Review Article

Medical Treatment: An Emerging Standard in Acute Appendicitis?

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Abstract

Appendicectomy has been accepted as the gold standard for the management of appendicitis over the years, but there has been an increasing evidence and trend toward the conservative approach to the management of appendicitis. The aim of this review is to search existing literature and to evaluate and compare the conservative and operative approaches to the management of appendicitis. An electronic search of published literature was conducted through Pubmed, Google Scholar, Embase, and Medline using a variety of search items to find relevant observational studies, randomized clinical trials, systematic reviews, and meta-analyses. Bibliographies of selected articles were also analyzed for publications of interest relevant to the scope of the topic. The articles that reported primary outcomes after the management of appendicitis, complications, economic implications, and duration of follow-up were reviewed in detail. The major primary outcomes show a high recurrence rate and failed treatment associated with the conservative management of appendicitis. The other outcomes obtained show that there is an increased incidence of complications associated with operative management. Economic implications and cost-effectiveness analysis show that conservative treatment may be preferred. The length of hospital stay was significantly higher in conservative approach to management; however, shorter time off activities was observed. In general, the conservative management of appendicitis is still regarded as safe, effective, and efficacious, and further research with well-constructed study design, and larger sample size is required.

Keywords: Appendicitis, conservative, operative

Introduction

Globally, appendicectomy is one of the most common surgical procedures performed every year.[1,2] It is the most common urgent, intra-abdominal surgery performed in the United States with an annual statistics of over 300,000.[3] More than a century has passed since the earliest appendicectomies were first advocated as viable operations for patients with acute appendicitis.[4] The first paper published on acute appendicitis was by Fitz in 1886, while the first case series on appendectomies was by McBurney in 1889.

Appendicectomy has been accepted as the gold standard for the management of appendicitis over the years, but there has been an increasing evidence and trend toward the conservative approach to the management of appendicitis with debates on the equivalence of treatment efficacy in both approaches. Coldrey in 1959 was the first to mention the successful treatment of appendicitis using the conservative approach. Since then, various studies which aim to evaluate the effectiveness and safety of nonoperative treatment of appendicitis have been conducted.

Researchers have attempted to evaluate the superlative approach with respect to favorable outcomes, prognosis, reduced complication rates, shorter hospital stay, and overall cost of treatment. However, the idea is still as controversial today as it was a century ago. Despite its success as shown by various publications, antibiotic treatment alone has not yet been accepted as a standardized treatment for noncomplicated cases of acute appendicitis.[4]

This paper aims to review available evidence in support and against both approaches to management, laying emphasis on

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short- and long-term outcomes, complications, duration of hospitalization, and overall cost implications.

Pathophysiology of Acute Appendicitis

The exact pathophysiology of acute appendicitis is unclear with many implicated factors.[5] The disease process is believed to occur from luminal obstruction by a fecolith, lymphoid follicle hyperplasia, foreign bodies, or parasites.[2,5-8] Fecoliths occur as a result of inspissated feces covered by calcium salts within the lumen of the vermiform appendix. Obstruction with hyperplastic lymphoid follicle is more likely in the pediatrics age group because of an abundance of lymphoid tissue in the submucosa which increases in size and number, and reach the maximum number and size during teenage years.[5] Mucus is also secreted by epithelial cells with no outflow tract thus leading to distension of the viscus.[6] This also inhibits venous and lymphatic drainage.

In acute appendicitis, there is a bacterial proliferation, increased intraluminal pressure, and pressure necrosis due to the edema and blockage of arterial blood flow. Subsequently, gangrene and perforation of the appendix occurs.[7,9] When perforation occurs, there is a spillage of intraluminal bowel content into the peritoneal cavity which causes generalized peritonitis or abscess formation in some cases. However, a recent study conducted shows that intraluminal pressure is not always increased in patients with acute appendicitis.[10] Some authors suggest a direct mucosal ulceration with bacterial invasion without luminal obstruction.[6,11] Moreover, fecoliths may be present in the appendix and fail to give an obstructive symptomatology.[12]

There is also a growing evidence to suggest that perforated appendicitis and nonperforated appendicitis have separate pathophysiological processes and should be considered as separate entities.[13] Jackson and Mongodin[14] reported that perforation occurred more commonly in patients with altered inflammatory responses and colonic microbiome. However, there is currently a lack of substantial evidence to validate these claims.

Although no gene has been implicated in the pathogenesis of acute appendicitis, the risk of appendicitis is roughly three times higher in members of families with a positive history for appendicitis than in those with no family history.[2]

Management of Appendicitis: Conservative versus Operative

After Coldrey mentioned the success of the conservative approach in the treatment of patients with appendicitis, available comparative studies on the subject increased exponentially. It is now well known that treatment with antibiotics alone is a safe initial treatment strategy for acute uncomplicated appendicitis.[15-21] It could also be a primary treatment option for cases of acute uncomplicated appendicitis in high operative risk adult patients.[8,21] Being a suitable approach for patients with high operative risks is a pertinent benefit of the conservative approach as shown in Table 1, however, its superiority to surgery has not been well demonstrated in literature.

On the other hand, surgery has remained the gold standard of treating appendicitis for over a century.[22-25] Operative management of intra-abdominal infections still rests on the principles of elimination of focus, reduction of contamination of the peritoneal cavity, and treatment of residual infection.[25-27]

Appendicectomy may not be necessary in all cases of acute appendicitis as several publications show that some inflamed appendix may resolve spontaneously and others can be treated with antibiotics alone.[28-31] However, the conservative approach is flawed with the possibility of recurrence which is almost absent if appendicectomies are performed. Recurrence rates after conservative treatment range from 0% to 40.2%, but authors also suggest that most recurrences progress in a much milder clinical course which could be conservatively treated again or surgically removed with no increase in complication rate.[29,31-33]

In addition to the almost 100% cure rate conferred by operative management of appendicitis, appendicectomy can also provide a definitive diagnosis and may sometime reveal an unexpected malignancy as shown in Table 2. Several pathologies can mimic appendicitis such as cecal neoplasm and carcinoid tumors, which can have fatal consequences if missed. Surgery helps in eliminating those risks as gross inspection and histopathology analysis is performed on all the samples. Some authors believe that the adult population managed conservatively should be followed up with colonoscopies to rule out sinister pathologies and colonic neoplasia rather than opt for an interval appendicectomy which could come out as normal appendix.[4,34]

Authors who advocate the conservative approach argue that the approach totally eliminates the risks and complications associated with surgery. Moreover, there has been a high rate of negative appendicectomy on histopathology examinations over the years.[31,35,36]

Some authors have even noted that appendicectomy in the presence of an appendix mass is a far more technically challenging procedure with an increased incidence of complications, morbidity, and mortality when compared with routine appendicectomy, thus reinforcing the implementation of the conservative approach.[37]

Furthermore, the issue of antibiotics resistance has become an increasingly grave threat to global public health. The empirical use of broad-spectrum antibiotics over a period of time without a culture and sensitivity result could lead to growth of resistant strains of microbes. This raises a point for the continued use of the gold standard appendicectomy in the management of appendicitis.

A limitation of the surgical approach could be considered due to the significant rates of negative appendectomies, higher cost, longer length of stay, and higher morbidity.[38,39] Using the standardized mortality ratio to describe the excess mortality

in the operated patient compared with the general population in Sweden, Blomqvist *et al*.,[40] found 3.5-fold excess mortality after an appendicectomy for nonperforated appendicitis, 6.5-fold excess mortality after perforated appendicitis, and 9.1-fold increase after a negative appendicectomy. Flum and Koepsell[39] found a three-fold increase in mortality after negative appendicectomy compared with appendicectomy for appendicitis.

It is suggested that each year over 250,000 appendectomies for presumed appendicitis are performed in the United States with a 15% negative appendicectomy rate. Deliberations linger as to what should be the appropriate "negative" appendicectomy rate for patients suspected of having acute appendicitis. The controversy centers on balancing the complications of appendicectomy for a normal appendix with those for a perforated appendix.[38] Fortunately, improvement in diagnostic tools such as computed tomography scan, diagnostic colonoscopy, and laparoscopy has reduced the incidence of negative appendicectomies to a large extent, although more sensitive and specific diagnostic methods would provide better insight.

Table 1: Pros and cons of the conservative management of acute appendicitis

Conservative management of appendicitis	
Pros	**Cons**
A suitable approach for high operative risk adults	Recurrence of appendicitis is high after conservative management
Conservative management eliminates the risks, mortality and complications associated with surgery	Length of hospital stay is increased with this approach to management
It reduces the rate of negative appendicectomies	Appendicitis mimics such as cecal neoplasm, carcinoid tumors could be missed
Recuperation is faster in patients treated with antibiotics	The public health threat of antimicrobial resistance may be increased with the use of empirical broad spectrum antibiotics without microbial culture and sensitivity
A cost-effective approach with subtler economic implications when compared to surgical approach	Longer duration of follow-up is demanded
Patients treated using the conservative approach have been shown to have a shorter sick leave and resume work and leisure earlier	

Table 2: Pros and cons of the operative management of acute appendicitis

Operative management of appendicitis	
Pros	**Cons**
Operative management has a cure rate of 100% with no risk of recurrence	High rates of negative appendectomies have been recorded
Gross inspection and histological examination of specimen can be done thus a definite pathological diagnosis can be made	Surgeries are associated with complications and could carry a significant morbidity and mortality
Appendicetomies may help reveal unexpected malignancies and sinister pathologies	Cost of surgery (especially laparoscopic) is high
Quick recovery time in cases of uncomplicated acute appendicitis	Surgery is challenging if appendicitis is complicated with appendiceal mass or phlegmon or adhesions

Primary Outcomes of Conservative versus Operative Management of Appendicitis

Although antibiotics have been successfully utilized in the management of acute appendicitis for decades,[41] Eriksson and Granstrom were the first individuals to conduct a randomized control trial in 1995 to evaluate the efficacy of conservative and operative treatment;[42] they concluded that antibiotics treatment is effective in the treatment of acute appendicitis but with a high recurrence rate (35%).

Lai *et al*.[43] found the rate of recurrence after conservative treatment to be 25.5%. Kaminski *et al*.[44] reported a 5% recurrence rate within a median follow-up time of 4 years in 864 patients with acute appendicitis treated solely with antibiotics. Furthermore, other researchers have reported a high success rate for the nonoperative medical treatment of acute appendicitis as compared to the high complication rates of appendectomies performed in suboptimal conditions during situations of remote medical care;[44] a scenario which is of grave significance in resource-strained third-world countries in Sub-Saharan Africa.

Mason[28] in his systemic review stated that appendicectomy may not be necessary for the majority of patients with acute uncomplicated appendicitis, as many patients resolve spontaneously and others may be treatable with antibiotics alone but that antibiotics regimen had an inferior efficacy.[32]

Hansson *et al*.[16] in their randomized controlled trial aimed to evaluate antibiotic treatment as the first-line therapy in the management of acute uncomplicated appendicitis and found the treatment efficacy to be 90.8% for antibiotic therapy and 89.2% for surgery, thus concluding that antibiotics treatment is a safe alternative to surgery. This is the first study which rates antibiotics over surgery in terms of primary outcomes, but it is important to note that all the studies have varying definitions for what is considered as treatment success and this can create a bias when analyzing the data available.

In the meta-analysis by Liu and Fogg,[45] there was 6.9% initial treatment failure with conservative treatment and a 14.2% recurrence rate thus concluding that in some cases, antibiotic treatment may fail, and there is a risk of recurrence. However, surgically treated patients, including those with the potential for spontaneous resolution and those with a normal appendix, are subjected to the risks of operative morbidity

and mortality. Antibiotic therapy incurs significantly fewer complications.

Ansaloni *et al*.,[4] systematically evaluated evidence available in relevant literature to compare the relative effectiveness of antibiotic therapy as a viable alternative to appendectomies. They found out that efficacy was significantly higher for surgery although accompanied by higher complication rates.

Svensson *et al*.,[18] assessed the feasibility and safety of nonoperative treatment of acute nonperforated appendicitis with antibiotics in children. They found out that 92% treated with antibiotics had an initial resolution of symptoms, only 5% had recurrence of acute appendicitis during follow-up. Mason *et al*.[32] stated that the overall treatment failure rate in the antibiotic group was 40.2% versus 8.5% in the appendicectomy group which shows an inferior efficacy in the antibiotic group. Varadhan *et al*.,[46] found a 68% success rate with antibiotics alone and a trend toward a reduced risk of complications with a recurrence rate of 15%.

The largest multicenter open-label noninferiorly randomized control trial on "Antibiotic versus Operative management of appendicitis" was conducted in the appendicitis acuta trial by Paajanen *et al*.[47] The aim was to compare antibiotics (Ertapenem) therapy with appendicectomy in the treatment of uncomplicated acute appendicitis. The result showed 99.6% success rate in surgery and 72.7% in the antibiotic group. Recurrence was associated with a milder form of the disease with only 10% having complicated appendicitis on recurrence which was operated successfully. A 5-year follow-up of antibiotic therapy for uncomplicated acute appendicitis in the APPAC Randomized controlled trial by Salminen *et al*.,[48] showed a cumulative incidence of appendicitis recurrence at 39.1% in 5 years for patients treated with antibiotics and an overall complication rate of 6.5% at 5 years compared to 24.4% in patients who underwent an appendicectomy.

The NOTA study conducted by Di Saverio *et al*.,[49] showed that antibiotics for suspected acute appendicitis are safe and effective and may avoid unnecessary appendicectomy, reducing operation rate, surgical risks, and overall costs. After 2 years of follow-up, recurrences in patients treated conservatively was <14% and these patients may be safely and effectively treated with further antibiotics.

Tanaka *et al*.[50] found the initial success rate of nonoperative treatment to be 98.7%. Follow-up was done for 4.3 years, and the recurrence rate of appendicitis was 28.6%, with 20.8% occurring in the 1st year. Gorter *et al*.[51] stated that there was no treatment failure in all the pediatric patients conservatively managed. However, a limitation to his study was a short follow-up time of just 8 weeks, as there might be possibilities of recurrence. Di Saverio *et al*.,[49] Wojciechowicz *et al*.,[52] both reported the long-term efficacy of nonoperative treatment of appendicitis. Huston *et al*.[31] however critiqued this study due to logical concerns with study designs, conduct of study and use of open appendicectomy in majority of the cases.

Sippola *et al*.,[53] in their study, stated the results for the primary endpoint which showed that most patients randomized to antibiotic treatment did not require appendicectomy even a year after follow-up. Huang *et al*.[23] in their meta-analysis showed that antibiotics as the initial treatment for pediatric patients with uncomplicated appendicitis may be feasible and effective without increasing the risk for complications. However, the failure rate mainly caused by the presence of appendicolith is higher than for appendicectomy. Surgery is suggested for uncomplicated appendicitis with appendicolith.

Sakran *et al*.[54] aimed to synthesize evidence from randomized controlled trials comparing nonoperative versus surgical management of uncomplicated acute appendicitis in adult patients. They found treatment efficacy at 1-year follow-up significantly lower (63.8%) compared to surgery (93%) concluding that conservative management of uncomplicated appendicitis in adults warrants further study. Addressing patients' expectations through a shared decision-making process is a crucial step in optimizing these nonoperative outcomes.

An amazing approach taken by Talan *et al*.[55] was to compare the outcomes of antibiotic treatment and appendicectomy based on the 1-month major complication rate rather than failure rate or recurrence rates. This evaluation of the primary outcome independent of treatment strategy helped to reduce bias. The result showed major complications in two appendicectomy participants (14.3%) and 1 antibiotics-first participant (6.3%). This suggests the use of antibiotics rather than the surgical approach to management might be beneficial.

Studies have also shown that in addition to the management of acute uncomplicated appendicitis with antibiotics, it is possible to manage complicated appendicitis conservatively. The conservative management of complicated appendicitis is associated with a decrease in complication and reoperation rate compared with acute appendicectomy.[56]

In general, antibiotics can be safely used to manage acute uncomplicated appendicitis, as literature supports this. However, the bone of contention remains whether it has the same efficacy as surgery or one approach is superlative. As many surgeons are still skeptical about the total reliance on conservative treatment because of the high rate of recurrence in comparison with appendicectomy, this makes it very difficult to standardize the antibiotic treatment or choose it as a gold standard. Research on its superiority to surgery remains rather inconclusive although it has been proven to be safe and effective.

Analysis of Associated Complications

Every surgical procedure is associated with risks of morbidity and mortality. Appendicectomy is not exempted, with the morbidity of interval appendicectomy ranging from 3.4% to 19% according to literature reviews performed by Lai *et al*.[43]

Appendicectomy, either done as an emergency or interval procedure, is not devoid of complications. The mortality and

morbidity associated with these procedures are significant, with values of 10%–19% for acute appendicitis without perforation and 12%–30% for those with perforation.[22,40,57-60] Hoffmann *et al*. stated that treating appendiceal mass conservatively, morbidity, and expense of routine interval appendicectomy was thus eliminated in 80% of the patients.[61]

The perforated appendix is known to be associated with a significant increase in morbidity. This has been a rationale for immediate surgical treatment of acute appendicitis. Interestingly, some studies show no difference in morbidity between patients who had intact acute appendicitis and those with perforated appendix.[62]

In comparison with operative management, the conservative approach seems to carry lower morbidity (as low as 2.8%).[24,28,45,47] Liu and Fogg[45] also found out that complications were considerably less likely to occur with antibiotic treatment than with appendicectomy.

Ansaloni *et al*.[4] found that the number of patients who developed complications was significantly higher in the surgery group. They also reported significantly reduced pain observed after 12 h of conservative treatment and lower pain scores during follow-up for those treated conservatively. Other authors based on their research findings have similar views.

In contrast, while authors such as Harnoss *et al*.,[36] Kirby *et al*.[63] found that suspected uncomplicated appendicitis has a lower rate of major postintervention complications when managed with primary appendicectomy compared to antibiotic therapy; others found no difference in complications between the two approaches.[54]

Complications associated with operative management could be intraoperative and postoperative. Early surgical postoperative complications include bleeding, hematoma formation, colonic fistula, surgical site infection, intra-abdominal abscess, and ileus. Late complications which includes postoperative hypertrophic scars, incisional hernia (especially with open appendicectomy approach), intraperitoneal adhesions leading to small bowel obstructions, and tubal infertility (in females).[49]

It is important to consider the approach of surgical intervention utilized when comparing complications in surgery versus antibiotics management. Conducting a meta-analysis of randomized control trials that failed to differentiate what surgical approach was utilized could create bias because laparoscopic surgery and open surgery are not equivalent. It is believed that laparoscopy is associated with lower complication rates. Sauerland *et al*.[64] compared the diagnostic and therapeutic effects of laparoscopic and conventional "open" surgery and found that laparoscopic approach is associated with less wound infection, less pain, and increased return back to activity; although there was a higher rate of intra-abdominal abscess in laparoscopic compared to the open approach.

Vahdad *et al*.[65] found no type of laparoscopic approach superior as the outcome of Laparo-endoscopic single site (LESS-A) through one transumbilical port versus a three-port laparoscopy was similar. However, Sporn *et al*.[66] reported a higher risk of complication in laparoscopic approach to uncomplicated acute appendicitis as compared to the open approach.

Economic Implication and Cost Analysis of Conservative and Operative Management

In 1997, overwhelming resources were spent on treating acute appendicitis in the United States, including roughly one million hospitalization days costing nearly 3 billion dollars.[67] A lot of clinicians consider the direct and indirect costs of appendicectomies on the patient and health system. Arguably, a cost-effective way of managing patients with acute uncomplicated appendicitis is the conservative approach.[68]

Sippola *et al*.,[53] concluded that the overall costs in the operative group were 1.6 times higher than those in the antibiotics group. In the same study, only 5.5% of the operated population had laparoscopic surgery, while others had a laparotomy. It can be proposed that the cost of laparoscopic appendicectomy might be even higher due to the increased cost of ports, laparoscopic sutures, and disposable equipment, but the meta-analysis conducted by Ohtani *et al*.[68] showed similar cost for laparoscopic and open appendicectomy.

Wu *et al*.[69] in a meta-analysis comparing the cost-effectiveness of nonoperative management versus laparoscopic surgery also found out that nonoperative management without interval appendicectomy is the least costly and most effective treatment for acute uncomplicated appendicitis and warrants further evaluation in a disease thought to be definitively surgical.

Although many of the studies did not differentiate what surgical approach was utilized (open or laparoscopic approach), it was stated in the study by Sporn *et al*.[66] that the cost of laparoscopic appendicectomy is 22% higher compared to the cost of open surgery. In fact, McCahill *et al*. stated that laparoscopic appendicectomy is more expensive and does not necessarily provide a better clinical outcome.[56] However, this is also debatable.

This difference in costs to both the service providers and society overall strongly encourages further evaluation of antibiotic therapy as the first line treatment for uncomplicated acute appendicitis as shown in Table 1. The mean cost was also higher for surgery in studies by some authors.[3,55,62] It can be inferred from those studies that the nonsurgical approach may result in substantial cost-savings thus has an advantage over operative management in this regard.

Evaluation of the Secondary Outcomes in Operative and Nonoperative Management of Appendicitis

While stating "treatment efficacy" as the primary outcome in most literature, secondary outcomes included the duration of hospitalization and the total duration the patient had to spend off activities such as school, work, or leisure. Although it might

seem redundant to evaluate these outcomes, it is important to manage the patient holistically. To achieve this, "patient factor" must be considered.

The patient-reported outcome has been increasingly used by the modern researchers because there has been a tilt to the patient-centered clinical methods rather than physician-centered. Thus, in a comparative study, patient-reported outcomes such as health status, quality of life, should be considered, but there has been paucity of data as regards this in the meta-analyses over the years.

With regard to the duration of hospitalization, most researchers found that patients who had acute uncomplicated appendicitis who were managed surgically spent lesser time in the hospital compared to those who were managed conservatively.[36,49,53,62] This is probably due to the antibiotics regimen which has to be taken intravenously over a period of 3–5 days as compared to surgery without complications with a next-day discharge. The studies reviewed also concluded that patients who were managed conservatively had a shorter sick leave and resumed work earlier than those who underwent surgery.[53] An explanation to this could be because surgery incites the stress response and it takes significant amount of days to recuperate after an operation. Patients who had surgery miss a median of 10–14 days from work and resume normal activity in 7–21 days.[64]

As expected, there would be results that are not in tandem with a longer duration of hospital stay in the antibiotics group. Some authors report a similar duration of stay between both groups.[32,54,70] Ansaloni *et al*.[4] reported that the difference in hospital stay between the two groups was not significant. From the literature search, no author established if there was a significant difference in the length of stay between open appendicectomy and antibiotics versus laparoscopic appendicectomy versus antibiotics, but Sporn *et al*.[66] stated that the length of stay is shorter for laparoscopic appendicectomy (15%) in both complicated and uncomplicated appendicectomy when compared to open appendicectomy. Few studies reported a reduction in the duration of sick leave in the patients treated using nonoperative management but found no difference in the length of stay in hospital between the two groups.[32,50]

Talan *et al*.[55] also reported a shorter hospital stay for the antibiotic group. The median total hospital time during 1 month was 16.2 h (range 10.9–106.6 h) in the antibiotics-first group compared with 42.1 h (range 28.0–128.8 h) in the appendicectomy group.

The inference from various literature is that although conservative management could result in increased length of hospitalization, overall the patients recuperate faster than those who had surgery, thus making it more efficacious in this aspect. Scientific questions have been raised over the years whether it is practical to administer antibiotic treatment to patients with acute uncomplicated appendicitis on an outpatient basis, thus reducing the increased length of in-patient hospital admission associated with conservative treatment. Talan *et al*.[55] went ahead to conduct a pilot randomized trial which describes a novel, safe, and effective strategy that allows outpatient antibiotic management of imaging-confirmed uncomplicated appendicitis. This method was regarded as safe and effective with a low recurrence rate (6%). As novel as this sounds, it could pose a problem of patient compliance to medications, which can limit the efficacy of the antibiotics administered.

Limitations and recommendations

Majority of the randomized control trials performed with respect to the evaluation of conservative versus operative management of appendicitis had small sample sizes, short follow-up time, flawed study designs and randomization techniques, lacked homogeneity, and were inconsistent in their choice of terms. There was largely a vague definition of "treatment successes" in most studies, with disparities among various studies as to what efficacy encompassed. Future studies should consider these limitations and improve on them.

Furthermore, it was impossible to blind patients in these randomized control trials because an invasive approach is being compared to a conservative approach. Patients need to be fully involved in their management; thus, this creates a form of bias in the studies as there was no blinding.

Although many authors declared that antibiotics were safe and effective, there was no consensus as to which antibiotics were to be used. The conservative approach was largely not standardized. For example, an author decided to use amoxicillin and clavulanic acid as the antibiotic of choice, another used Ertrapenem. *Escherichia coli* is relatively resistant to amoxicillin and clavulanate, so if the offending organism was *E. coli*, these antibiotics would be ineffective and thus be recorded as a treatment failure. Future studies should work with the same or similar class of antibiotics and a regimen to cover enteric anaerobic bacteria.

More research should be done on analyzing the predictors of successful antibiotic treatment as this will improve the efficacy of conservative treatment and reduce the risk of recurrences. Furthermore, a combined approach to diagnosis should be employed. This should involve clinical findings with laboratory and imaging studies to reduce the incidence of negative appendicectomy and diagnostic uncertainties. Reliance solely on clinical judgment is not advocated as a lot of pathologies can mimic the presentation of acute appendicitis.

There is a need for an increase in research focused on patient outcomes rather than only the researcher or physician's point of view. Patient-centered clinical methods should be employed as often as possible. Outpatient conservative treatment should also be explored to reduce length of hospitalization and overall cost. Finally, the role of the appendix in immune mediation should be explored rather than regard it as a vestigial organ.

Conclusion

Despite the increasing use of antibiotics as the first line of treatment in acute uncomplicated appendicitis, the actual

application and effectiveness of nonoperative treatment have been questioned due to evidence gaps in the literature. Many of the authors agree that with its high success rate, reduced complication rates, and cost-effectiveness, medical treatment seems to be a good alternative to the gold standard therapy of surgery in the management of acute appendicitis. However, due to the disparities and inconsistencies in literature over the years, the superiority of conservative approach over surgery in the management of acute appendicitis cannot be verified.

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Conflicts of interest

There are no conflicts of interest.

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