incorporates eight variables related to the patient's history, physical examination, and laboratory findings. These include migratory right lower quadrant (RLQ) pain, anorexia, nausea or vomiting, RLQ tenderness, rebound tenderness, elevated temperature, leukocytosis, and a left shift in the leukocyte differential. Each variable is assigned a specific number of points, producing a total score that helps classify patients according to their likelihood of appendicitis. An RLQ tenderness and leukocytosis receive two points each, while the remaining variables receive one point each. The total score ranges from 0 to 10. A score of 0–4 suggests that appendicitis is unlikely, 5–6 indicates possible appendicitis, 7–8 suggests probable appendicitis, and a score of 9 or 10 indicates a very high probability of the disease. The score provides a practical method of organizing clinical findings and identifying patients who require further diagnostic assessment. The modified Alvarado score retains most components of the original system but removes the leukocyte left shift. This modification simplifies the assessment by reducing dependence on differential leukocyte measurements while maintaining the use of clinical findings and total white blood cell count. The modified score has a maximum of 9 points and is generally interpreted as indicating a low likelihood of appendicitis below 3 points, whereas a score of 4 or higher supports further evaluation. In one comparative study, patients with an original Alvarado score of 9–10 had a sensitivity of 88% and specificity of 100%, while those scoring 7–8 had a sensitivity of 63% and specificity of 68%. The corresponding modified Alvarado score of 9–10 demonstrated a sensitivity of 96% and specificity of 100%, while scores of 7–8 showed a sensitivity of 77% and specificity of 86% [33]. These findings suggest that the modified version may provide useful discrimination in selected patient groups. However, the performance of either version depends on the population being assessed and the clinical threshold used to classify patients.

The AIR score was introduced in 2008 and represents another widely used approach to clinical risk assessment. It incorporates vomiting, right iliac fossa pain, the degree of rebound tenderness or muscular defense, fever, polymorphonuclear leukocyte proportion, total white blood cell count, and C-reactive protein (CRP) concentration. Unlike the Alvarado score, the AIR score places greater emphasis on inflammatory markers and the severity of physical examination findings. Rebound tenderness is graded according to its intensity, while leukocyte count, neutrophil proportion, and CRP are categorized into ranges with increasing point values. The resulting score is used to classify patients into low-, intermediate-, and high-risk groups. A score below 4 indicates low risk and may support outpatient follow-up, a score of 5–8 indicates an intermediate probability requiring active observation, and a score of 9 or higher indicates high risk and supports urgent surgical assessment. This structure allows clinicians to use the score not only to estimate the probability of appendicitis but also to guide the intensity and timing of subsequent evaluation. The Adult Appendicitis Score was developed specifically to assess adults with suspected acute appendicitis. It includes RLQ pain, migration of pain, RLQ tenderness, guarding, white blood cell count, neutrophil proportion, and CRP concentration. An important feature is the adjustment of certain clinical findings according to patient characteristics. For example, the points assigned to RLQ tenderness differ between women aged 16–49 years and other patients. The score also considers the duration of symptoms when interpreting CRP concentrations, recognizing that inflammatory marker levels change over the course of the disease. Patients are classified into low-, intermediate-, and high-risk categories. Scores of 1–4 indicate low risk and may support observation or discharge, whereas scores of 5–10 indicate intermediate risk, for which additional imaging may be appropriate. Scores of 11–15 indicate high risk and support surgical assessment, with imaging considered according to the clinical circumstances [3,25,26]. The incorporation of symptom duration and sex-related differences in selected variables provides a more individualized approach to risk assessment in adults.

The RIPASA score is another clinical prediction system designed to improve the identification of patients with acute appendicitis. It includes demographic characteristics, clinical symptoms, physical examination findings, and urinalysis results. Its variables include sex, age, foreign nationality, right iliac fossa pain, migration of pain, anorexia, nausea or vomiting, symptom duration, tenderness, guarding, rebound tenderness, Rovsing sign, temperature, elevated white blood cell count, and a negative urinalysis. The inclusion of demographic characteristics and urinalysis distinguishes this score from several other commonly used systems. Patients with scores below 5 are considered unlikely to have appendicitis, while scores of 5–7 indicate a low probability and support observation, repeat assessment, or further investigation. Scores of 7.5–11 indicate a high probability and warrant surgical consultation, whereas scores of 12 or higher indicate definite acute appendicitis according to the proposed classification [29–36]. Nevertheless, the usefulness of RIPASA should be interpreted in relation to the population in which it is applied, particularly because some of its demographic components may influence its performance across different healthcare settings. Comparative evidence indicates that the diagnostic

accuracy of these scoring systems varies. A 2025 meta-analysis involving 26 studies and 15,699 participants found that the AIR score had greater overall diagnostic accuracy than the Alvarado score. The AIR score demonstrated an area under the receiver operating characteristic curve (AUROC) of 0.86 (95% confidence interval [CI], 0.83–0.88) for all patients with appendicitis and 0.93 (95% CI, 0.91–0.96) for complicated appendicitis. In comparison, the Alvarado score achieved AUROC values of 0.79 (95% CI, 0.76–0.81) for all cases and 0.88 (95% CI, 0.82–0.95) for advanced appendicitis [26]. These findings indicate that the AIR score provides stronger discrimination, particularly when identifying patients with complicated disease.

The diagnostic performance of the AIR score also depends on the threshold selected for clinical decision-making. At a threshold greater than 3 points, its sensitivity was 0.95 (95% CI, 0.90–0.97) for all patients with appendicitis and 0.99 (95% CI, 0.97–0.99) for patients with advanced appendicitis. These sensitivity estimates support its potential value in identifying patients who are unlikely to have the disease when their scores fall below the selected threshold. Conversely, at a threshold greater than 8 points, the specificity was 0.98 (95% CI, 0.97–0.99) for all appendicitis cases and 0.99 (95% CI, 0.97–0.99) for advanced appendicitis [26]. The high specificity at this threshold indicates that patients with markedly elevated scores have a high probability of appendicitis and may require prompt surgical evaluation. Therefore, the AIR score can help identify both low-risk patients and those who require urgent assessment. The Alvarado and RIPASA scores have also been compared in a meta-analysis of 33 articles. The hierarchical summary receiver operating characteristic model demonstrated a summary sensitivity of 0.72 (95% CI, 0.66–0.77) and specificity of 0.77 (95% CI, 0.70–0.82) for the Alvarado score [34]. In comparison, the RIPASA score demonstrated a higher summary sensitivity of 0.95 (95% CI, 0.92–0.97), although its specificity was lower at 0.71 (95% CI, 0.60–0.80) [43]. This difference suggests that RIPASA may be more useful for identifying patients who could have appendicitis, whereas its lower specificity may result in more patients without appendicitis being classified as high risk. Consequently, a positive score should not automatically be considered confirmation of the diagnosis, and additional clinical assessment or imaging may remain necessary.

Clinical guidelines support the use of risk stratification tools as part of the diagnostic pathway. The Emergency General Surgery Algorithms Work Group of the *Journal of Trauma and Acute Care Surgery* recognizes the potential role of the Alvarado score in determining the need for confirmatory imaging, while identifying the AIR score as having the highest sensitivity and specificity among the evaluated systems [9]. Similarly, the World Society of Emergency Surgery (WSES) recommends clinical scoring systems to identify patients at low risk of acute appendicitis and distinguish intermediate-risk patients who require diagnostic imaging [3]. These recommendations emphasize that clinical scores should complement, rather than replace, clinical judgment and appropriate diagnostic investigations. The WSES guidelines specifically advise against using the Alvarado score as a definitive diagnostic test. Although it can help identify patients with a low probability of appendicitis, its specificity is insufficient to confirm the diagnosis. Furthermore, its ability to distinguish uncomplicated from complicated appendicitis is limited in elderly patients, and its sensitivity may be reduced in patients with human immunodeficiency virus infection [3]. These limitations are clinically important because the accuracy of prediction tools may vary according to age, underlying conditions, and the clinical characteristics of the population being assessed. A low score should therefore not override persistent clinical suspicion, particularly in patients with atypical presentations or an increased risk of complicated disease.

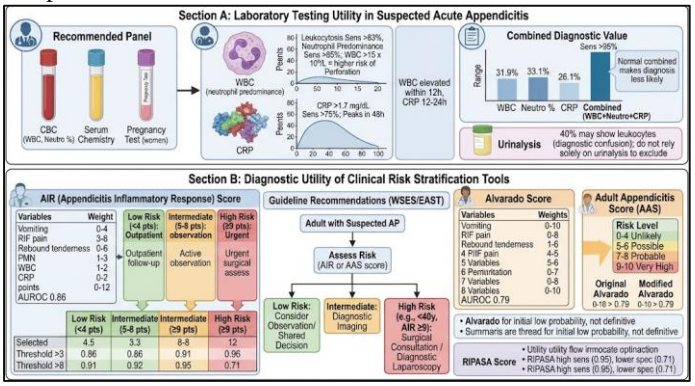


Figure-2: Laboratory Testing.

For adult patients with suspected acute appendicitis, the WSES guidelines recommend the AIR or AAS score as clinical prediction tools because of their favorable clinical performance and higher discriminating capacity [3]. Both systems can support the identification of low-risk patients, reduce unnecessary diagnostic imaging and hospital admission, and decrease negative appendectomy rates. Their use may also help direct resources toward patients with intermediate or high clinical probability, for whom further evaluation or surgical consultation is more appropriate. In patients younger than 40 years who have a high probability of appendicitis based on clinical scoring, the guidelines indicate that surgical consultation may be appropriate without routine preoperative imaging, with diagnostic and therapeutic laparoscopy considered according to the clinical assessment [3]. Overall, risk stratification scores provide a structured approach to evaluating adults with suspected acute appendicitis. The AIR and AAS scores are supported by guideline recommendations because of their clinical discrimination, while

RIPASA demonstrates high sensitivity in comparative evidence but lower specificity. The Alvarado score remains useful as an accessible initial assessment tool, particularly for identifying patients with a low probability of disease, but it should not be used alone to confirm appendicitis or determine disease severity. In younger patients with a low clinical risk, selected scoring systems may support observation and shared decision-making to reduce unnecessary imaging. Patients with intermediate scores generally require further diagnostic assessment, including imaging when indicated, while those with high scores should undergo prompt surgical evaluation. Ultimately, these tools are most effective when integrated with the patient's clinical presentation, laboratory findings, disease progression, and the availability of imaging and surgical services.

Recommended Imaging

Imaging plays an important role in the diagnosis of acute appendicitis, particularly in patients whose clinical presentation and laboratory findings do not establish a definitive diagnosis. Several imaging modalities are available, including computed tomography (CT), ultrasonography (US), and magnetic resonance imaging (MRI). The selection of an appropriate modality depends on the patient's clinical condition, pre-imaging probability of appendicitis, age, pregnancy status, availability of imaging facilities, and the need to identify alternative causes of abdominal pain [3,37]. Imaging can confirm inflammation of the appendix, identify complications such as perforation or abscess formation, and detect other abdominal or pelvic conditions that may require intervention. The American College of Radiology (ACR) Appropriateness Criteria identifies CT of the abdomen and pelvis with intravenous (IV) contrast as the recommended initial imaging examination in patients presenting with right lower quadrant (RLQ) pain, fever, and leukocytosis when acute appendicitis is suspected. CT with IV contrast is also considered usually appropriate in patients presenting with isolated RLQ pain. Depending on the clinical presentation, CT without IV contrast, US, and MRI may also be appropriate alternatives [37]. These recommendations reflect the diagnostic accuracy of CT and its ability to identify alternative abdominal and pelvic pathologies that may require medical or surgical management. In pregnant patients with suspected appendicitis, the ACR recommends abdominal US or MRI of the abdomen and pelvis without IV contrast as usually appropriate initial investigations. Pelvic US and CT with or without IV contrast may be considered appropriate in selected circumstances [37]. The Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) also recognizes US as a reasonable first-line examination because of its low cost and absence of ionizing radiation, although CT and MRI are considered more definitive diagnostic modalities [10].

CT is a reliable imaging technique for diagnosing acute appendicitis in adults and has demonstrated high sensitivity and specificity across multiple studies. Meta-analysis data indicate that CT performed with IV contrast has a sensitivity of approximately 96% and a specificity exceeding 93% [38]. Although CT with IV contrast is recommended as the initial examination by the ACR in many adult patients with suspected appendicitis, non-contrast CT also provides high diagnostic accuracy. A systematic review of seven studies reported a sensitivity of 92.7% and specificity of 96.1% for CT performed without contrast [39]. Similarly, a 2019 Cochrane review reported a sensitivity of 91% and specificity of 93% for non-contrast CT [38]. These findings indicate that IV contrast is not essential in every patient, particularly when contraindications or limitations prevent its administration. Nevertheless, the choice between contrast-enhanced and non-contrast CT should take into account the clinical question and the need to evaluate alternative diagnoses or complications. The administration of oral or rectal contrast does not appear to improve the diagnostic yield of CT in suspected appendicitis. Consequently, these contrast agents are not routinely recommended for this purpose [38,40,41]. A Cochrane review reported a sensitivity of 89% for CT performed with oral contrast, supporting the use of protocols that avoid unnecessary oral contrast administration [38]. Avoiding oral and rectal contrast may also simplify the imaging process and reduce delays in emergency assessment. CT protocols have additionally been modified to reduce radiation exposure, particularly because appendicitis frequently affects younger adults who may undergo repeated imaging examinations. Low-dose protocols generally deliver approximately 2–4 mSv, compared with 8–10 mSv for standard-dose CT [38,42].

Evidence supports the diagnostic performance of low-dose CT. A single-center study involving 879 patients found no meaningful difference in diagnostic sensitivity between low-dose and standard-dose CT, with reported values of 94.5% and 95.0%, respectively. Specificity was also similar, at 93.3% and 93.8%, respectively [42]. The OPTICAP trial further demonstrated that a low-dose CT protocol using IV contrast was not inferior to the standard-dose protocol in terms of diagnostic accuracy, while providing a lower radiation dose [43]. Consistent with these findings, a Cochrane review reported comparable sensitivity and specificity for low-dose and standard-dose CT, with sensitivity estimates of approximately 94% and 95%, respectively [38]. These results support the use of low-dose CT protocols when clinically appropriate, particularly in younger patients, provided that diagnostic image quality is maintained. Characteristic

CT findings of acute appendicitis include an enlarged appendix with an outer-to-outer diameter of at least 8–9 mm, luminal occlusion, periappendiceal fat stranding, appendiceal wall thickening exceeding 3 mm, and wall enhancement following IV contrast administration. An appendicolith may also be identified within the appendiceal lumen [37,44,45]. The presence of several of these findings increases the likelihood of acute appendicitis. Periappendiceal inflammatory changes and associated abnormalities may also help identify advanced disease. In addition to confirming appendiceal inflammation, CT can demonstrate findings associated with complicated appendicitis, including perforation, inflammatory masses, and abscess formation. This ability to evaluate both the appendix and surrounding structures makes CT particularly useful in patients with severe presentations, suspected complications, or alternative diagnoses.

Graded-compression ultrasonography is another imaging modality used to evaluate suspected acute appendicitis in adults. It is particularly valuable because it does not expose patients to ionizing radiation and is generally less expensive than CT. US is also recommended as the first-line imaging modality in pregnant patients, in whom minimizing radiation exposure is an important consideration. However, its diagnostic performance varies considerably across studies. Reported sensitivity ranges from 21% to 96%, while specificity ranges from 71% to 98% [46–57]. One important limitation is the inability to visualize the appendix consistently. Non-visualization rates range from 34% to 71%, and indeterminate examinations have been reported in up to 85% of cases [52,53,58–60]. Therefore, a non-visualized appendix should not automatically be interpreted as evidence against appendicitis, particularly when clinical suspicion remains high. The diagnostic reliability of US depends on several patient-related and technical factors. The appendix is more likely to be visualized in men, individuals with a body mass index below 22, and patients reporting a pain index greater than 6 [50,52]. Operator experience, the patient's body habitus, the anatomical position of the appendix, and the ability to apply adequate graded compression may also influence the examination. Standardized reporting of US findings has been associated with improved diagnostic reliability and may help reduce variation in interpretation [60]. Typical sonographic findings include a non-compressible appendix, appendiceal wall thickness greater than 6 mm, localized tenderness during compression over the appendix, a hyperechoic appendicolith, increased echogenicity of the surrounding periappendiceal fat, and free fluid in the RLQ [46–57]. The identification of several characteristic findings supports the diagnosis, whereas an equivocal examination generally requires correlation with clinical findings and consideration of additional imaging.

MRI is used less frequently than CT in the general adult population and is commonly considered a second- or third-line imaging modality. Its main application is the assessment of suspected appendicitis during pregnancy, particularly when US is unavailable, technically limited, or inconclusive. MRI may also be used as an initial imaging examination when appropriate facilities and experienced radiologists are available [61,62]. Unlike CT, MRI does not involve ionizing radiation, making it an important alternative when radiation exposure should be avoided. The principal imaging finding is a fluid-filled, enlarged appendix with a diameter greater than 7 mm [63–69]. Additional inflammatory changes in the surrounding tissues may support the diagnosis. The diagnostic performance of MRI in adults depends partly on radiologist experience. In studies involving experienced radiologists, sensitivity ranges from 85% to 98% and specificity from 97% to 99%. However, lower diagnostic performance has been reported among less experienced readers, with sensitivity ranging from 77% to 89% and specificity from 79% to 83% [63–69]. MRI also has a non-diagnostic rate of approximately 20–40%, which may limit its usefulness when the appendix cannot be adequately assessed [63–69]. In pregnant patients, MRI demonstrates sensitivity ranging from 89% to 100% and specificity from 93% to 99% [70–75]. These findings support its use as an important diagnostic modality in pregnancy, particularly after inconclusive US. However, MRI requires a longer acquisition time than CT, which may affect its suitability in emergency situations where rapid diagnosis and intervention are necessary [66].

Guidelines differ somewhat regarding the preferred initial imaging strategy. The ACR recommends CT with IV contrast as the initial imaging modality for many adults presenting with RLQ pain or suspected appendicitis because of its high diagnostic accuracy and ability to identify alternative pathologies [37]. In contrast, the World Society of Emergency Surgery (WSES) emphasizes the importance of integrating clinical assessment and pre-imaging probability with validated risk stratification scores [3]. According to the WSES approach, US is an appropriate first-line imaging examination in patients classified as intermediate risk using the AIR, AAS, or Alvarado scores. If US is inconclusive and right iliac fossa pain persists, further evaluation using cross-sectional imaging is recommended [3]. This approach aims to reduce unnecessary radiation exposure while maintaining diagnostic accuracy. The WSES guidelines also support the use of low-dose CT with IV contrast in patients with suspected appendicitis when clinically appropriate [3]. For pregnant patients, MRI is considered a sensitive and specific imaging modality; however, a negative or inconclusive MRI should not be used to exclude appendicitis when the clinician maintains a high level of suspicion. Continued

clinical assessment and further evaluation may therefore be necessary in selected cases [3]. CT with IV contrast is recommended when complicated appendicitis is suspected, including cases involving perforation, phlegmon, or abscess formation. It is also particularly useful in elderly patients, in whom atypical presentations and alternative abdominal pathologies may complicate the diagnostic process.

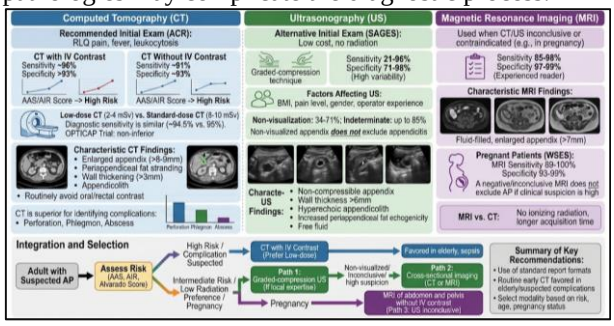


Figure-3: Recommended Imaging of Appendicitis.

Overall, imaging selection should be individualized according to clinical risk, patient characteristics, and the suspected severity of disease. In well-appearing adults with an intermediate probability of appendicitis, US may be considered as an initial examination, particularly when radiation exposure is a concern and local expertise is available. If the appendix cannot be visualized, the findings remain indeterminate, or clinical suspicion persists, CT should be considered, preferably with IV contrast when appropriate. CT is also favored in elderly patients, critically ill patients, and those with suspected sepsis or complicated appendicitis because of its ability to assess the appendix and surrounding structures. Oral and rectal contrast should not be routinely used because they do not improve diagnostic yield. In pregnant patients, US and MRI should be prioritized when available, with MRI serving as an important option after inconclusive US. Ultimately, the optimal imaging strategy combines clinical risk assessment, appropriate modality selection, and reassessment when imaging findings do not adequately explain the patient's clinical presentation.

Antibiotics Or Operative Intervention:

Management of acute appendicitis involves determining whether the patient requires immediate operative intervention or may be suitable for non-operative treatment with antibiotics. All patients diagnosed with acute appendicitis should receive surgical consultation, and intravenous (IV) antibiotics should be initiated as soon as possible after diagnosis [76]. The choice of treatment depends on disease severity, the presence of complications, clinical stability, imaging findings, and patient-related factors. Patients with perforated appendicitis accompanied by a phlegmon or localized abscess may be managed initially with IV antibiotics and image-guided drainage when appropriate. Early appendectomy in these patients has been associated with worse outcomes, making initial non-operative management a reasonable approach in selected clinically stable cases [3,9]. However, patients who fail to improve with antibiotic therapy and drainage require further intervention, including appendectomy when indicated [77]. Continuous clinical reassessment is essential to identify treatment failure or progression of infection. Non-operative management with antibiotics alone has also emerged as an alternative to appendectomy in selected patients with uncomplicated acute appendicitis [78–87]. Uncomplicated appendicitis is generally defined by the absence of abscess, gangrene, perforation, sepsis, and hemodynamic instability [78–87]. Appropriate patient selection is important because the success of antibiotic treatment depends partly on the severity of inflammation and the presence of an appendicolith. A 2025 meta-analysis evaluated six randomized trials published between 2011 and 2021, involving 2,101 participants, of whom 1,050 received antibiotics and 1,051 underwent appendectomy [87]. Within one year, complications occurred in 57 patients (5.4%) receiving antibiotics alone compared with 87 patients (8.3%) undergoing appendectomy. This difference was not statistically significant (OR 0.49, 95% CI 0.20–1.20) [87]. Nevertheless, 33.9% of patients initially assigned to antibiotic treatment had undergone appendectomy by one year, demonstrating that non-operative management does not eliminate the possibility of subsequent surgery.

The presence of an appendicolith is an important factor when considering antibiotic-only treatment. In the 2025 meta-analysis, patients with an appendicolith who received antibiotics had a higher complication rate than those undergoing appendectomy (15.0% versus 6.3%; OR 2.82, 95% CI 1.11–7.18; risk difference 13.2%, 95% CI 2.3%–24.2%) [87]. Furthermore, among patients randomized to antibiotics alone, 94 of 193 patients with an appendicolith (48.7%) underwent appendectomy within one year, compared with 262 of 857 patients without an appendicolith (30.6%) [87]. These findings indicate that the presence of an appendicolith increases the likelihood of treatment failure, complications, and subsequent operative intervention. Therefore, patients without an appendicolith are generally more suitable candidates for antibiotic-first management. Guidelines differ regarding the preferred treatment strategy. The Journal of Trauma and Acute Care Surgery Emergency General Surgery Work Group, the American Association for the Surgery of Trauma (AAST), and the World Society of Emergency Surgery (WSES) support non-operative management with antibiotics in selected patients with uncomplicated appendicitis [3,9,88]. In contrast, the Eastern Association for the Surgery of Trauma does not recommend either for or against antibiotic-first treatment compared with surgery because of

limitations in the available evidence [89]. The 2024 SAGES guidelines recommend operative management for both uncomplicated and complicated appendicitis rather than non-operative treatment [10]. Differences also exist regarding appendicoliths. The WSES supports antibiotic treatment in uncomplicated appendicitis without an appendicolith, whereas the AAST states that a fecalith does not absolutely exclude non-operative management but increases the likelihood of requiring additional procedures [3,88].

When antibiotic-first treatment is selected, guidelines generally recommend initiating IV antibiotics followed by conversion to oral therapy according to the patient's clinical condition and response to treatment [3]. Many studies evaluating this approach used CT imaging to confirm uncomplicated appendicitis before treatment. Their protocols commonly involved several days of inpatient IV antibiotic therapy, followed by oral antibiotics for 7–10 days [3,90]. However, the optimal antibiotic regimen and duration may vary between protocols. The APPAC II trial, which included 583 patients with uncomplicated appendicitis, compared oral moxifloxacin 400 mg daily for seven days with IV ertapenem 1 g followed by oral levofloxacin 500 mg and metronidazole 500 mg three times daily for five days [91]. Oral moxifloxacin monotherapy failed to demonstrate non-inferiority compared with the combination regimen. A secondary analysis also identified a slightly higher appendectomy rate among patients receiving oral antibiotic monotherapy, and non-inferiority could not be established [92]. These findings indicate that antibiotic route and regimen should be selected carefully rather than assuming that oral monotherapy is equivalent to an IV-to-oral treatment strategy. Antibiotics are also recommended in patients awaiting appendectomy. A 2025 nested trial randomized patients with appendicitis without perforation who were awaiting surgery to receive antibiotics until induction of anesthesia or to receive no antibiotics during this period [93]. The rates of perforation were similar between the groups (8.3% versus 8.9%; difference 0.6%, 95% CI −2% to 3.2%). However, the surgical site infection rate was lower among patients receiving antibiotics, occurring in 14 of 887 patients (1.6%), compared with 28 of 886 patients (3.2%) who did not receive antibiotics. The absolute difference was 1.6 percentage points (95% CI 0.2–3.0) [93]. These findings support the continued use of antibiotics following diagnosis, including in patients scheduled for operative management, consistent with current guidelines [3,9].

Overall, appendectomy remains an established treatment for acute appendicitis, particularly in patients with complicated disease, clinical deterioration, sepsis, or hemodynamic instability. Antibiotic-only treatment may be considered in carefully selected patients with uncomplicated appendicitis, especially when imaging confirms the absence of an appendicolith and the patient remains clinically stable. All patients should receive surgical consultation, and shared decision-making should address the potential for treatment failure, recurrence, complications, and subsequent appendectomy [3]. Antibiotic-only management is not recommended by the cited guidance for pregnant patients or elderly patients who are suitable candidates for surgery [3,94]. The final treatment decision should therefore consider disease severity, imaging findings, patient characteristics, clinical response, and the patient's informed preference.

Conclusion:

Acute appendicitis in adults requires recognition and a coordinated diagnostic and treatment strategy. History and physical examination remain essential, but their findings should be interpreted alongside inflammatory markers and validated risk scores. No individual symptom, sign, or laboratory result can reliably establish or exclude the diagnosis. Imaging should be selected according to clinical risk and patient characteristics. CT offers high diagnostic accuracy in most adults, whereas ultrasonography can limit radiation exposure and MRI provides an alternative during pregnancy. Appendectomy remains an established and definitive treatment. Antibiotic therapy alone is a reasonable option for selected patients with uncomplicated disease, particularly when an appendicolith is absent, provided that patients understand the possibility of treatment failure, recurrence, and subsequent surgery. Complicated appendicitis requires individualized decisions based on perforation, abscess, physiological stability, and response to initial treatment. A risk-based approach and shared decision-making can support care and reduce avoidable interventions.

References:

1. Morley EJ, Bracey A, Reiter M, et al. Association of pain location with computed tomography abnormalities in emergency department patients with abdominal pain. *Journal of Emergency Medicine*. 2020;59:485-490.
2. Cervellin G, Mora R, Ticinesi A, et al. Epidemiology and outcomes of acute abdominal pain in a large urban emergency department: retrospective analysis of 5,340 cases. *Annals of Translational Medicine*. 2016;4:362.
3. Di Saverio S, Podda M, De Simone B, et al. Diagnosis and treatment of acute appendicitis: 2020 update of the WSES Jerusalem guidelines. *World Journal of Emergency Surgery*. 2020;15(1):27.
4. Petroianu A. Diagnosis of acute appendicitis. *International Journal of Surgery*. 2012;10(3):115-119.
5. Livingston EH, Woodward WA, Sarosi GA, et al. Disconnect between incidence of nonperforated and perforated appendicitis: implications for pathophysiology and

management. *Annals of Surgery*. 2007;245:886-892.
6. Ilves I. Seasonal variations of acute appendicitis and nonspecific abdominal pain in Finland. *World Journal of Gastroenterology*. 2014;20:4037.
7. Viniol A, Keunecke C, Biroga T, et al. Studies of the symptom abdominal pain: a systematic review and meta-analysis. *Family Practice*. 2014;31:517-529.
8. Bhangu A, Søreide K, Di Saverio S, et al. Acute appendicitis: modern understanding of pathogenesis, diagnosis, and management. *The Lancet*. 2015;386(10000):1278-1287. (Published correction appears in *The Lancet*. 2017;390(10104):1736.)
9. Diaz JJ, Napolitano L, Livingston DH, et al. Evidence-based, cost-effective management of acute appendicitis: an algorithm of the Journal of Trauma and Acute Care Surgery Emergency General Surgery Algorithms Work Group. *Journal of Trauma and Acute Care Surgery*. 2025;98(3):368-373.
10. Kumar SS, Collings AT, Lamm R, et al. SAGES guideline for the diagnosis and treatment of appendicitis. *Surgical Endoscopy*. 2024;38(6):2974-2994.
11. Sartelli M, Baiocchi GL, Di Saverio S, et al. Prospective observational study on acute appendicitis worldwide (POSAW). *World Journal of Emergency Surgery*. 2018;13:19.
12. Fugazzola P, Ceresoli M, Agnoletti V, et al. The SIFIPAC/WSES/SICG/SIMEU guidelines for diagnosis and treatment of acute appendicitis in the elderly (2019 edition). *World Journal of Emergency Surgery*. 2020;15(1):19.
13. Lee SL, Walsh AJ, Ho HS. Computed tomography and ultrasonography do not improve and may delay the diagnosis and treatment of acute appendicitis. *Archives of Surgery*. 2001;136(5):556-562.
14. Wagner JM, McKinney WP, Carpenter JL. Does this patient have appendicitis? *JAMA*. 1996;276(19):1589-1594.
15. Golledge J, Toms AP, Franklin IJ, et al. Assessment of peritonism in appendicitis. *Annals of the Royal College of Surgeons of England*. 1996;78(1):11-14.
16. Andersson RE, Hugander AP, Ghazi SH, et al. Diagnostic value of disease history, clinical presentation, and inflammatory parameters of appendicitis. *World Journal of Surgery*. 1999;23(2):133-140.
17. Lane R, Grabham J. A useful sign for the diagnosis of peritoneal irritation in the right iliac fossa. *Annals of the Royal College of Surgeons of England*. 1997;79(2):128-129.
18. Tanrıdan Okcu N, Banlı Cesur İ, İrkörücü O. Acute appendicitis in pregnancy: 50 case series, maternal and neonatal outcomes. *Ulusal Travma ve Acil Cerrahi Dergisi*. 2021;27(2):255-259.
19. Franca Neto AH, Amorim MM, Nóbrega BM. Acute appendicitis in pregnancy: literature review. *Revista da Associação Médica Brasileira*. 2015;61(2):170-177.
20. Lapsa S, Ozolins A, Strumfa I, Gardovskis J. Acute appendicitis in the elderly: a literature review on an increasingly frequent surgical problem. *Geriatrics (Basel)*. 2021;6(3):93.
21. Er S, Özden S, Turan UF, Özdemir E, Saylam B, Tez M. Differences in the clinical course of acute appendicitis in geriatric patient groups. *Bulletin of Emergency and Trauma*. 2020;8(4):224-228.
22. Khan MN, Davie E, Irshad K. The role of white cell count and C-reactive protein in the diagnosis of acute appendicitis. *Journal of Ayub Medical College Abbottabad*. 2004;16(3):17-19.
23. Yang HR, Wang YC, Chung PK, et al. Laboratory tests in patients with acute appendicitis. *ANZ Journal of Surgery*. 2006;76(1-2):71-74.
24. Yang HR, Wang YC, Chung PK, et al. Role of leukocyte count, neutrophil percentage, and C-reactive protein in the diagnosis of acute appendicitis in the elderly. *The American Surgeon*. 2005;71(4):344-347.
25. Andersson M, Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. *World Journal of Surgery*. 2008;32(8):1843-1849.
26. Andersson RE, Stark J. Diagnostic value of the appendicitis inflammatory response (AIR) score: a systematic review and meta-analysis. *World Journal of Emergency Surgery*. 2025;20(1):12.
27. Chen KC, Arad A, Chen KC, et al. The clinical value of pathology tests and imaging study in the diagnosis of acute appendicitis. *Postgraduate Medical Journal*. 2016;92(1092):611-619.
28. Baird DLH, Simillis C, Kontovounisios C, et al. Acute appendicitis. *BMJ*. 2017;357:j1703.
29. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Annals of Emergency Medicine*. 1986;15(5):557-564.
30. Bolívar-Rodríguez MA, Osuna-Wong BA, Calderón-Alvarado AB, et al. Análisis comparativo de escalas diagnósticas de apendicitis aguda: Alvarado, RIPASA y AIR [Comparative analysis of diagnostic scales of acute appendicitis: Alvarado, RIPASA and AIR]. *Cirugía y Cirujanos*. 2018;86(2):169-174.
31. Ghali MS, Hasan S, Al-Yahri O, et al. Adult appendicitis score versus Alvarado score: a comparative study in the diagnosis of acute appendicitis. *Surgery Open Science*. 2023;14:96-102.
32. Chong CF, Adi MI, Thien A, et al. Development of the RIPASA score: a new appendicitis scoring

system for the diagnosis of acute appendicitis. *Singapore Medical Journal*. 2010;51(3):220-225.
33. Sulo SS, Al-Atrakchi HA. The modified Alvarado score versus Alvarado score in the diagnosis of acute appendicitis. *Medical Journal of Babylon*. 2019;16(3):203-206.
34. Favara G, Maugeri A, Barchitta M, et al. Comparison of RIPASA and ALVARADO scores for risk assessment of acute appendicitis: a systematic review and meta-analysis. *PLoS One*. 2022;17(9):e0275427.
35. Frountzas M, Stergios K, Kopsini D, et al. Alvarado or RIPASA score for diagnosis of acute appendicitis? A meta-analysis of randomized trials. *International Journal of Surgery*. 2018;56:307-314.
36. Appendicitis Score. https://www.appendicitisscore.com/
37. Expert Panel on Gastrointestinal Imaging; Kambadakone AR, Santillan CS, Kim DH, et al. ACR Appropriateness Criteria® right lower quadrant pain: 2022 update. *Journal of the American College of Radiology*. 2022;19(11S):S445-S461.
38. Rud B, Vejborg TS, Rappeport ED, et al. Computed tomography for diagnosis of acute appendicitis in adults. *Cochrane Database of Systematic Reviews*. 2019;2019(11):CD009977.
39. Hlibczuk V, Dattaro JA, Jin Z, et al. Diagnostic accuracy of noncontrast computed tomography for appendicitis in adults: a systematic review. *Annals of Emergency Medicine*. 2010;55:51-59.e1.
40. Kepner AM, Bacasnot JV, Stahlman BA. Intravenous contrast alone vs intravenous and oral contrast computed tomography for the diagnosis of appendicitis in adult ED patients. *American Journal of Emergency Medicine*. 2012;30(9):1765-1773.
41. Paulson EK, Coursey CA. CT protocols for acute appendicitis: time for change. *American Journal of Roentgenology*. 2009;193(5):1268-1271.
42. Kim K, Kim YH, Kim SY, et al. Low-dose abdominal CT for evaluating suspected appendicitis. *New England Journal of Medicine*. 2012;366(17):1596-1605.
43. Sippola S, Virtanen J, Tammilehto V, et al. The accuracy of low-dose computed tomography protocol in patients with suspected acute appendicitis: the OPTICAP study. *Annals of Surgery*. 2018.
44. Ives E, Sung S, McCue P, Durrani H, Halpern E. Independent predictors of acute appendicitis on CT with pathologic correlation. *Academic Radiology*. 2008;15(8):996-1003.
45. Cho J, Akers M, Siavoshi M, et al. Features on computed tomography that correlate with acute appendicitis. *The American Surgeon*. 2023;89(6):2876-2879.
46. Sezer TO, Gulece B, Zalluhoglu N, et al. Diagnostic value of ultrasonography in appendicitis. *Advances in Clinical and Experimental Medicine*. 2012;21:633-636.
47. Hasani SA, Fathi M, Daadpey M, et al. Accuracy of bedside emergency physician performed ultrasound in diagnosing different causes of acute abdominal pain: a prospective study. *Clinical Imaging*. 2015;39:476-479.
48. Eng KA, Abadeh A, Ligocki C, et al. Acute appendicitis: a meta-analysis of the diagnostic accuracy of US, CT, and MRI as second-line imaging tests after an initial US. *Radiology*. 2018;288:717-727.
49. Piyarom P, Kaewlai R. False-negative appendicitis at ultrasound: nature and association. *Ultrasound in Medicine & Biology*. 2014;40:1483-1489.
50. Al-Ajerami Y. Sensitivity and specificity of ultrasound in the diagnosis of acute appendicitis. *Eastern Mediterranean Health Journal*. 2012;18:66-69.
51. Boonstra PA, van Veen RN, Stockmann HB. Less negative appendectomies due to imaging in patients with suspected appendicitis. *Surgical Endoscopy*. 2015;29:2365-2370.
52. Kaewlai R, Lertlumsakulsub W, Srichareon P. Body mass index, pain score and Alvarado score are useful predictors of appendix visualization at ultrasound in adults. *Ultrasound in Medicine & Biology*. 2015;41:1605-1611.
53. Lourenco P, Brown J, Leipsic J, Hague C. The current utility of ultrasound in the diagnosis of acute appendicitis. *Clinical Imaging*. 2016;40:944-948.
54. Stewart JK, Olcott EW, Jeffrey RB. Sonography for appendicitis: nonvisualization of the appendix is an indication for active clinical observation rather than direct referral for computed tomography. *Journal of Clinical Ultrasound*. 2012;40:455-461.
55. Shen G, Wang J, Fei F, et al. Bedside ultrasonography for acute appendicitis: an updated diagnostic meta-analysis. *International Journal of Surgery*. 2019;70:1-9.
56. Chang ST, Jeffrey RB, Olcott EW. Three-step sequential positioning algorithm during sonographic evaluation for appendicitis increases appendiceal visualization rate and reduces CT use. *American Journal of Roentgenology*. 2014;203:1006-1012.
57. Fields JM, Davis J, Alsup C, et al. Accuracy of point-of-care ultrasonography for diagnosing acute appendicitis: a systematic review and meta-analysis. *Academic Emergency Medicine*. 2017;24:1124-1136.
58. Segev L, Segev Y, Rayman S, et al. The diagnostic performance of ultrasound for acute appendicitis in pregnant and young nonpregnant

women: a case-control study. *International Journal of Surgery*. 2016;34:81-85.
59. Lehnert BE, Gross JA, Linnau KF, et al. Utility of ultrasound for evaluating the appendix during the second and third trimester of pregnancy. *Emergency Radiology*. 2012;19:293-299.
60. Sola R, Theut SB, Sinclair KA, et al. Standardized reporting of appendicitis-related findings improves reliability of ultrasound in diagnosing appendicitis in children. *Journal of Pediatric Surgery*. 2018;53:984-987.
61. Garcia EM, Camacho MA, Karolyi DR, et al. ACR Appropriateness Criteria® right lower quadrant pain: suspected appendicitis. *Journal of the American College of Radiology*. 2018;15:S373-S387.
62. Amitai MM, Katorza E, Guranda L, et al. Role of emergency magnetic resonance imaging for the workup of suspected appendicitis in pregnant women. *Israel Medical Association Journal*. 2016;18:600-604.
63. Blumenfeld YJ, Wong AE, Jafari A, et al. MR imaging in cases of antenatal suspected appendicitis: a meta-analysis. *Journal of Maternal-Fetal & Neonatal Medicine*. 2011;24:485-488.
64. Heverhagen JT, Pfestroff K, Heverhagen AE, et al. Diagnostic accuracy of magnetic resonance imaging: a prospective evaluation of patients with suspected appendicitis (DIAMOND). *Journal of Magnetic Resonance Imaging*. 2012;35:617-623.
65. Inoue A, Furukawa A, Nitta N, et al. Accuracy, criteria, and clinical significance of visual assessment on diffusion-weighted imaging and apparent diffusion coefficient quantification for diagnosing acute appendicitis. *Abdominal Radiology (NY)*. 2019;44:3235-3245.
66. Petkovska I, Martin DR, Covington MF, et al. Accuracy of unenhanced MR imaging in the detection of acute appendicitis: single-institution clinical performance review. *Radiology*. 2016;279:451-460.
67. Byott S, Harris I. Rapid acquisition axial and coronal T2 HASTE MR in the evaluation of acute abdominal pain. *European Journal of Radiology*. 2016;85:286-290.
68. Leeuwenburgh MM, Wiarda BM, Wiezer MJ, et al. Comparison of imaging strategies with conditional contrast-enhanced CT and unenhanced MR imaging in patients suspected of having appendicitis: a multicenter diagnostic performance study. *Radiology*. 2013;268:135-143.
69. Duke E, Kalb B, Arif-Tiwari H, et al. A systematic review and meta-analysis of diagnostic performance of MRI for evaluation of acute appendicitis. *American Journal of Roentgenology*. 2016;206:508-517.
70. Ramalingam V, LeBedis C, Kelly JR, et al. Evaluation of a sequential multi-modality imaging algorithm for the diagnosis of acute appendicitis in the pregnant female. *Emergency Radiology*. 2015;22:125-132.
71. Burke LM, Bashir MR, Miller FH, et al. Magnetic resonance imaging of acute appendicitis in pregnancy: a 5-year multiinstitutional study. *American Journal of Obstetrics and Gynecology*. 2015;213:693.e1-e6.
72. Theilen LH, Mellnick VM, Longman RE, et al. Utility of magnetic resonance imaging for suspected appendicitis in pregnant women. *American Journal of Obstetrics and Gynecology*. 2015;212:345.e1-e6.
73. Konrad J, Grand D, Lourenco A. MRI: first-line imaging modality for pregnant patients with suspected appendicitis. *Abdominal Imaging*. 2015;40:3359-3364.
74. Rapp EJ, Naim F, Kadivar K, et al. Integrating MR imaging into the clinical workup of pregnant patients suspected of having appendicitis is associated with a lower negative laparotomy rate: single-institution study. *Radiology*. 2013;267:137-144.
75. American College of Radiology, ACR Committee on MR Safety. *ACR Manual on MR Safety*. Version 1.0. 2022. https://www.acr.org/-/media/ACR/Files/Radiology-Safety/MR-Safety/Manual-on-MR-Safety.pdf. Accessed March 31.
76. Bratzler DW, Dellinger EP, Olsen KM, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. *American Journal of Health-System Pharmacy*. 2013;70(3):195-283. doi:10.2146/ajhp120568.
77. Gorter RR, Eker HH, Gorter-Stam MA, et al. Diagnosis and management of acute appendicitis: EAES consensus development conference 2015. *Surgical Endoscopy*. 2016;30(11):4668-4690.
78. Podda M, Gerardi C, Cillara N, et al. Antibiotic treatment and appendectomy for uncomplicated acute appendicitis in adults and children: a systematic review and meta-analysis. *Annals of Surgery*. 2019;270:1028-1040.
79. Harnoss JC, Zelienka I, Probst P, et al. Antibiotics versus surgical therapy for uncomplicated appendicitis: systematic review and meta-analysis of controlled trials (PROSPERO 2015: CRD42015016882). *Annals of Surgery*. 2017;265(5):889-900.
80. Salminen P, Paajanen H, Rautio T, et al. Antibiotic therapy vs appendectomy for treatment of uncomplicated acute appendicitis: the APPAC randomized clinical trial. *JAMA*. 2015;313(23):2340-2348.
81. Huston JM, Kao LS, Chang PK, et al. Antibiotics vs. appendectomy for acute uncomplicated

appendicitis in adults: review of the evidence and future directions. *Surgical Infections*. 2017;18:527-535.
82. Vons C, Barry C, Maitre S, et al. Amoxicillin plus clavulanic acid versus appendicectomy for treatment of acute uncomplicated appendicitis: an open-label, non-inferiority, randomised controlled trial. *The Lancet*. 2011;377(9777):1573-1579.
83. Talan DA, Saltzman DJ, Mower WR, et al; Olive View-UCLA Appendicitis Study Group. Antibiotics-first versus surgery for appendicitis: a US pilot randomized controlled trial allowing outpatient antibiotic management. *Annals of Emergency Medicine*. 2017;70(1):1-11.e9.
84. O'Leary DP, Walsh SM, Bolger J, et al. A randomized clinical trial evaluating the efficacy and quality of life of antibiotic-only treatment of acute uncomplicated appendicitis: results of the COMMA trial. *Annals of Surgery*. 2021;274(2):240-247.
85. Ceresoli M, Pisano M, Allievi N, et al. Never put equipoise in appendix! Final results of ASAA (antibiotics vs. surgery for uncomplicated acute appendicitis in adults) randomized controlled trial. *Updates in Surgery*. 2019;71(2):381-387.
86. CODA Collaborative; Davidson GH, Flum DR, Monsell SE, et al. Antibiotics versus appendectomy for acute appendicitis: longer-term outcomes. *New England Journal of Medicine*. 2021;385(25):2395-2397.
87. Scheijmans JCG, Haijanen J, Flum DR, et al. Antibiotic treatment versus appendicectomy for acute appendicitis in adults: an individual patient data meta-analysis. *The Lancet Gastroenterology & Hepatology*. 2025;10(3):222-233.
88. Schuster KM, Holena DN, Salim A, et al. American Association for the Surgery of Trauma emergency general surgery guideline summaries 2018: acute appendicitis, acute cholecystitis, acute diverticulitis, acute pancreatitis, and small bowel obstruction. *Trauma Surgery & Acute Care Open*. 2019;4(1):e000281.
89. Rushing A, Bugaev N, Jones C, et al. Management of acute appendicitis in adults: a practice management guideline from the Eastern Association for the Surgery of Trauma. *Journal of Trauma and Acute Care Surgery*. 2019;87(1):214-224.
90. Podda M, Cillara N, Di Saverio S, et al. Antibiotics-first strategy for uncomplicated acute appendicitis in adults is associated with increased rates of peritonitis at surgery: a systematic review with meta-analysis of randomized controlled trials comparing appendectomy and non-operative management with antibiotics. *The Surgeon*. 2017;15:303-314.
91. Sippola S, Haijanen J, Grönroos J, et al. Effect of oral moxifloxacin vs intravenous ertapenem plus oral levofloxacin for treatment of uncomplicated acute appendicitis: the APPAC II randomized clinical trial. *JAMA*. 2021;325(4):353-362.
92. Selänne L, Haijanen J, Sippola S, et al. Three-year outcomes of oral antibiotics vs intravenous and oral antibiotics for uncomplicated acute appendicitis: a secondary analysis of the APPAC II randomized clinical trial. *JAMA Surgery*. 2024;159(7):727-735.
93. Jalava K, Sallinen V, Lampela H, et al. Role of preoperative antibiotic treatment while awaiting appendectomy: the PERFECT-antibiotics randomized clinical trial. *JAMA Surgery*. 2025;160(7):745-754.

Antoniou SA, Mavridis D, Kontouli KM, et al. EAES rapid guideline: appendicitis in the elderly. *Surgical Endoscopy*. 2021;35(7):3233-3243.