



State of the Art Review: Evidence based management of acute appendicitis

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Abstract

Introduction: Even though acute appendicitis is the world's most common emergency general surgical operation, it remains under-researcher with wide variations in care. The aim of this review was to present current evidence on the management of acute appendicitis, focusing on risk assessment, diagnostic modalities, treatment strategies, and special considerations for specific patient populations.

Methods: We conducted a modified, scoping Delphi to prioritise topic areas for inclusion in this review. Consensus was achieved when each topic had >70% for either important or strongly important. Scoping reviews of current and grey literature were conducted to identify relevant evidence, focussing on new publications in the last 5 years (2019-2024).

Results: Validated risk scoring systems, such as the Adult Appendicitis Score and the AIRS score, aid in identifying low-risk patients suitable for ambulatory management, while imaging modalities, including CT scans and ultrasound, play a pivotal role in confirming diagnosis and guiding treatment decisions. The review highlights the efficacy of surgical intervention versus antibiotic therapy, emphasising the importance of shared decision-making and individualised treatment plans. Tailored care strategies are needed for elderly patients, pregnant women, and those with appendiceal neoplasms whilst strategies for optimising antibiotic stewardship, minimising negative appendectomy rates, and enhancing postoperative care will provide the best evidence-based care.

Discussion: This review provides evidence-based practices can be integrated into routine clinical care and ongoing education for frontline clinicians. The practice recommendations are designed to be evidence based and can be tailored depending on local resources. These should form the basis of future educational packages and surgical training programmes.

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Cite as: SK Kamarajah, M El Boghdady, TTK Anyomih, JM Wohlgemut, A Bhangu. State of the Art Review: Evidence based management of acute appendicitis. *Impact Surgery*. 2024;1(2):35-40. Doi: <https://doi.org/10.62463/surgery.45>

Introduction

Acute appendicitis remains one of the most common surgical emergencies worldwide, presenting clinicians with diagnostic and therapeutic challenges. With advancements in diagnostic modalities and treatment strategies, there is a growing need for a comprehensive review of the evidence-based management of this condition. The aim of this review was to present current evidence on the management of acute appendicitis, focusing on risk assessment, diagnostic modalities, treatment strategies, and special considerations for specific patient populations. We seek to update medical students, surgeons, and educational modules in current best evidence-based practice.

Methods

We conducted a modified Delphi process involving a writing panel of experienced surgeons actively involved in the clinical care of patients presenting with acute appendicitis. The Delphi process commenced with the identification of key topics essential for inclusion in this evidence-based review. After creating a long-list of potential topics, including but not limited to risk scoring systems, antibiotic therapy, and management strategies for high-risk patients, two rounds of prioritisation were conducted. During these rounds, panelists independently rated the importance of each topic based on predefined criteria, including clinical relevance, potential impact on patient outcomes, and gaps in current literature.

Following the prioritisation rounds, consensus was reached among the panelists, resulting in the selection of six core topics deemed critical for comprehensive coverage in the review. Consensus was achieved when each topic had >70% for either important or strongly important. These topics were:

1. Risk scoring in patients with acute appendicitis
2. Computed tomography imaging for medium- and high-risk patients
3. Optimal treatment strategies for acute appendicitis
4. Duration of postoperative antibiotic therapy
5. Management of appendicitis in pregnant patients
6. Appendicitis management considerations for patients aged >55 years.
7. Appendiceal neoplasms

The final selection of topics was based on the collective expertise and consensus among the panelists, ensuring a robust and comprehensive examination of evidence-based practices in the management of acute appendicitis. Scoping reviews of current and grey literature were conducted to identify relevant evidence, focussing on new publications in the last 5 years (2019-2024).

Results

Risk scoring in patients with acute appendicitis

Risk assessment for patients with acute appendicitis is crucial in clinical management. A significant number of patients presenting with right iliac fossa pain do not have appendicitis and may require admission or further imaging. However, low-risk patients can be safely managed on an ambulatory pathway. Identifying these patients can be facilitated by utilizing validated risk scores such as the Adult Appendicitis Score for males and the AIRS score for females.¹ Despite accumulating evidence supporting the efficacy of these scores, their integration into routine clinical practice remains limited. This can be attributed to a lack of understanding among clinicians regarding the most recent research findings. Addressing this gap may involve implementing regular training sessions for frontline clinicians, including incoming surgeons to your department.

Computed tomography imaging for medium- and high-risk patients

The process of selecting an imaging modality for diagnosing appendicitis presents a complex challenge. While CT scans are the preferred choice in regions such as the US, concerns regarding radiation exposure and cost have led to a preference for ultrasound in countries like Netherlands and the UK, particularly among younger patients. However, ultrasound's effectiveness can be compromised by variability between operators, and its availability may be limited to working hours, unlike CT scans which are accessible round-the-clock. Utilising a low-dose, non-contrast CT scan provides the best evidence to guide decisions regarding discharge or surgical intervention. Relying solely on surgery for high-risk patients often results in unnecessary operations, contributing to a significant number of negative appendicectomies which is an operation that should no longer be viewed as a diagnostic or routine procedure.

The hesitancy towards imaging, particularly CT scans,

is often rooted in concerns over potential risks of haematological malignancies, particularly in paediatric patients. However, it's important to note that many of these studies only suggest an association without establishing causation, with a minimal estimated increase in cancer incidence of 0.02%. When juxtaposed with the mortality rates associated with appendectomy (0.04% in adults, 0.01% in children) and their respective complication rates (3% in adults, 2.1% in children), the necessity for imaging becomes evident. Its judicious use can significantly reduce the occurrence of negative appendectomies, which can occur at rates as high as 19 - 21%.²⁻⁴

Although MRI shows promise, its widespread adoption is hindered by cost, accessibility, and the requirement for specialised expertise in MRI gastrointestinal radiology. Currently, MRI is predominantly reserved for pregnant women or children with inconclusive ultrasound results. Whenever possible, CT scans should be prioritised as the initial diagnostic imaging modality due to their higher accuracy and lower rates of negative appendectomy compared to other imaging techniques.

Optimal treatment strategies for acute appendicitis

Although surgery remains the predominant treatment modality for acute appendicitis, antibiotic therapy has emerged as a potential non-operative approach for select patients. Studies have shown that approximately 70-80% of patients treated with antibiotics experience resolution of symptoms without immediate surgical intervention.⁵ However, it's crucial to note that despite initial success, antibiotic failure rates are substantial in the long term. One landmark randomized controlled trial (RCT) published in JAMA Surgery reported a failure rate of antibiotic therapy for uncomplicated appendicitis as high as 39% within one year of treatment initiation. Similarly, a meta-analysis encompassing multiple RCTs found that while initial success rates with antibiotics were promising, recurrence rates ranged from 20% to 45% within one year, highlighting the challenges associated with long-term efficacy.⁶ These statistics underscore the importance of careful patient selection and ongoing monitoring when considering antibiotic therapy as a non-operative option for appendicitis.

Moreover, while antibiotic therapy offers certain advantages such as avoiding surgical risks and reducing healthcare costs, its efficacy must be weighed against the potential for recurrence and the need for subsequent surgical intervention. Despite the higher failure rates compared to surgery, antibiotic therapy

remains a valuable option for patients who are unfit for surgery or prefer a non-operative approach. Additionally, recent studies have explored strategies to optimize the effectiveness of antibiotic therapy, such as prolonged antibiotic courses or adjunctive therapies. For instance, a systematic review published in the Annals of Surgery suggested that prolonged antibiotic courses beyond seven days may reduce recurrence rates and improve long-term outcomes. Furthermore, adjunctive therapies such as probiotics have shown promise in reducing the risk of recurrent appendicitis following antibiotic treatment. Overall, while antibiotic therapy for appendicitis offers a non-operative alternative for select patients, careful consideration of patient factors and long-term outcomes is essential in decision-making regarding treatment strategies.

Duration of postoperative antibiotic therapy

The administration of antibiotics following appendectomy exhibits considerable variability in clinical practice. For patients with acute uncomplicated appendicitis, robust evidence from randomized controlled trials (RCTs) supports the equivalence of shorter antibiotic courses post-laparoscopic surgery.⁷ This approach not only offers comparable outcomes but also holds potential for cost savings and mitigating antimicrobial resistance.

Conversely, in cases of complicated appendicitis or open surgeries necessitating more extensive procedures, a brief course of post-operative antibiotics is recommended, aligning with guidelines from the World Society of Emergency Surgery (WSES).⁸ There's an ongoing opportunity to refine postoperative antibiotic stewardship, particularly in healthy young adult patients, aiming to judiciously discontinue prophylactic antibiotics and introduce enhanced recovery and ambulatory treatment pathways for uncomplicated appendicitis.

Recent studies have further corroborated the safety and efficacy of short antibiotic regimens for complicated appendicitis. A multicentre randomized trial demonstrated non-inferiority between 2-day and 5-day postoperative intravenous antibiotic courses for complex appendicitis in terms of postoperative infectious complications. Similarly, a prospective randomized trial evaluating complicated appendicitis types, including gangrenous, perforated, and those with peri-appendicular abscesses, found comparable outcomes between 24-hour oral administration and intravenous antibiotics following laparoscopic appendectomy. These findings underscore the feasibility and efficacy of tailored antibiotic approaches in managing complicated

appendicitis, emphasizing the importance of evidence-based antibiotic stewardship in postoperative care protocols.

Management of appendicitis in pregnant patients

Diagnosing appendicitis and managing operative intervention in pregnant women can be challenging.⁹ The displacement of the appendix due to the enlarging uterus to the right upper quadrant, coupled with physiological changes (e.g. elevated white cell count during pregnancy), complicates accurate diagnosis. Despite the scarcity of robust evidence due to ethical constraints on randomising pregnant patients, several evidence-based recommendations can guide clinical practice.

Firstly, imaging is best practice for confirming diagnosis, ideally with a same day MRI scan through an established protocol with radiology. Secondly, timely surgical intervention should be available, as delaying operative management of acute appendicitis can lead to adverse outcomes, including heightened risks to the foetus. Limited intra-abdominal space, particularly in the third trimester, can make laparoscopic surgery challenging and, in such cases, senior surgical expertise is crucial.¹⁰

Appendicitis management considerations for patients aged >55 years

Patients aged 55 years and older merit special attention in clinical practice due to their increased susceptibility to appendicitis-related complications, including the potential association with colorectal cancer. Luminal obstruction by proximal colonic cancers can lead to appendicitis and serve as the initial manifestation of colorectal malignancy. Consequently, this age group faces a seven-fold elevated risk of caecal cancer compared to the general population. Preoperative CT scans in this age groups are common, and high-resolution CT scanners may reduce the need for

postoperative colonoscopy.

In instances where preoperative CT scanning is not feasible or is of low quality, postoperative colonoscopy should be promptly arranged to ensure timely detection of potential colonic pathologies. A recent randomized controlled trial (RCT) evaluating routine interval appendectomy and MRI follow-up in patients over 40 years old was prematurely halted due to markedly increased tumour rates.^{11,12} In light of these findings, the World Society of Emergency Surgery (WSES) advocates for routine interval colonoscopy and contrast CT imaging for patients with complicated appendicitis managed nonoperatively, with strong consideration for interval appendectomy to mitigate associated risks.

Appendiceal Neoplasms

Approximately 65% of malignant tumours of the appendix are neuroendocrine in origin, while 20% are adenocarcinomas (mucinous, signet ring, or non-mucinous).^{13,14} It is widely known that less than 1% (0.2-0.3%) of acute appendectomies will have appendiceal mucinous neoplasms (AMN) in the specimen.¹⁵ However, there is controversy regarding the management on AMN.¹⁶ There is a spectrum of low- to high-grade AMN, where the clinical manifestation does not necessarily correlate with the histology, and even the AJCC grading for low-grade AMNs has been challenged in recent data.¹⁷ There is a distinct subset of AMN that lacks usual forms of destructive invasion but spreads to the peritoneum and ovaries, often leading to the clinical syndrome known as pseudomyxoma peritonei, and increases risk of mortality.¹⁸ In high-grade AMN, surgical resection (cytoreductive surgery) is recommended while the role of further treatment, including early post-operative intraperitoneal chemotherapy (EPIC) and hyperthermic intraperitoneal chemotherapy (HIPEC), are still debated.¹⁹ Once peritoneal involvement is established, patients' care should involve high-

Table 1. Key research agenda for the management of acute appendicitis

1.	Global cohort study to understand current practice
2.	Understand barriers and facilitators to delivery of these practices
3.	Delphi of key interventions that is acceptable and feasible to implement, delivered with a network of key stakeholders globally
4.	Implement a high-quality implementation study to deliver evidence-based practice for patients with acute appendicitis

volume institutions with multi-disciplinary services.²⁰ Contrastingly, the term “low-grade AMN” is used by the WHO to define both malignant and non-malignant processes. Though this simplifies the pathological reporting of specimens, decisions about treatment and follow-up are more challenging, and some patients may undergo unnecessary treatment and surveillance for benign disease. This has led to variation in management pathways and follow-up for these patients from pathologists, radiologists, and surgeons.

Discussion

The state-of-the-art review on evidence-based management of acute appendicitis provides a comprehensive overview of current practices, challenges, and future directions in the field. The review underscores the importance of evidence-based approaches in guiding clinical decision-making for this common surgical condition. Key findings highlight the efficacy of various treatment modalities, including antibiotic therapy, laparoscopic surgery, and non-operative management in select cases. Additionally, the review emphasises the significance of risk stratification tools, imaging modalities, and surgical techniques.

We have identified future research priorities. Large-scale cohort studies conducted across diverse geographical regions are essential to understand the epidemiology, clinical outcomes, and healthcare disparities associated with acute appendicitis in lower resource settings. It may expose high negative appendectomy rates in areas that lack access to imaging, and high morbidity rates where access to surgeons is frequently delayed or expensive. Patient engagement, to better understand priorities for patients around diagnoses and timing of treatment, are necessary. The best way to disseminate best practice and affect surgeon behaviour also requires research. While significant progress has been made in evidence-based management of acute appendicitis, several research gaps and priorities remain.

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