



Current opinions and practices for the management of acute appendicitis: an international survey

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Abstract

Background In recent decades the management of acute appendicitis has evolved significantly. Improved access to early imaging and better clinical scoring algorithms have resulted in less negative appendectomy rates. In addition, non-operative management has become increasingly utilized. The aim of this study was to assess the variability of management of acute appendicitis globally.

Methods This was a multi-national targeted survey of general surgeons across 39 countries. A structured set of questions was utilized to delineate nuances between management styles of consultants and trainees. Opinions on the pathological diagnosis of appendicitis, acceptable negative appendectomy rates, and the role of non-operative treatment of appendicitis (NOTA) were surveyed.

Results A total of 304 general surgeons responded to this survey, 42% of which were consultants/attendings. Sixty-nine percent advocated that a histologically normal appendix was the most appropriate definition of a negative appendectomy, while 29% felt that anything other than inflammation, necrosis, gangrene, or perforation was more appropriate. Forty-three percent felt that negative appendectomy rates should be less than 10%, with 41% reporting that their own negative appendectomy rate was < 5%. Interestingly, only 17% reported routinely using NOTA for uncomplicated appendicitis, with one-fifth stating that they would undergo NOTA if they themselves had uncomplicated appendicitis.

Conclusion This study represents the largest sampling of management strategies for acute appendicitis. It shows substantial global heterogeneity between clinicians regarding what constitutes a negative appendectomy as well as the appropriateness of non-operative management.

Keywords Appendicitis · Negative appendectomy · Non-operative treatment of appendicitis · Surgical management

Introduction

Appendicitis is the most common cause of emergency surgical admission worldwide with an incidence of 86 cases per

100,000 per year [1]. Appendectomy has been a standard treatment since McBurney described the procedure in 1889 [2, 3]. Numerous developments have occurred in the management of acute appendicitis over the last hundred years

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including laparoscopy, image guided drainage, widespread availability of computed tomography (CT), and various scoring algorithms. More recently, the use of non-operative treatment of appendicitis (NOTA) has been promoted. However, this is not a new concept, having been first used successfully among submarine sailors during the Second World War [4]. Recent studies have shown it as a viable treatment option in the hospital setting and as both safe and effective [5–9]. However, there remains resistance around its routine use and reported recurrence rates of > 20% in 1 year and almost 40% at 5 years [10–12].

Historically, negative appendectomy rates (NAR) have been as high as 15–25% [13–16]. But with better use of radiological imaging, negative appendectomy rates have significantly reduced [17, 18]. Improvements in imaging modalities and more widespread use have also facilitated the selection of patients in whom a NOTA approach is possible. However, it is not yet clear if NOTA is a regular management approach by the majority of surgeons across the world. Furthermore, while computed tomography (CT) scanning is widely available, some have cautioned against an over-reliance on CT imaging [18] with the Right Iliac Fossa Pain Treatment (RIFT) Study identifying significant differences in approaches to diagnostic modalities across its treatment arms. The aim of this study was to assess the variability of management options for acute appendicitis among general surgeons.

Methods

A standardized questionnaire was created and circulated among several surgical societies and trainee groups (Royal College of Surgeons in Ireland; Royal College of England; College of Physicians & Surgeons in Pakistan; College of Surgeons Academy of Medicine Malaysia; European Society of Coloproctology; and British, Australian and Italian surgical trainee groups). Participants received an electronic invitation to contribute to the survey (freeonlinesurveys.com). This provided a secure method to collect and store the data, as well as edit or add questions if required.

Demographic questions included staff grade, gender, age, years in clinical practice, and their geographical location. Questions then focused on the surgeons' perspective on acute appendicitis diagnosis including the following: how to correctly define a negative appendectomy, histopathological findings that should be classified as a negative appendectomy, acceptable negative appendectomy rates, and an estimate of their own negative appendectomy rate. In addition, the usefulness of clinical, biochemical, and radiological imaging in the diagnosis of appendicitis were assessed. Lastly, participants were questioned on management options for acute appendicitis including non-operative treatment, removal of

macroscopically normal appendix, and the role of interval appendectomy following NOTA management. Data was stored on the freeonlinesurveys.com account and the website functions facilitated analysis. The data was also exported to SPSS facilitating analysis.

Results

Demographics

From February 2019 to October 2019, there were 304 responses in total, from surgeons across 39 countries (Fig. 1). Of these, 128 (42.1%) were consultant/attending grade, and 176 (57.9%) were registrars, specialist registrars, or fellows. Two hundred twenty-one (72.7%) were male. With regard to clinical experience, the vast majority (85.5%, $n = 260/304$) had at least 5 years of clinical experience (Table 1).

Opinions on negative appendectomy

Respondents were asked how a negative appendectomy should be defined. Of these, 69.4% ($n = 211/304$) were of the opinion that a “histologically normal appendix” was correct, versus 28.6% ($n = 87/304$) who felt that a histological finding of anything other than inflammation, necrosis, perforation or gangrene was more appropriate. Participants were also asked if specific histological findings should be considered negative, with little agreement on this subject: lymphoid hyperplasia (51.6%, $n = 157/304$), fibrosis (49.3%, $n = 150/304$), atrophy (59.9% ($n = 182/304$), and *Enterobius vermicularis* (32.2%, $n = 98/304$). The majority felt that a NAR of < 10% was acceptable (77.3%, $n = 235/304$), while a small proportion believing a > 20% rate was appropriate (1.6%, $n = 5/304$). When asked to estimate their own NAR, the results were similar; 79.9% ($n = 243/304$) reported rates < 10%, and 2.6% ($n = 8/304$) reported > 20% (Table 2).

Diagnosis and operative management of appendicitis

Most respondents did not find the Alvarado score to be beneficial for use in either the paediatric (55.9%, $n = 170/304$) or adult (58.2%, $n = 177/304$) populations. The majority did advocate the routine use of ultrasound (US) imaging in both female (88.2%, $n = 255/289$) and male (62.6%, $n = 181/289$) pediatric patients. However, less agreed with routine use of CT to out-rule appendicitis in adults. Only 31.7% ($n = 92/290$) agreed with its use in females, while a lower proportion of 20.7% ($n = 60/290$) advocated for it in males. In general, three quarters of those surveyed agreed with the removal of a macroscopically normal appendix on laparoscopy, for both males (74.8%, $n = 217/290$) and females (76.8% $n = 222/289$). Interestingly, 20% also recommend continuing antibiotic

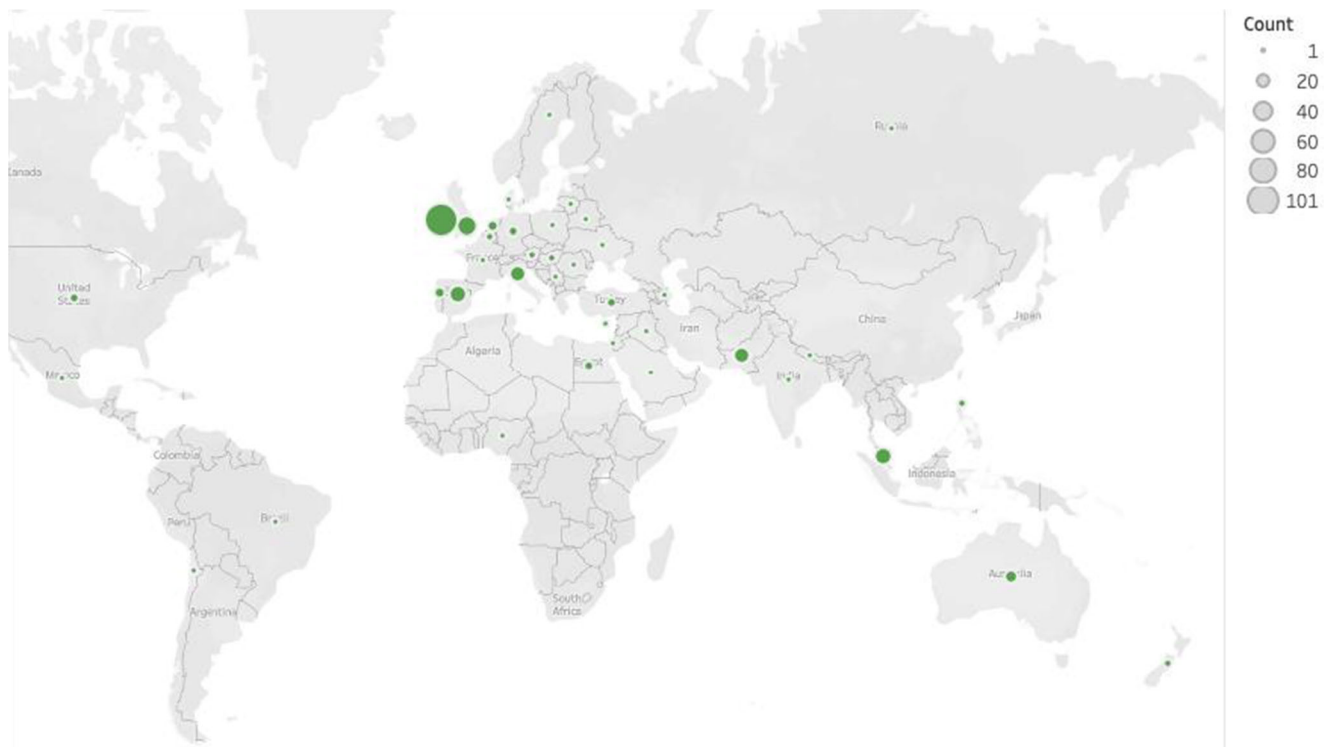


Fig. 1 Geographical location of participants

therapy post-operatively for acute uncomplicated appendicitis (21.4%, $n = 62/290$) (Table 3).

Opinions on non-operative treatment of appendicitis

A small majority of surgeons agreed that NOTA is a viable routine management option (55.2%, $n = 160/290$). A significantly lower proportion routinely utilize NOTA in their practice (17.3%, $n = 50/290$). Notably, a small percentage would opt for NOTA if they themselves had acute uncomplicated

appendicitis (22.4%, $n = 65/290$). Almost one-third advocated for interval appendicectomy following NOTA for uncomplicated appendicitis (32.1%, $n = 93/290$). Twice as many respondents felt that interval appendicectomy was appropriate following complicated appendicitis (70.7%, $n = 205/290$) (Table 4).

Discussion

This study represents the largest worldwide survey of surgeons on the management of acute appendicitis and provides an interesting insight to current opinions and practices. The survey is both diverse, with 39 countries surveyed, and the vast majority of respondents had at least 5 years of clinical experience. Interestingly, there was little agreement among participants on how to define a negative appendicectomy. Despite this, the majority (>75%) feel that with improved technology, negative appendicectomy rates should be < 10%. In general, the Alvarado score is not trusted, while most surgeons advocate for routine ultrasound in pediatric populations, particularly in females. Conversely, the participants did not feel that routine CT was appropriate in the adult population. Approximately 75% would remove a macroscopically normal appendix in patients with right iliac fossa (RIF) pain with no obvious cause, and only half believe that NOTA is a viable treatment option.

Table 1 Demographics of respondents

Demographic	
Consultant	115 (37.8%)
Attending	13 (4.3%)
Registrar/specialist registrar	119 (39.1%)
Resident	40 (13.2%)
Male:female	221:83
Age	35 (25–68)
Years of clinical practice	
0–4 years	44 (14.5%)
5–9 years	124 (40.8%)
10–14 years	75 (24.7%)
15–19 years	32 (10.5%)
> 20 years	29 (9.5%)

Table 2 Negative appendectomy

Question	Answer	Total
Which definition of a negative appendectomy is the most appropriate?	Histologically normal appendix	69.6% (n = 211/303)
	Histological findings of anything other than inflammation, necrosis perforation, or gangrene	28.7% (n = 87/303)
	Other	1.7% (n = 5/303)
Should lymphoid hyperplasia be classified as a negative appendectomy?	Yes	51.6% (n = 157/304)
	No	48.6% (n = 147/304)
Should fibrosis be classified as a negative appendectomy?	Yes	49.3% (n = 150/304)
	No	50.7% (n = 154/304)
Should atrophy be classified as a negative appendectomy?	Yes	59.9% (n = 182/304)
	No	40.1% (n = 122/304)
Should <i>Enterobius vermicularis</i> be classified as a negative appendectomy?	Yes	32.2% (n = 98/304)
	No	67.8% (n = 206/304)
What is an acceptable negative appendectomy rate?	< 5%	33.9% (n = 103/304)
	5.1–10%	43.4% (n = 132/304)
	10.1–15%	14.5% (n = 44/304)
	15.1–20%	6.6% (n = 20/304)
	20.1–25%	0.7% (n = 2/304)
	> 25%	1% (n = 3/304)
What is your approximate negative appendectomy rate?	< 5%	41.1% (n = 125/304)
	5.1–10%	38.8% (n = 118/304)
	10.1–15%	13.8% (n = 42/304)
	15.1–20%	3.6% (n = 11/304)
	20.1–25%	1.3% (n = 4/304)
	> 25%	1.3% (n = 4/304)

The survey's participants demonstrate optimistic aspirations around negative appendectomy rates, with approximately one-third suggesting that it should be kept below 5% and three-quarters suggesting that it should be kept below 10%. Such a target may be achievable with correct utilization of CT imaging and scoring algorithms [17, 19, 20]. However, the majority of participants do not support routine use of CT imaging for diagnosis of appendicitis and do not find the

Alvarado score useful. The lack of trust for the Alvarado score is particularly notable. Algorithms such as the Alvarado and Appendicitis Inflammatory Response (AIR) score are derived from small retrospective studies and, to date, are poorly validated [21–23]. With this in mind, it is not surprising that such scoring systems are not therefore widely employed. The RIFT audit advocated for the routine scoring of adults presenting with acute RIF pain or suspected appendicitis using the

Table 3 Diagnostics

Question	Yes	No
Do you find the Alvarado score useful in pediatric patients?	44.1% (n = 134/304)	55.9% (n = 170/304)
Do you find the Alvarado score useful in adult patients?	41.8% (n = 127/304)	58.2% (n = 177/304)
Do you use US imaging in diagnosing appendicitis in pediatric females?	88.2% (n = 255/289)	11.8% (n = 34/289)
Do you use US imaging in diagnosing appendicitis in pediatric males?	62.6% (n = 181/289)	37.4% (n = 108/289)
Should CT be routinely used to out rule appendicitis in males > 18 years?	20.7% (n = 60/290)	79.3% (n = 230/290)
Should CT be routinely used to out rule appendicitis in females > 18 years?	31.7% (n = 92/290)	68.3% (n = 198/290)
During laparoscopy, should a macroscopically normal appendix be removed in a male in which no other cause for pain is identified?	74.8% (n = 217/290)	25.2% (n = 73/290)
During laparoscopy, should a macroscopically normal appendix be removed in a female in which no other cause for pain is identified?	76.8% (n = 222/289)	23.2% (n = 67/222)
Do you continue antibiotics post-operatively in uncomplicated appendicitis?	21.4% (n = 62/290)	78.6% (n = 228/290)

Table 4 Non-operative treatment of appendicitis

Question	Yes	No
Is NOTA a viable option for uncomplicated appendicitis in otherwise healthy patients?	55.2% (<i>n</i> = 160/290)	44.8% (<i>n</i> = 130/290)
Do you routinely practice NOTA for uncomplicated appendicitis in otherwise healthy patients?	17.3% (<i>n</i> = 50/290)	82.8% (<i>n</i> = 240/290)
If you personally developed uncomplicated appendicitis, would you prefer NOTA over operative intervention?	22.4% (<i>n</i> = 65/290)	77.6% (<i>n</i> = 225/290)
Would you perform an interval appendicectomy in a patient with uncomplicated appendicitis who underwent NOTA?	32.1% (<i>n</i> = 93/290)	67.9% (<i>n</i> = 197/290)
Would you perform an interval appendicectomy in a patient with complicated appendicitis who underwent NOTA?	70.7% (<i>n</i> = 205/290)	29.3% (<i>n</i> = 85/290)

appropriate risk prediction model with a mobile, tablet, and desktop compatible web application developed to support the calculation [24].

Approximately 50% of general surgeons view NOTA as a viable management option. However, the vast majority do not practice NOTA and would not personally choose it over appendicectomy. This is potentially due to the high rate of recurrence. The recent 7-year follow-up of the APPAC trial showed higher patient satisfaction in the operative group than those treated conservatively with antibiotics [25]. It is important to note that this survey was undertaken prior to the global COVID-19 pandemic. Since its onset, conservative management has been advised where possible, in an attempt to mitigate potential risk to staff and patients alike [26, 27]. A recent survey of Irish trainees and consultants showed that 76 % of participants changed their practice to predominantly NOTA. The majority (74%) obtained CT at presentation. However, it must be noted that 83% would return to operative management after the COVID-19 pandemic. This same study also studied 18 patients treated for acute appendicitis in Ireland during this period, with 11 (61%) undergoing NOTA. The median length of stay was 3.5 days for NOTA vs 2 days for operative management. At 1 week post-discharge, 54% in the NOTA group had ongoing discomfort, 63% stated that they would have chosen appendicectomy, and 45% wanted to pursue interval appendicectomy [28].

With a lower patient satisfaction, and the apparent mistrust among surgeons illustrated in this study, should health professionals be advocating for NOTA treatment at all? Further prospective studies will delineate if it is a sustainable management option.

Conclusion

There is significant heterogeneity among surgeons regarding on how to correctly define a negative appendicectomy and the role of routine radiological imaging. Furthermore, there is a considerable debate around the non-operative treatment of

appendicitis, and the majority of respondents do not routinely use NOTA within their practice.

Data availability Survey data held on [freeonlinesurveys.com](https://www.freeonlinesurveys.com). Available at request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval Survey of expert opinion. Not applicable.

Consent to participate Consent obtained when email sent to participants.

Consent for publication Participants informed prior to participation that results would be published.

Code availability Not applicable.

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