Global attitudes in the management of acute appendicitis during COVID-19 pandemic: the ACIE Appy Study

Benedetto Ielpo[1], Mauro Podda[2], Gianluca Pellino[3,4], Francesco Pata[5,6], Riccardo Caruso[7], Gianpiero Gravante[8], Salomone Di Saverio[9], on behalf of the *ACIE Appy Study Collaborative**

1 Department of Surgery, HPB Unit, University Hospital Leon, Leon, Spain.
2 Department of General and Emergency Surgery, Cagliari University Hospital, Cagliari, Italy.
3 Department of Advanced Medical and Surgical Sciences, Universitá degli Studi della Campania "Luigi Vanvitelli", Naples, Italy.
4 Colorectal Surgery, Vall d'Hebron University Hospital, Barcelona, Spain.
5 General Surgery Unit, Nicola Giannettasio Hospital, Corigliano-Rossano, Italy.
6 La Sapienza University, Rome, Italy.
7 HM Sanchinarro, Madrid, Spain.
8 Ospedale "Francesco Ferrari", Casarano, Italy.
9 Department of General Surgery, University of Insubria, University Hospital of Varese, ASST Sette Laghi, Regione Lombardia, Varese, Italy.
B Ielpo, M Podda, G Pellino and F Pata equally contributed to the manuscript
**all collaborators are reported in the Appendix 1*

Short title: Global management of appendicitis during COVID-19 pandemic

Abstract word count: 244

Text word count: 4435

Conflict of interest: The authors have no conflict of interests to disclose

Source of Funding: The authors did not receive any funding for the present study

Correspondence to:

Dr. Benedetto Ielpo, MD, PhD, FACS, Department of Surgery, HPB Unit, University Hospital Leon, Leon, Spain, founder of the Association of Italian Surgeons in Europe (*Associazione Chirurghi Italiani in Europa,* ACIE), Study Guarantor.

email: ielpo.b@gmail.com

Twitter: @IelpoB @ACIEuro

Abstract

Background: Surgical strategies are being adapted to face the pandemic. Recommendations on the management of acute appendicitis during COVID-19 crisis are based on expert opinion as no evidence is available. The aim of this study is to describe the global management of acute appendicitis during COVID-19 pandemic.

Method: The "Association of Italian Surgeons in Europe" (ACIE) designed an online survey to assess the current attitude of surgeons globally, regarding the management of patients with acute appendicitis during the pandemic. Questions were divided into baseline information, hospital organization and screening, personal protective equipment, management and surgical approach, patient presentation before vs during the pandemic. Chi-square test was used for comparisons.

Results: Of 744 answers, 709 (66 countries) were complete and were included. Most hospitals are treating COVID and non-COVID patients. There is variability in screening indications and modality, chest-CT and PCR being the commonest method (18.1%). 6.6% and 2.4% used conservative management of complicated and uncomplicated appendicitis, respectively, before, vs 23.7% and 5.3% during the pandemic ($p<0.0001$). 36.6% changed their approach from laparoscopic to open surgery, and most reported higher rates of open appendicectomy during the pandemic. No agreement on how to filter smoke during laparoscopy was observed. There has been a reduction in patients admitted with acute appendicitis, and 34.3% felt that patients are presenting with more advanced disease features.

Conclusion: Surgeons are using open appendicectomy and conservative management more frequently during the pandemic. Variability in screening policies and intraoperative measures warrant prompt action.

Key-words: appendicitis; COVID-19; SARS-CoV2; nonoperative; appendicectomy; laparoscopy

Short summary

COVID-19 pandemic required reorganization of surgical services, affecting patients with common surgical diseases including acute appendicitis. No evidence is available on the topic. This study found global variability in screening policies, personal protective equipment use, and intraoperative directives. There has been an increased adoption of non-operative management and open appendicectomy.

Introduction

Since the first cases of an unusual pneumonia were described in China during late December 2019, the new coronavirus of Severe Acute Respiratory Syndrome CoronaVirus 2 (SARS-CoV-2), that causes COronaVIrus Disease 2019 (COVID-19), has rapidly spread worldwide. On the 11th March 2020, COVID-19 disease was declared as a pandemic infection by the World Health Organization. As of 02 of June 2020, 6,194,533 confirmed cases and 376,320 deaths are reported globally [1].

Healthcare systems adopted specific measures to preserve hospital capacity, increase intensive care unit beds and create COVID-19 units, including the postponement of all non-oncologic elective procedures [2]. Furthermore, in light of preliminary data [3] reporting a high perioperative mortality (20.5%) in patients operated in the incubation phase of COVID-19, several surgical societies globally recommend a safety approach even in emergency surgery, implementing non operative management (NOM) whenever possible, including acute appendicitis [4-6]. Other recommendations advocate a selective use of minimally invasive surgery (MIS), the use of ultrafiltration systems for C02 filtering and evacuation during laparoscopy [2,3,6,7]. However, given the unavailability of ultrafiltration systems, the paucity of personal protective equipment (PPE), the shortage of surgical workforce, and the impossibility of routine testing of all patients, a trend towards a more conservative attitude may occur the COVID-19 pandemic.

Approximately, 300,000 people undergo appendicectomy annually in the US [8]. According to a recent meta-analysis on the topic, the most recently reported incidence of acute appendicitis is approximately 98/100 000 individuals per year in the US [9]. Therefore, it could be estimated that around 322,000 patients might have suffered from acute appendicitis in 2019 in the US [10]. In other words, should the state of emergency last two months, only in the US, approximately 54,000 patients would be affected, which would be 80,000 in the event of a prolongation of the state of emergency for an additional month.

Given the rapidly evolving scenario and the absence of evidence to support recommendations during the COVID-19 pandemic, it is useful to assess how the current situation is impacting the management of patients with acute appendicitis, as no definitive conclusions can be drawn at present.

The aim of this global, multicenter, study survey is to explore if and how the strategies of management and the choice of surgical approach for patients who are being admitted for acute appendicitis during the pandemic have changed among a large pool of responders from several countries.

Method

The "Association of Italian Surgeons in Europe" (*Associazione Chirurghi Italiani in Europa*, ACIE) working group conducted an Internet-based survey to investigate how the COVID-19 pandemic changed the clinical decision for patients with acute appendicitis. The data sampling came from different surgeons and trainees working in general surgery units across Europe, Asia, Africa, Oceania, North and South America. Survey respondents were informed of the purpose of the study and their participation remained voluntary as no incentives were offered to the participants.

Questionnaire Development and Composition

The steering committee developed the questionnaire using web based and remote discussion and brainstorming, after identifying the components and topics to include. The technical functionality of the electronic questionnaire has been tested before the invitations were sent. The baseline information of the respondents, along with the names and the locations of the surgical units were stored with the questionnaire. Once agreement was reached, the questionnaire was completed using Google Form [*The COVID-19 Appy Study Form*] survey software (Google LLC, Mountain View, California US).

The questionnaire is composed of 5 Sections, including 40 questions, described in details in **Supplementary Table 1**. Only closed-ended questions were used. The first four sections included general questions about the hospital organization, screening policies, personal protective equipment and personal attitudes about the management of acute appendicitis. The last section focused on the real-life analysis of patient presentation and management strategies of patients with acute appendicitis before and during COVID-19 pandemic.

Uncomplicated appendicitis was defined as appendicitis without abscess, whereas complicated appendicitis included the presence of an intraabdominal abscess. Non-operative management (NOM) was defined as conservative management with antibiotics; this could include percutaneous abscess drainage.

The list of alternatives for every single quantitative question included a percentage category as follows: "< 25%", "26-50%", "51-75%", "76-100%". The steering committee decided to use ranges of predetermined percentages in order to allow an easier aggregation and analysis of the information collected.

The estimated time to complete the survey was 8-10 minutes. Aim was to define the current status of the management of acute appendicitis as compared with the pre-pandemic period.

The respondents were invited to disclose their Hospital and Country of practice.

Study circulation

On April 8th 2020 the questionnaire was online and open to completion until April 15th 2020. The link (https://docs.google.com/forms/d/e/1FAIpQLSfVelIe3yrEZRZx5FebUYMCrxzC3WqYi3GNnOuN8jjRPyO9ZA/formResponse) was circulated by means of personal email invitations, and it was shared on Social Media (LinkedIn, Twitter, Facebook, WhatsApp groups) by members of the Steering Committee.

Data handling and extraction

A member of the Steering Committee (MP) downloaded the questions and shared them with the other members for data analysis and discussion. Multiple entries from the same individual or members of the same surgical unit were manually searched and eliminated if contradictory findings were observed.

Statistical analysis

The data of the surveys were compared using 4x2 contingency tables and analyzed with the Chi-square test. Categorical variables were reported using counts and percentages. The differences were considered statistically significant when the p value was <0.05. Statistical Package for the Social Sciences (SPSS), version 22 (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis.

Results

Baseline information

Overall, 744 answers were received; after removing those which were incomplete, 709 were included from 66 Countries. The distribution of respondents by country of origin is shown in **Figure 1**. Most respondents were from Countries that were the most affected at the time of the survey (almost half of the answers were returned from Spain and Italy). 69.9% of them were consultant/attending surgeons, 22.7% trainees/residents and 6.9% fellows. General surgeons had higher participation (57.6%) compared with colorectal (22.9%), hepato-pancreato-biliary (9.9%), upper GI (6.3%) and pediatric surgeons (3.3%) .

Baseline information about the National Health System and the type of hospital in which each of the survey participants reported working is shown in **Figure 2**.

Hospital organization and screening policies

Eight-point nine percent of the participants declared that their hospital was exclusively dedicated to COVID-19 patients, while 83.1% reported restricted COVID-19 areas, and 8.0% do not treat COVID-19 patients. The majority of respondents (51.0%) reported that only patients with respiratory symptoms or suspect of SARS-CoV-2 infection are screened before surgery for acute appendicitis, 37.4% routinely screen all patients before surgery, whereas 11.6% of respondents declared that they do not test under any circumstances.

Surgeons who stated to screen patients with acute appendicitis before surgery adopted the following protocols: chest X-ray (7.3%), chest X-ray and serology (6.3%), chest X-ray and PCR (19.8%), chest CT scan (13.9%), chest CT scan and serology (6.7%), chest CT scan and PCR (18.1%), serology alone (1.4%), PCR alone (17.2%) and rapid test (9.3%).

Overall, 28.2% of respondents reported that patients tested positive for SARS-CoV2 after surgery, with 21.3% reporting that this occurred in 1-5% of cases at their center, 2.8% in 5-10%, and 4.1% in >10% of cases.

Subgroup analyses based on the country of the respondents are presented in **Supplementary Table 2**. In Spain, UK, and Italy more than 50% of respondents screened all patients, irrespective of clinical symptoms. In other countries, such as Brazil, the USA, Mexico and France, the most frequent trend has been to test patients only in the presence of respiratory symptoms. 17.2% of respondents from the USA, 35.9% from Mexico, 15.8% from France and 13.3% from Brazil did not routinely screen patients with appendicitis for SARS-CoV-2.

Personal protective equipment (PPE)

Table 1 shows changes in the use of PPE. Most surgeons (37.9%) did not change their PPE in COVID-19 negative patients, whereas the remainder adopted some measures that are not usually used, the commonest being face masks and goggles (24.0%). In COVID-19 positive patients, 4.1 % of surgeons stated that no changes for operative protection were adopted, 4.3% use of FFP2/FFP3 face mask, 1.9% N95 face mask, 0.4% goggles, 56.3% FFP2/FFP3 face mask and goggles, 33.0% N95 face mask and goggles.

In COVID-19 untested patients, 40.1% are using FFP2/FFP3 face mask and goggles, 22.6% N95 face mask and goggles, 10.6% use FFP2/FFP3 and 6% N95 masks, 2.4% only goggles, whereas 18.1% did not adopt PPE.

Personal attitude: operative vs non-operative management of acute appendicitis

In patients with uncomplicated appendicitis (no right iliac fossa abscess), 28.5% of the surgeons changed their attitude during COVID-19 pandemic: out of them, 15.6% did so in COVID-19-positive and untested patients, and only 13.2% only in COVID-19-positive patients; 42.7% did not change their conduct at all. In case of appendicitis complicated by right iliac fossa abscess, 24.6% changed

their attitude only in COVID-19-positive patients and 47.1% did not change their attitude at all. Approximately 22% of the respondents declared that they would change their attitude from surgery to NOM with antibiotics, or vice versa, if they had the chance to test all patients before surgery. 17.5 % stated that they already test all patients, whereas 26.9% stated that they would have changed their attitude only if quick tests or PCR were available.

Before the COVID-19 pandemic, 6.6% of the respondent surgeons adopted NOM with antibiotics for patients with uncomplicated acute appendicitis, compared with 23.7% during the pandemic ($p<0.0001$) (**Table 2)**. Regarding complicated acute appendicitis, NOM was used by 2.4% vs 5.3% before and during the pandemic, whereas percutaneous drainage by 21.1% vs 32.9%, respectively ($p<0.0001$) (**Table 2, Figure 3)**.

Personal attitude: surgical approach

A total of 39% of respondents changed their standard surgical approach from laparoscopic to open (36.6%) or from open to laparoscopic (2.4%) during the pandemic. **Figure 4** shows how the rate of open appendicectomy changed before versus during the pandemic globally.

Table 3 summarizes the preferred surgical approach and associated safety measures being adopted. 30.1% and 28% of surgeons prefer open appendicectomy in COVID-19-positive and untested patients, respectively. Specific devices to filter surgical plumes are used by 43% in COVID-19-positive and by 17% in untested patients, whereas no filtering systems for CO2 are being used by 6.2% COVID-19-positive and by 49.4% in untested patients. If any smoke evacuation system with filters is used, 32.8% of surgeons used commercially available systems (**Table 3**).

A straightforward open appendicectomy for uncomplicated appendicitis was used by 7.2% participants before vs 15.0% during the pandemic, and in case of complicated appendicitis this approach was used by 14.0% before vs 28.1% after the pandemic ($P< 0.00001$) (**Table 2**, **Figure 3**).

76.4 % of surgeons who took part in the survey were confident in performing open appendicectomy, whereas 15.8% preferred supervision by someone with experience in open appendicectomy.

Patient presentation before and during the pandemic at participants' Institutions

Before the pandemic, 32.8% of surgeons stated that >20 patients per month were usually referred to their hospital with acute appendicitis. During the pandemic, only 10.5% reported >20 referrals per month (p< 0.0001)(**Table 2, Figure 5**).

According to 34.3% of participants, patients had more advanced disease features at presentation during COVID-19 emergency.

In case of uncomplicated appendicitis, only 8.9% of the respondents reported that NOM was being used in >50% of cases at their institution before versus 23.7% during the COVID-19 pandemic (p<0.0001)(**Table 2**).

The percentage of patients with uncomplicated appendicitis treated with antibiotics at home and followed-up at the outpatient clinic has increased from 5.2% to 9.8% of centers performing it in almost all cases (76-100%) before vs during pandemic (p=0.00002). Similar trends in NOM with antibiotics with or without percutaneous drainage were observed in patients with complicated appendicitis, with 11.9% vs 19.1% of the respondents' Institution using it in >50% of cases before vs during the pandemic (p=0.00106)(**Table 2**).

Regarding the surgical technique, centers that are using open appendicectomy in >50% of patients increased from 17.7% vs 32.5% during the pandemic (p<0.0001)(**Table 2**).

Additional subgroup analyses are presented in **Appendix 2.**

Discussion

Given the lack of available data about management of acute appendicitis during the COVID-19 pandemic, the authors decided to set the first worldwide survey about its current management. The present survey showed a high degree of variation among the policies used for screening patients (indications and modalities) with acute appendicitis, as well as different attitudes in the management of the condition.

Since the outbreak of COVID-19 pandemic in Europe, several guidelines and recommendations have been released [4,6,11-13] to support the decision-making process in surgery. The overall level of evidence is low, with many recommendations based on expert opinion and case series. Even if a substantial agreement exists on many issues, some aspects remain still controversial.

Personal protective equipment (PPE)

Delivering surgical service in a safe condition is a key factor in response to a pandemic. According to this survey, 18.1% of surgeons stated that they did not change their PPE for untested patients, and 4.1% are not using protective measures even in COVID-19-positive patients. These figures might be justified by the shortage of PPE. Of note, 37.9% of surgeons did not change their PPE in COVID-19 negative patients, which is reasonable giving the possibility of false positive results. The results confirm the current uncertainty concerning PPE use in the context of COVID-19 crisis.

Availability of PPEs is a relevant aspect, that can impact perceived safety and fear of surgeons working under such stressful conditions[14]. This should be addressed in details, considering that some countries have not yet reached the peak of the pandemic and additional waves of COVID-19 have been anticipated in a near future.

Local policies and Screening

Most hospitals were treating both COVID-19 and non-COVID-19 patients, but the screening policies in patients with appendicitis varied widely among centers. Screening all emergency patients for SARS-CoV2 is advisable before surgery, whenever possible [4]. However, half of the respondents are only screening patients with respiratory symptoms or with suspected infection. This raises concerns, as data on asymptomatic patients suggest that postoperative outcomes are poor, with high complication rates and mortality [3]. Approximately 12% of participants are not screening emergency patients at all. This is deeply worrisome, when considering that 28.2% reported that at least one patient tested positive after surgery, occurring in more than 10% of cases according to 4.1% of respondents. Furthermore, given the recently reported data that COVID-19 patients may have a worse postoperative outcome, it is paramount to test patients before any surgery, especially in an emergency setting where complications may be increased [3]. The high rate of respondents from countries like Mexico and UK that did not test patients routinely might have been responsible for the course of COVID-19 observed in these countries (**Supplementary Table 2**).

Guidelines for screening and testing continue to evolve as knowledge of the pandemic improves and availability of testing kits increases. According to the latest Chinese guidelines the diagnosis of COVID-19 must be confirmed by one of the following: real-time RT-PCR (reverse transcriptase polymerase chain reaction); viral gene identified by gene sequencing highly homologous with SARS-CoV2; SARS-CoV2-specific IgM and IgG [15]. Several studies suggest that the majority of patients develop antibody response only in the second week after onset of symptoms, thereby limiting their usefulness for early diagnosis [16]. The role of chest CT is debated. The American College of Radiology (ACR) recommends not using chest CT for screening COVID-19 and recommends reserving it for hospitalized patients, when needed for management [17]. Some societies recommend against the use of chest CT to screen for COVID-19 [18], whereas others suggest that it can be used in emergency settings when it is not possible to wait for the results of PCR test [4]. When assessing screening modalities, disagreement was noted among respondents. Most participants used chest CT

scan plus PCR (18.1%) or PCR alone (17.2%). Some 14% used only chest CT whereas some 7% only chest x-ray. Clearer guidance about testing is desirable.

Open vs laparoscopic appendicectomy

Although there is no evidence that SARS-CoV-2 could spread by aerosolization both by pneumoperitoneum and smoke during MIS, the risk cannot be ruled out at present. Some data on hepatitis B virus (HBV) positive patients suggested that HBV could be detected in surgical smoke during MIS [19]. Even if the risk is hypothetical with SARS-CoV-2, some suggested that this should be prioritized over the benefits of laparoscopy. These considerations justify some discrepancies among current guidelines. Some contradictions can be detected in recommendations from the same surgical society, with the American College of Surgeon (ACS), emphasizing the benefits of laparoscopic appendicectomy as outpatient procedure in patients with failed NOM in a guide [12] and suggesting to avoid laparoscopy in another document about the optimal protection for surgeons [20].

On the other hand, the current British Intercollegiate General Surgery Guidance on COVID-19 suggests to consider laparoscopy only in selected cases where clinical benefit for the patient substantially outweighs the risk of potential viral transmission [https://www.rcseng.ac.uk/coronavirus/joint-guidance-for-surgeons-v2/]. Whenever possible, NOM should be considered, and, if not feasible, open appendicectomy is recommended. Because ultrafiltration devices can be difficult to implement, recommending to err on the side of safety may be the best option in the current scenario [21].

The benefits of laparoscopic appendicectomy should also be considered, including the possibility of performing surgery as an outpatient procedure [22], shorter hospital stay, lower incidence of surgical site infections, and faster recovery when compared to the open technique [23,24]**.** These are promising features during an outbreak, where hospital capacity and resources are limited. Interestingly, most of the respondents did not change their attitude in the management of acute

appendicitis, but approximately one out of three changed the approach from laparoscopic to open. Almost half of the participants reported to be performing open appendicectomy in all COVID-19 patients, but 40% of those would use laparoscopy if the devices for smoke filtering were available at their centers. In fact, special attention should be paid to the establishment and evacuation of pneumoperitoneum and liberal use of suction devices to remove smoke and aerosol during operations with an ultra-filtration (smoke evacuation system or filtration), especially before converting from laparoscopy to open surgery [25,26]. Moreover, intraoperative pneumoperitoneum pressure and CO2 ventilation should be kept at the lowest possible levels without compromising the surgical field exposure in order to minimize the effect of pneumoperitoneum on lung function and circulation, in an effort to reduce pathogen susceptibility, and incisions for ports should be as small as possible to avoid leakage around ports [6]. Less than 33% of respondents are using commercially available systems to filter smoke, among those who are adopting them.

However, some (26%) replied that they are performing laparoscopic appendicectomy with no devices to filter CO2. Half of the respondents use laparoscopy in untested patients (49.4%). The finding that 4.1% of respondents declared they had not changed their operational protection measures in COVID-19 positive patients is a result that deserves a thorough reflection. The importance of using the adequate measures is highlighted by the fact that almost 30% of patients tested positive after surgery in the present study. Filtering the pneumoperitoneum through filters able to remove most viral particles is highly recommended [25]. Considering the COVID-19 virus size ranging from 0.06 to 0.14 micron, surgeons might be aware that not all smoking filters are effective on filtering it. The ULPA (Ultra-Low Particulate Air) filters are extremely efficient to filter the SARS-CoV-2. According to the ISO standard 29463 (issued to harmonize the European Standard EN 1822 and the U.S. MIL-STD-282), an ULPA filter must have a ≥ 99.9995% efficiency at filtering particles with a MMPS (Most Penetrating Particle Size) of 0.12 micrometer. The MMPS is the particle that the filter is less efficient to remove. Smaller particles are filtered with an even higher efficiency. Therefore, our advice is to check for the appropriate filter (0.1 micron) before performing the

laparoscopic surgery as well as to perform a test insufflation and smoke evacuation before using. Appropriate equipment and understanding are paramount to mitigate the risk of aerosolization.

It is worth considering that smoking evacuation might be easier with laparoscopy than with open surgery [4], on condition that adequate measures are adopted. Considering this, even if evidence is poor, there are some concerns that the risk of virus aerosolization is higher during the open approach as smoke generated from electrocautery is more difficult to be captured. Very few respondents reported to have changed their usual management from open to laparoscopic appendicectomy. Conversely, the rate of centers that performed 76-100% of appendectomies open went to 9.1% before to 22.7% during the pandemic ($p<0.0001$).

A potential issue that has been raised recently is the actual capability of training programs to provide the skills to perform open appendicectomy proficiently and safely, during the recent years [27]. Most of the respondents were confident in performing open appendicectomy, thereby excluding the possibility that this factor might have influenced their decision.

One aspect that needs to be taken into consideration is the fact that, during the pandemic, according to the present survey, there might be a reduction in the number of patients admitted at emergency departments (13.3% centers had <5 patients with appendicitis per month referred before vs 39.3% during the pandemic, $p<0.0001$). Moreover, a trend towards more aggressive presentation might be occurring (34.2% stated so, while 39.3% were unsure). These factors might also play a role in the decision making between open vs MIS appendicectomy.

Non-Operative Management (NOM)

NOM with antibiotics represent a promising strategy to reduce resource consuming and avoid unnecessary surgery during the outbreak.

Our study shows that a NOM with antibiotics was routinely used in >50% of patients with uncomplicated appendicitis by only 8.9% of the respondents before the pandemic, whereas the same approach is currently used by the 23.7% of respondents. Antibiotic management of

uncomplicated appendicitis remains an uncommon practice worldwide [28-30], but randomized controlled trials have recently demonstrated that this strategy is safe, with no increased risk of appendiceal perforation and sepsis, and no reported mortality [31-35]. Although relapse rate is not negligible with 27% of patients undergoing appendicectomy within one year [36], these data may be acceptable in the context of an overall strategy during outbreak.

Furthermore, a NOM strategy may be implemented as outpatient treatment for uncomplicated appendicitis, with discharge directly from the emergency department after antibiotic treatment initiation and symptoms control [34].

In our study, the percentage of patients with uncomplicated appendicitis treated with antibiotics at home and followed-up at the outpatient clinic has increased from 5.2% of centers performing it in almost all cases (76-100%) before to 9.8% of centers during the pandemic.

A therapeutic strategy based on as short as possible in-hospital stay can be of great relevance during the COVID-19 crisis, as it can reduce the risk of infection and the overload of the hospital already stretched by the outbreak effects. Safe and effective strategies that allow outpatient antibiotic management of imaging-confirmed uncomplicated appendicitis can be feasible only if established pathways exist to separate suspected, infected, and non-COVID patients [13]. Furthermore, a careful evaluation of the clinical presentation, the assessment of CT-scan images and a minimum in-hospital observation of 6-10 hours may be necessary.

Appendicular abscess

A trend towards NOM with antibiotics with or without percutaneous drainage in patients with appendicular abscess has been shown in our study, with an 8% increase in those using it in >50% of cases before vs during the COVID-19 pandemic.

Conservative treatment of appendicular abscess has been reported to be successful in over 90% of patients, with an overall risk of recurrence of 7.4% and only 19.7% of cases of abscess requiring percutaneous drainage [37]. Conservative treatment has been associated with fewer overall

complications (wound infections, postoperative abdominal/pelvic abscesses, ileus/bowel obstructions, and re-operations) if compared to immediate appendicectomy [38]. On the contrary, current evidence shows that surgical treatment is preferable to NOM with antibiotics in reduction of length of hospital stay and need for readmissions, especially when laparoscopic expertise is available [39]. A high-quality randomized trial demonstrated that laparoscopic appendicectomy in experienced hands is a safe and feasible first-line treatment for appendiceal abscess. Indeed, in this study, early laparoscopic appendicectomy was associated with fewer readmissions (3% vs 27%) and fewer additional interventions (7% vs 30%) than conservative treatment, with comparable hospital stay [40].

The authors would suggest that the laparoscopic approach remains the treatment of choice for patients with complicated appendicitis with an abscess, if the patient's clinical condition and the hospital organizational pathways allow to appropriately establish and manage pneumoperitoneum and to safely perform laparoscopy. Conversely, if the management of COVID-19 emergency does not allow surgery to be performed safely, NOM can be a reasonable first-line treatment. Percutaneous drainage as an adjunct to antibiotics, if accessible, could be beneficial.

Study limitations

This study has limitations. In an effort to collect the highest number of replies, the link was circulated by means of social media, email lists and via personal contacts. Therefore, the number of recipients cannot be accurately quantified. Using closed questions eased the delivery and rapid analysis of data and is used in most studies; however, this might have resulted in some information not being captured (e.g. other hospital settings not reported in question 8). It should be noted that the reported data are estimates based on the best available surgical data from each participating center. Moreover, respondents in countries where the pandemic was in its earliest stages at the time of survey circulation, such as in Latin America, UK and USA, may had underestimated the real

impact of COVID-19 on emergency surgery referrals and operations. The relative short period since outbreak outset could have been insufficient to detect overall changes in decision making strategies. However, this is the first study to assess the attitude of surgeons worldwide on very common disease, and - at a time where sound evidence is lacking - important information can be obtained. Such data can be useful to identify adherence to the available guidance statements, and to highlight the priorities that need to be addressed in the near future.

Conclusions

According to the present study, a clear shift towards a wider use of conservative treatment of patients with acute appendicitis has occurred. Most respondents reported higher rates of open appendicectomy during the pandemic. When laparoscopy is used, there is no agreement on which system to use for smoke evacuation, and whether this is necessary. There has been overall a reduction in patients admitted with acute appendicitis, and patients are likely to be presenting with more advanced disease. Such variations warrant further investigation and should be addressed by international societies globally, ideally by means of joint assessment and preparation of agreed recommendations. The evolving scenario calls for dynamic guidance to be timely revised, as new evidence becomes available.

Legends to Tables and Figures

Table 1. Changes in the use of Personal Protective Equipment (PPE) during COVID-19 pandemic, according to patient SARS-CoV2 status.

Table 2. Patient presentation and management of acute appendicitis before and during the COVID-19 pandemic.

Table 3. Surgical approach for acute appendicitis and aspiration of smoking plumes.

Figure 1. Breakdown of countries of origin of the participants in the study. Most respondents were from Italy and Spain; however, a global participation was achieved.

Figure 2. Representation of the National Health Systems of the participants. Most surgeons are practicing in systems with universal coverage (74.2%).

Figure 3. Management of complicated and uncomplicated appendicitis before and during the COVID-19 pandemic. NOM: non-operative management. NOM, with or without percutaneous drainage, increased for both complicated and uncomplicated appendicitis. The number of straightforward laparoscopic appendectomies reduced in both conditions during the pandemic, whereas the rate of open appendectomies increased.

Figure 4. Use of open appendicectomy before (top) and during (bottom) COVID-19 pandemic. The mean number of participants that responded to the categories “25%”, “26-50%”, “51-70%, and “>75%” was computed. An increased use of open surgery can be recorded, more apparent in some Countries in South America, and Central and Northern Europe.

Figure 5. Hospital admissions for acute appendicitis before and during the COVID-19 pandemic at the participants’ institutions.

Supplementary Table 1. The questionnaire as it was circulated.

Supplementary Table 2. Breakdown of screening policies in some countries.

Supplementary Table 3. Overall results.

Appendix 1. Participants in the survey and ACIE Steering Committee.

Appendix 2. Country-specific sub-analyses.

References:

1. World Health Organization WHO. Coronavirus (COVID-19). Last update 2/6/2020 https://who.sprinklr.com/ (date accessed June 6 2020)
2. Spinelli A, Pellino G. COVID-19 pandemic: perspectives on an unfolding crisis. Br J Surg. 2020 Mar 19. doi: 10.1002/bjs.11627
3. Lei S, Jiang F, Su W, et al. Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. EClinicalMedicine. 2020 Apr 5:100331. doi: 10.1016/j.eclinm.2020.100331
4. Balibrea JM, Badia JM, Rubio Pérez I, et al. Surgical Management of Patients With COVID-19 Infection. Recommendations of the Spanish Association of Surgeons. Cir Esp. 2020 Apr 3 2020 doi: 10.1016/j.ciresp.2020.03.001
5. Asociación Española de Coloproctología (AECP) recommendations regarding surgical response to covid-19. March 2020. https://aecp-es.org/images/site/covid/DOCUMENTO_COVID.pdf (date accessed 4 Apr 2020)
6. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) and European Association for Endoscopic Surgery (EAES) recommendations regarding surgical response to covid-19 crisis. March 29, 2020. **https://www.sages.org/recommendations-surgical-response-covid-19/** (date accessed Mar 30 2020)
7. Di Saverio S, Khan M, Pata F, et al. Laparoscopy at all costs? Not now during COVID-19 and not for acute care surgery and emergency colorectal surgery. J Trauma Acute Care Surg. 2020;1.
8. Chang DC, Shiozawa A, Nguyen LL, et al. Cost of inpatient care and its association with hospital competition. J Am Coll Surg. 2011;212:12–19.
9. Ferris M, Quan S, Kaplan BS et al. The Global Incidence of Appendicitis: A Systematic Review of Population-based Studies. Ann Surg. 2017;266:237-241.
10. United States Census Bureau. 2019 U.S. Population Estimates Continue to Show the Nation's Growth Is Slowing https://www.census.gov/newsroom/press-releases/2019/popest-nation.html (date accessed Apr 18 2020)
11. Updated Intercollegiate General Surgery Guidance on COVID-19 April 2020. https://www.rcseng.ac.uk/coronavirus/joint-guidance-for-surgeons-v2/ (date accessed Apr 7 2020)

12. American College of Surgeons (ACS). COVID-19: Elective Case Triage Guidelines for Surgical Care. Emergency General Surgery Patients.https://www.facs.org/covid-19/clinical-guidance/elective-case/emergency-surgery (accessed April 15 2020)
13. Coccolini F, Perrone G, Chiarugi M, et al .Surgery in COVID-19 patients: operational directives. World J Emerg Surg. 2020;15:25.
14. An Y, Bellato V, Konishi T, et al. Surgeons' fear of getting infected by COVID19: a global survey. Br J Surg 2020, Accepted, In press
15. Liu Y, Liu Y, Diao B et al. Diagnostic indexes of a rapid IgG/IgM combined antibody test for SARS-CoV-2. 2020; Available from: https://doi.org/10.1101/2020.03.26.20044883
16. Zhao J, Yuan Q, Wang H et al. Antibody responses to SARS-CoV-2 in patients of novel coronavirus disease 2019. medxriv [Internet]. 2020; doi: 10.1101/2020.03.26.20044883 Available from: https://www.medrxiv.org/content/10.1101/2020.03.02.20030189v1.full.pdf
17. American College of Radiology (ACR) Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection https://www.acr.org/Advocacy-and-Economics/ACR-Position-Statements/Recommendations-for-Chest-Radiography-and-CT-for-Suspected-COVID19-Infection (date accessed April 01 2020).
18. Societá Italiana di Chirurgia Oncologica (SICO) recommendations regarding surgical response to COVID 19- March 2020 **https://www.sicoweb.it/raccomandazioni-sico.pdf** (date accessed April 18 2020).
19. Kwak HD, Kim SH, Seo YS, et al. Detecting hepatitis B virus in surgical smoke emitted during laparoscopic surgery. Occup Environ Med. 2016;73:857-863.
20. American College of Surgeons (ACS). COVID-19: Considerations for Optimum Surgeon Protection Before, During, and After Operation. https://www.facs.org/covid-19/clinical-guidance/surgeon-protection (date accessed April 15 2020).
21. Di Saverio S, Khan M, Pata F, et al. Laparoscopy at all costs? Not now during COVID-19 and not for acute care surgery and emergency colorectal surgery. J Trauma Acute Care Surg. 2020 doi:10.1097/TA.0000000000002727.
22. Cash CL, Frazee RC, Smith RW, et al. Outpatient laparoscopic appendectomy for acute appendicitis. Am Surg. 2012;78:213–215.
23. Jaschinski T, Mosch CG, Eikermann M, et al. Laparoscopic versus open surgery for suspected appendicitis. Cochrane Database Syst Rev. 2018;11:CD001546.

24. Athanasiou C, Lockwood S, Markides GA. Systematic Review and Meta-Analysis of Laparoscopic Versus Open Appendicectomy in Adults with Complicated Appendicitis: an Update of the Literature. World J Surg. 2017;41:3083–3099.
25. MIS filtration group. How to manage smoke evacuation and filter pneumoperitoneum during laparoscopy to minimize potential viral spread: different methods from SoMe. Colorectal Dis 2020 (accepted); video https://www.youtube.com/watch?v=FC-LofYpkOU
26. Mintz Y, Arezzo A, Boni L, et al. A Low Cost, Safe and Effective Method for Smoke Evacuation in Laparoscopic Surgery for Suspected Coronavirus Patients [published online ahead of print, 2020 Apr 13]. Ann Surg. 2020. https://journals.lww.com/annalsofsurgery/Documents/A%20Low%20Cost,%20Safe%20and%20Effective%20Method%20for%20Smoke%20Evacuation%20in%20Laparoscopic%20Surgery%20for%20Suspected%20Coronavirus%20Patients.pdf
27. Melmer PD, Chaconas C, Taylor R, et al. Impact of Laparoscopy on Training: Are Open Appendectomy and Cholecystectomy on the Brink of Extinction? Am Surg. 2019;85:761-763.
28. Khalil M, Rhee P, Jokar TO, et al. Antibiotics for appendicitis! Not so fast. J Trauma Acute Care Surg. 2016;80:923–932.
29. Bhangu A; RIFT Study Group on behalf of the West Midlands Research Collaborative. Evaluation of appendicitis risk prediction models in adults with suspected appendicitis. Br J Surg. 2020;107:73–86.
30. Sartelli M, Baiocchi GL, Di Saverio S, et al. Prospective Observational Study on acute Appendicitis Worldwide (POSAW). World J Emerg Surg. 2018;13:19.
31. 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. Lancet. 2011;377:1573–1579.
32. Hansson J, Körner U, Khorram-Manesh A, et al. Randomized clinical trial of antibiotic therapy versus appendicectomy as primary treatment of acute appendicitis in unselected patients [published correction appears in Br J Surg. 2009 Jul;96(7):830]. Br J Surg. 2009;96:473–481.
33. Hansson J, Khorram-Manesh A, Alwindawe A, et al. A model to select patients who may benefit from antibiotic therapy as the first line treatment of acute appendicitis at high probability. J Gastrointest Surg. 2014;18:961–967.
34. Talan DA, Saltzman DJ, Mower WR, et al. Antibiotics-First Versus Surgery for Appendicitis: A US Pilot Randomized Controlled Trial Allowing Outpatient Antibiotic Management. Ann Emerg Med 2017;70:1–11.

35. 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. Ann Surg. 2019;270:1028-1040.
36. 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;313:2340-8.
37. Andersson RE, Petzold MG. Nonsurgical Treatment of Appendiceal Abscess or Phlegmon: A Systematic Review and Meta-analysis. Ann Surg 2007;246:741–748.
38. Simillis C, Symeonides P, Shorthouse AJ, et al. A meta-analysis comparing conservative treatment versus acute appendectomy for complicated appendicitis (abscess or phlegmon). Surgery. 2010;147:818–829.
39. Helling TS, Soltys DF, Seals S. Operative versus non-operative management in the care of patients with complicated appendicitis. Am J Surg. 2017;214:1195–1200.
40. Mentula P, Sammalkorpi H, Leppäniemi A. Laparoscopic Surgery or Conservative Treatment for Appendiceal Abscess in Adults? A Randomized Controlled Trial: Ann Surg. 2015;262:237–242.

Table 1. Changes in the use of Personal Protective Equipment (PPE) during COVID-19 pandemic, according to patient SARS-CoV2 status.

	Patients who tested negative for COVID-19	**Patients who were not tested for COVID-19**	**Patients who tested positive for COVID-19**
No changes	**37.9%**	18.1%	4.1%
Face mask (FFP2/FFP3)	10.2%	10.6%	4.3%
N95 Face mask	6.4%	6.0%	1.9%
Goggles	3.4%	2.4%	0.4%
Face mask (FFP2/FFP3) and goggles	24.0%	**40.1%**	**56.3%**
N95 mask and goggles	18.0%	22.6%	33.0%

Table 2. Patient presentation and management of acute appendicitis before and during the COVID-19 pandemic.

Query	Options	Before COVID-19	During COVID-19	Chi-square Test *P* value
How do you manage uncomplicated (no abscess) acute appendicitis?	Non-operative management with antibiotics	6.6%	23.7%	*P* < 0.00001
	Case-by-case decision	29.0%	38.8%	
	Straightforward laparoscopic appendectomy	57.2%	22.5%	
	Straightforward open appendectomy	7.2%	15.0%	
How do you manage complicated (abscess) acute appendicitis?	Non-operative management with antibiotics	2.4%	5.3%	*P* < 0.00001
	Non-operative management with antibiotics and percutaneous drainage	21.1%	32.9%	
	Straightforward laparoscopic appendectomy	62.5%	33.7%	
	Straightforward open appendectomy	14.0%	28.1%	
How many patients with acute appendicitis are referred to your hospital?	< 5	13.3%	39.3%	*P* < 0.00001
	5-10	26.9%	33.5%	
	10-20	27.0%	16.7%	
	> 20	32.8%	10.5%	
In percentage, in how many patients with uncomplicated acute appendicitis (no abscess) a non-operative management with antibiotics is used at your hospital?	< 25%	79.3%	60.1%	*P* < 0.00001
	26-50%	11.8%	16.2%	
	51-75%	6.6%	11.6%	
	76-100%	2.3%	12.1%	
In percentage, how many patients with uncomplicated acute appendicitis (no abscess) treated conservatively with antibiotics are sent home and followed-up at the outpatient clinic at your hospital?	< 25%	78.2%	67.5%	*P* = 0.00002
	26-50%	10.9%	12.9%	
	51-75%	5.7%	9.8%	
	76-100%	5.2%	9.8%	
In percentage, how many patients with complicated acute appendicitis (with abscess) undergo conservative treatment with antibiotics +/- percutaneous drainage at your hospital?	< 25%	77.3%	68.4%	*P* = 0.00106
	26-50%	10.8%	12.5%	
	51-75%	5.6%	9.3%	
	76-100%	6.3%	9.8%	
In percentage, how many patients with acute appendicitis treated with surgery undergo open appendectomy at your hospital?	< 25%	73.6%	53.8%	*P* < 0.00001
	26-50%	8.7%	13.7%	
	51-75%	8.6%	9.8%	
	76-100%	9.1%	22.7%	

* percentage of respondents.

Table 3. Surgical approach for acute appendicitis and aspiration of plumes

Surgical Approach	**COVID-19 positive**	**Untested patients**
Always open surgery, personal preference	30.1%	28.0%
Laparoscopic surgery without specific devices for protection and smoke evacuation	6.2%	49.4%
Laparoscopic surgery with specific devices for protection and smoke evacuation	43.0%	17.0%
I would use laparoscopy, but I do not have devices for pneumoperitoneum/smoke evacuation	20.7%	5.6%
Systems to filter surgical smoke		
If laparoscopic appendectomy is performed, do you use any filter system?		***%***
Yes		37.8%
Yes, only in COVID-19 positive patients		11.9%
Yes, only in COVID-19 positive or untested patients		24.3%
No		26.0%
If any smoke evacuation system is used, which type of device do you use?		***%***
Commercially available		32.8%
Commercially available with filtration connected to a container with water		7.7%
Commercially available with filtration connected to a sealed container		22.0%
Homemade		11.9%
Homemade with filtration connected to a container with water		14.0%
Homemade with filtration connected to a sealed container		11.6%

Figure 1a

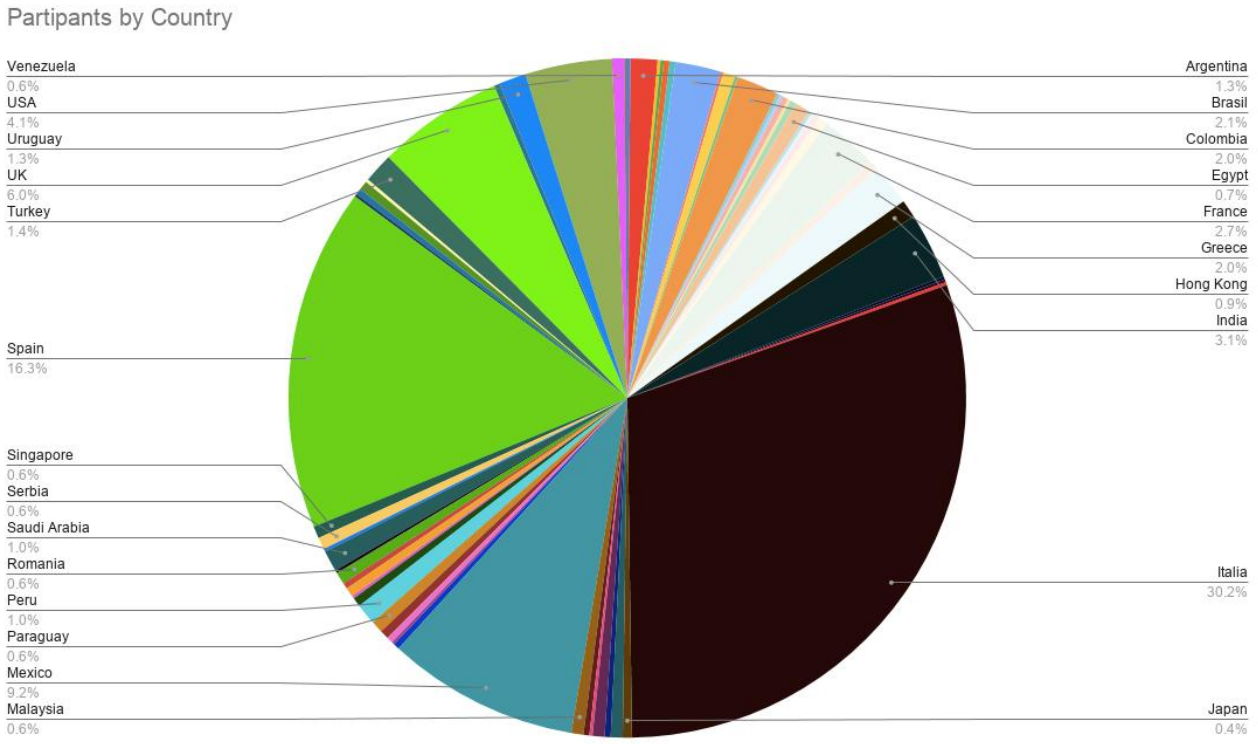


Figure 1b

Figure 2

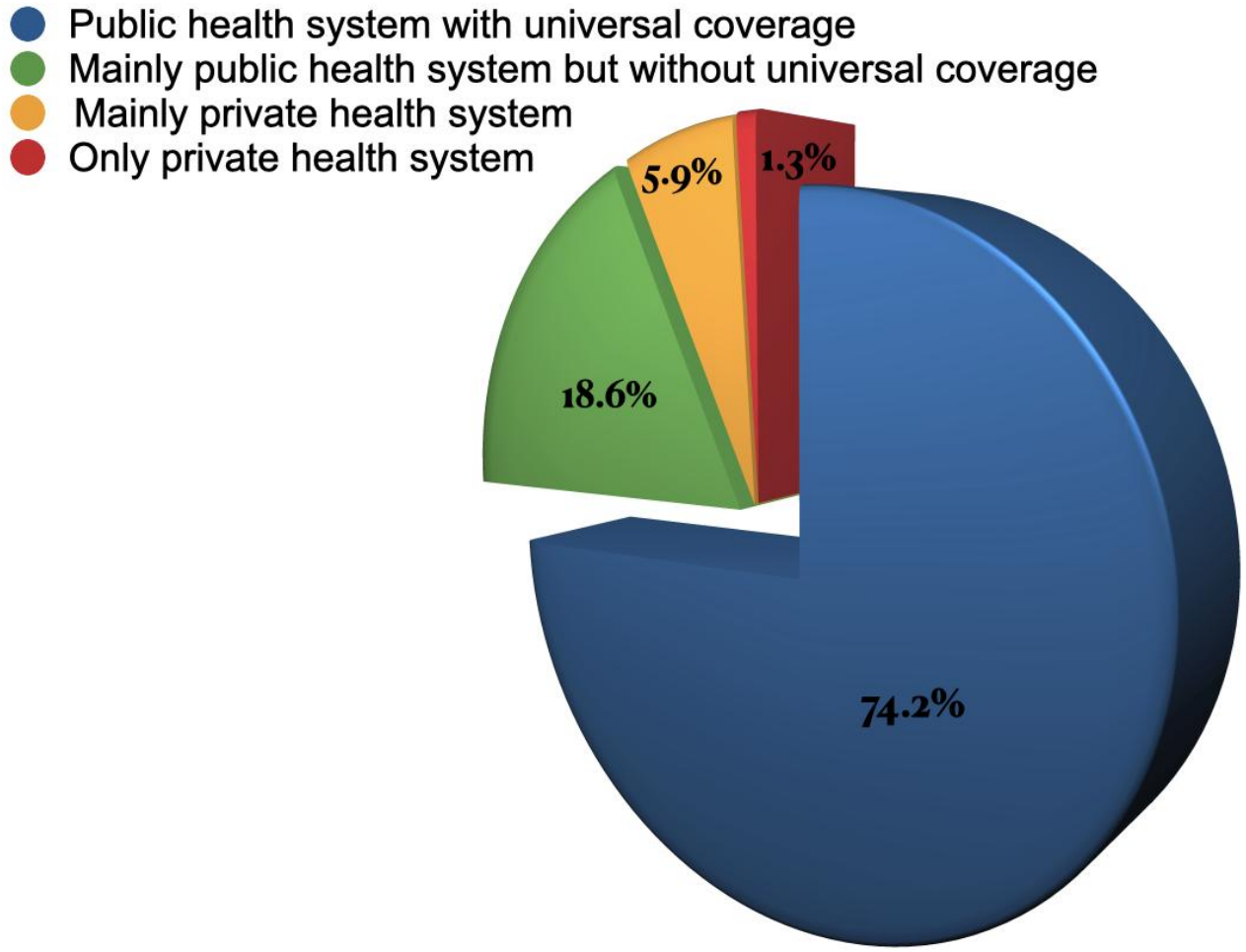
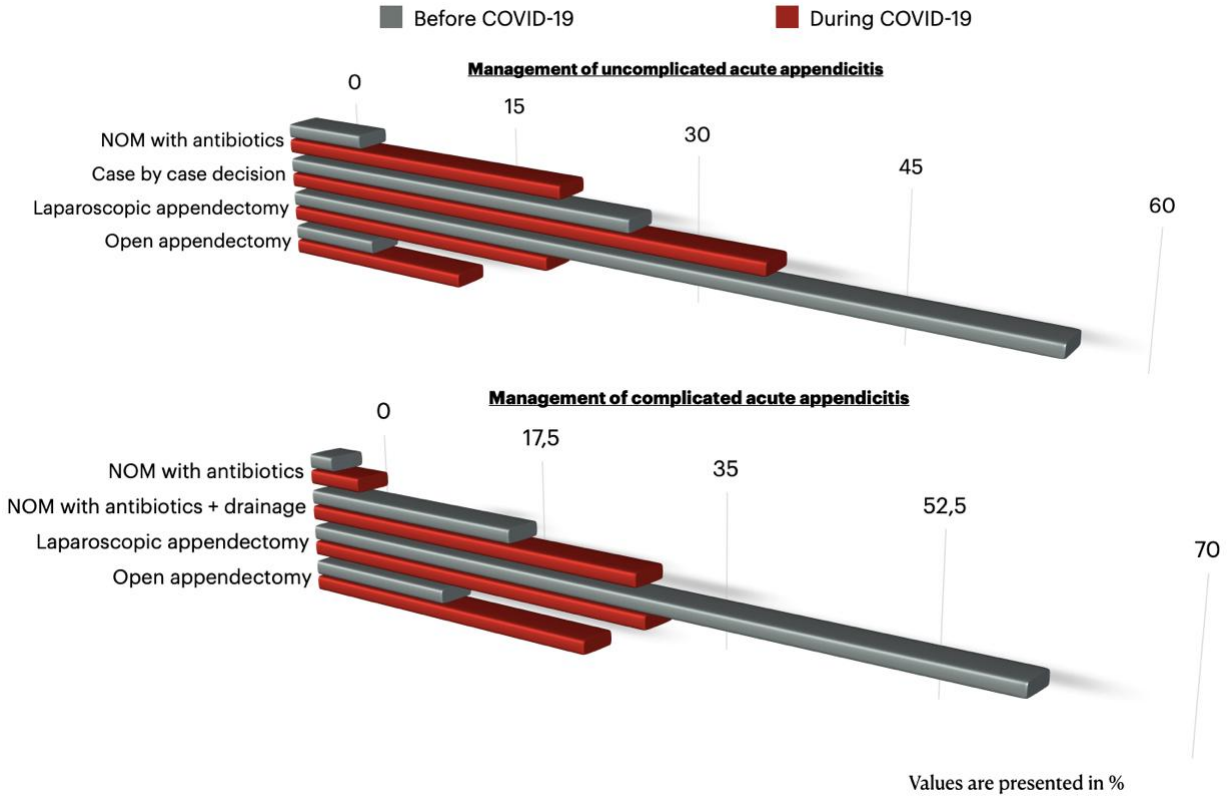

Public health system with universal coverage
Mainly public health system but without universal coverage
Mainly private health system
Only private health system
5.9%
1.3%
18.6%
74.2%

Figure 3



Values are presented in %

Figure 4

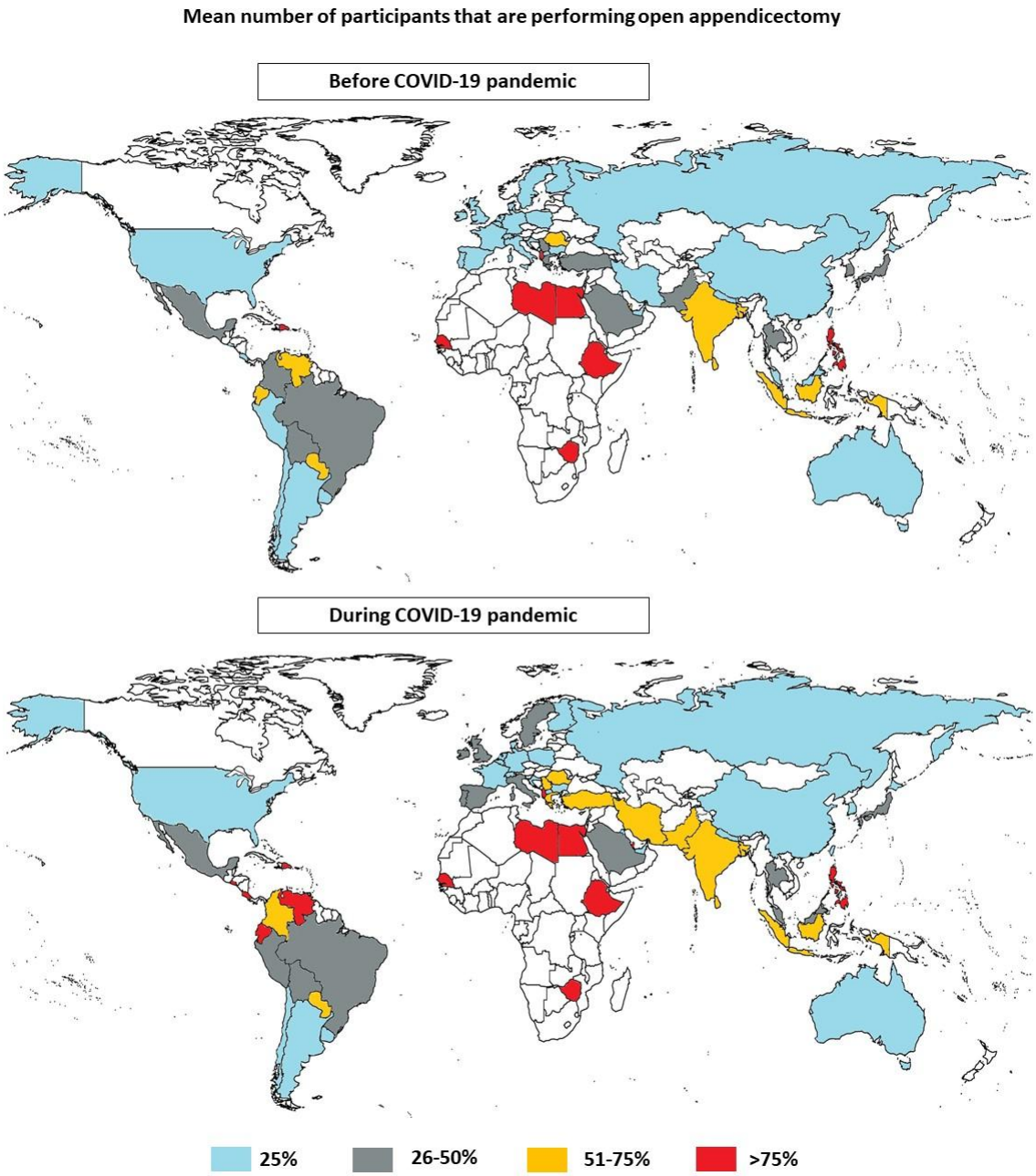
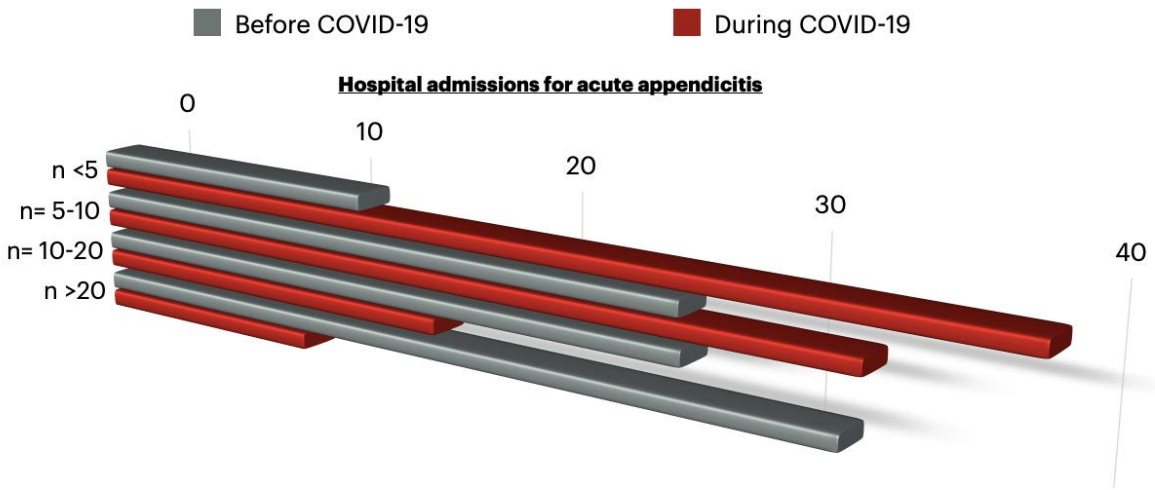

Mean number of participants that are performing open appendicectomy
Before COVID-19 pandemic
During COVID-19 pandemic
25%
26-50%
51-75%
>75%

Figure 5



Values are presented in absolute numbers

The COVID-19 Appy Study. Supplementary Table 1

	1 Baseline Information
1	Your email address
2	In which Country are you practicing?
3	Name of your hospital
4	Town
5	What is your level of expertise? • Student • Consultant/Attending • Fellow • Trainee/Resident
6	Please, pick the specialty that defines you better • General and emergency • Colorectal • Upper GI • HPB • Pediatric
7	In your Country, which kind of National Health System do you have? • Public health system with universal coverage • Mainly public health system, but without universal coverage • Mainly private health system • Only private health system
	2. Hospital organisation and screening policies
8	Which type of hospital do you work for? • Public university/teaching hospital • Private university/teaching hospital • Public non-teaching hospital • Private non-teaching hospital
9	Since COVID-19 pandemic, how did your hospital change its organization? • My hospital is exclusively dedicated to COVID-19 patients • My hospital has restricted areas dedicated to COVID-19 patients • My hospital does not treat COVID-19 patients
10	Do you routinely screen patients with appendicitis for SARS-CoV-2 infection before surgery? • Yes, all patients • Only patients with respiratory symptoms or suspect of SARS-CoV-2 infection • No
11	If you do, how do you screen patients? • Chest X-ray • Chest X-ray and serology • Chest X-ray and PCR • Chest CT scan • Chest CT scan and serology

	• Chest CT scan and PCR • Serology • PCR • Rapid test
	3. Personal protective equipment PPE
12	Did you change your operative protection in COVID-19 negative patients • No changes • Face mask (FFP2/FFP3) • N95 Face mask • Goggles • Face mask (FFP2/FFP3) and goggles • N95 mask and goggles
13	Did you change your operative protection in COVID-19 untested patients • No changes • Face mask (FFP2/FFP3) • N95 Face mask • Goggles • Face mask (FFP2/FFP3) and goggles • N95 mask and goggles
14	Did you change your operative protection in COVID-19 positive patients • No changes • Face mask (FFP2/FFP3) • N95 Face mask • Goggles • Face mask (FFP2/FFP3) and goggles • N95 mask and goggles
	4. Personal attitude: management of acute appendicitis
15	Personal attitude: Did you change your attitude in the management of uncomplicated acute appendicitis during the COVID-19 pandemic? • Yes • Yes, only in COVID+ patients • Yes, only in COVID+ and untested patients • No
16	Personal attitude: How do you manage uncomplicated (no abscess) acute appendicitis before COVID-19 pandemic? • Non-operative management with antibiotics • Case-by-case decision • Straightforward laparoscopic appendectomy • Straightforward open appendectomy
17	Personal attitude: How do you manage uncomplicated (no abscess) acute appendicitis during COVID-19 pandemic? • Non-operative management with antibiotics • Case-by-case decision • Straightforward laparoscopic appendectomy • Straightforward open appendectomy

18	Personal attitude: How do you manage complicated (abscess) acute appendicitis before COVID-19 pandemic? • Non-operative management with antibiotics • Non-operative management with antibiotics and percutaneous drainage • Straightforward laparoscopic appendectomy • Straightforward open appendectomy
19	Personal attitude: How do you manage complicated (abscess) acute appendicitis during COVID-19 pandemic? • Non-operative management with antibiotics • Non-operative management with antibiotics and percutaneous drainage • Straightforward laparoscopic appendectomy • Straightforward open appendectomy
20	Personal attitude: Did you change your attitude in the management of complicated (abscess) acute appendicitis during COVID-19 pandemic? • Yes • Only in COVID+ patients • No
21	Personal attitude: Would you change your overall attitude (surgery vs NOM with antibiotics) if you could test all patients? • I already test all patients • Only if quick test or PCR were available • Yes • No
22	Personal attitude: During the COVID-19 pandemic, did you change the surgical approach (open vs laparoscopic) to appendectomy? • No • Yes, from laparoscopic to open • Yes, from open to laparoscopic
23	Personal attitude: Would you say that you are confident in performing open appendectomy? • No • Yes, supervised by someone senior or with experience in open appendectomy • Yes, unsupervised
24	Personal attitude: How are you operating on COVID-19 positive patients with appendicitis? • Always open surgery, personal preference • Laparoscopic surgery without specific devices for protection and smoke evacuation • Laparoscopic surgery with specific devices for protection and smoke evacuation • I would use laparoscopic, but I do not have devices for pneumoperitoneum/smoke evacuation
25	Personal attitude: How are you operating on COVID-19 untested patients with appendicitis? • Always open surgery, I prefer • Laparoscopic surgery • I would use laparoscopic, but I do not have devices for pneumoperitoneum/smoke evacuation • I would use laparoscopic, but hospital policy does not allow it

26	Personal attitude: If laparoscopic appendectomy is performed, do you use any filter system? • Yes • Yes, only in COVID-19 positive patients • Yes, only in COVID-19 positive or untested patients • No
27	Personal attitude: If any evacuation system with filters is used, which type of device do you use? • Commercially available • Commercially available with filtration connected to a container with water • Commercially available with filtration connected to a sealed container • Homemade • Homemade with filtration connected to a container with water • Homemade with filtration connected to a sealed container
	5. Patient presentation before and during the pandemic
28	Did any patient referred for acute appendicitis test positive for SARS-CoV-2 before surgery at your hospital (percentage)? • 0% • 1-5% • 5-10% • >10%
29	Did any COVID-19 negative patient referred for acute appendicitis later test positive for SARS-CoV-2 at your hospital (percentage?) • 0% • 1-5% • 5-10% • > 10%
30	How many patients with acute appendicitis are referred to your hospital in one month (before COVID-19 pandemic)? • < 5 • 5-10 • 10-20 • > 20
31	How many patients with acute appendicitis have been referred to your hospital during the last month (during COVID-19 pandemic?) • < 5 • 5-10 • 10-20 • > 20
32	Would you agree that patients admitted with acute appendicitis had more aggressive presentation during COVID-19 pandemic? • Yes • No • Unsure
33	In percentage, in how many patients with uncomplicated acute appendicitis (no abscess) a non-operative management with antibiotics is usually used at your hospital (before COVID-19 pandemic)?

	• < 25% • 26-50% • 51-75% • 76-100%
34	In percentage, in how many patients with uncomplicated acute appendicitis (no abscess) a non-operative management with antibiotics is currently used at your hospital (during COVID-19 pandemic)? • < 25% • 26-50% • 51-75% • 76-100%
35	In percentage, how many patients with uncomplicated acute appendicitis (no abscess) treated conservatively with antibiotics were sent home and followed-up at the outpatient clinic at your hospital before COVID-19 pandemic? • < 25% • 26-50% • 51-75% • 76-100%
36	In percentage, how many patients with uncomplicated acute appendicitis (no abscess) treated conservatively with antibiotics are currently sent home and followed-up at the outpatient clinic at your hospital (during COVID-19 pandemic)? • < 25% • 26-50% • 51-75% • 76-100%
37	In percentage, how many patients with complicated acute appendicitis (with abscess) undergo conservative treatment with antibiotics +/- percutaneous drainage at your hospital (before COVID-19 pandemic)? • < 25% • 26-50% • 51-75 • 76-100%
38	In percentage, how many patients with complicated acute appendicitis (with abscess) currently undergo conservative treatment with antibiotics +/- percutaneous drainage at your hospital (during COVID-19 pandemic)? • < 25% • 26-50% • 51-75% • 76-100%
39	In percentage, how many patients with acute appendicitis treated with surgery undergo open appendectomy at your hospital (before COVID-19 pandemic)? • < 25% • 26-50% • 51-75% • 76-100%

The COVID-19 Appy Study. Supplementary Table 1

40	In percentage, how many patients with acute appendicitis treated with surgery currently undergo open appendectomy at your hospital (during COVID-19 pandemic)? • < 25% • 26-50% • 51-75% • 76-100%

Supplementary Table 2. Screening policies according to country.

Do you routinely screen patients with appendicitis for SARS-CoV-2?			
	Yes, all patients	Only patients with respiratory symptoms or suspected of SARS-CoV-2 infection	No
General	37.4%	51.0%	11.6%
USA	17.2%	65.5%	17.2%
UK	66.7%	-	33.3%
Spain	53.6%	39.3%	7.1%
Mexico	14.1%	50.0%	35.9%
Italy	57.1%	39.0%	3.8%
France	26.3%	57.9%	15.8%
Brazil	40.0%	46.7%	13.3%

Supplementary Table 2. Summary of results

1. Baseline information			
Query	**N. of respondents**	**Results**	
What is your level of expertise?	705	Student	0.5%
		Consultant/Attending	69.9%
		Fellow	6.9%
		Trainee/Resident	22.7%
Pick the specialty that defines you better	708	General and emergency	57.6%
		Colorectal	22.9%
		Upper GI	6.3%
		HPB	9.9%
		Pediatric	3.3%
In your Country, which kind of National Health System do you have?	707	Public health system with universal coverage	75.0%
		Manly public health system, but without universal coverage	18.0%
		Mainly private health system	6.0%
		Only private health system	1.0%
2. Hospital organization and screening policies			
Which type of hospital do you work for?	708	Public university/teaching hospital	63.5%
		Private university/teaching hospital	13.0%
		Public non-teaching hospital	16.6%
		Private non-teaching hospital	6.9%
Since COVID-19 pandemic, how did your hospital change its organization?	709	My hospital is exclusively dedicated to COVID-19 patients	8.9%
		My hospital has restricted areas dedicated to COVID-19 patients	83.1%
		My hospital does not treat COVID-19 patients	8.0%
Do you routinely screen patients with appendicitis for SARS-CoV-2 infection before surgery?	708	Yes, all patients	37.4%
		Only patients with respiratory symptoms or suspected of SARS-CoV-2 infection	51.0%

		No	11.6%
If you do, how do you screen patients?	654	Chest X-ray	7.3%
		Chest X-ray and serology	6.3%
		Chest X-ray and PCR	19.8%
		Chest CT scan	13.9%
		Chest CT scan and serology	6.7%
		Chest CT scan and PCR	18.1%
		Serology	1.4%
		PCR	17.2%
		Rapid test	9.3%
3. Personal protective equipment			
Did you change your operative protection in COVID-19 negative patients?	709	No changes	37.9%
		Face mask (FFP2/FFP3)	10.2%
		N95 Face mask	6.4%
		Goggles	3.4%
		Face mask (FFP2/FFP3) and goggles	24.0%
		N95 mask and goggles	18.0%
Did you change your operative protection in COVID-19 untested patients?	705	No changes	18.1%
		Face mask (FFP2/FFP3)	10.6%
		N95 Face mask	6.0%
		Goggles	2.4%
		Face mask (FFP2/FFP3) and goggles	40.1%
		N95 mask and goggles	22.6%
Did you change your operative protection in COVID-19 positive patients?	702	No changes	4.1%
		Face mask (FFP2/FFP3)	4.3%
		N95 Face mask	1.9%
		Goggles	0.4%
		Face mask (FFP2/FFP3) and goggles	56.3%
		N95 mask and goggles	33.0%
4. Personal attitude: management of acute appendicitis			

Did you change your attitude in the management of uncomplicated acute appendicitis during the COVID-19 pandemic?	705	Yes	28.5%
		Yes, only in COVID+ patients	13.2%
		Yes, only in COVID+ and untested patients	15.6%
		No	42.7%
How do you manage uncomplicated (no abscess) acute appendicitis before COVID-19 pandemic?	705	Non-operative management with antibiotics	6.6%
		Case-by-case decision	29.0%
		Straightforward laparoscopic appendectomy	57.2%
		Straightforward open appendectomy	7.2%
How do you manage uncomplicated (no abscess) acute appendicitis during COVID-19 pandemic?	705	Non-operative management with antibiotics	23.7%
		Case-by-case decision	38.8%
		Straightforward laparoscopic appendectomy	22.5%
		Straightforward open appendectomy	15.0%
How do you manage complicated (abscess) acute appendicitis before COVID-19 pandemic?	704	Non-operative management with antibiotics	2.4%
		Non-operative management with antibiotics and percutaneous drainage	21.1%
		Straightforward laparoscopic appendectomy	62.5%
		Straightforward open appendectomy	14.0%
How do you manage complicated (abscess) acute appendicitis during COVID-19 pandemic?	701	Non-operative management with antibiotics	5.3%
		Non-operative management with antibiotics and percutaneous drainage	32.9%
		Straightforward laparoscopic appendectomy	33.7%
		Straightforward open appendectomy	28.1%
Did you change your attitude in the management of complicated (abscess) acute appendicitis during COVID-19 pandemic?	704	Yes	28.3%
		Only in COVID+ patients	24.6%
		No	47.1%
Would you change your overall attitude (surgery versus non-operative management with antibiotics) if you could test all patients?	703	I already test all patients	17.5%
		Only if quick test for PCR were available	26.9%
		Yes	22.2%
		No	33.4%
During the COVID-19 pandemic, did you change the surgical approach	703	No	61.0%

(open versus laparoscopic) to appendectomy?		Yes, from laparoscopic to open	36.6%
		Yes, from open to laparoscopic	2.4%
Would you say that you are confident in performing open appendectomy?	704	No	7.8%
		Yes, supervised by someone senior, or with experience in open appendectomy	15.8%
		Yes, unsupervised	76.4%
How are you operating on COVID-19 positive patients with appendicitis?	695	Always open surgery, personal preference	30.1%
		Laparoscopic surgery without specific devices for protection and smoke evacuation	6.2%
		Laparoscopic surgery with specific devices for protection and smoke evacuation	43.0%
		I would use laparoscopy, but I do not have devices for pneumoperitoneum/smoke evacuation	20.7%
How are you operating on COVID-19 untested patients with appendicitis?	700	Always open surgery, personal preference	28.0%
		Laparoscopic surgery	49.4%
		I would use laparoscopy, but I do not have devices for pneumoperitoneum/smoke evacuation	17.0%
		I would use laparoscopy, but hospital policy does not allow it	5.6%
If laparoscopic appendectomy is performed, do you use any filter system?	695	Yes	37.8%
		Yes, only in COVID-19 positive patients	11.9%
		Yes, only in COVID-19 positive or untested patients	24.3%
		No	26.0%
If any smoke evacuation system is used, which type of device do you use	637	Commercially available	32.8%
		Commercially available with filtration connected to a container with water	7.7%
		Commercially available with filtration connected to a sealed container	22.0%
		Homemade	11.9%
		Homemade with filtration connected to a container with water	14.0%
		Homemade with filtration connected to a sealed container	11.6%

5. Patient presentation before and during the COVID-19 pandemic			
Did any patient referred for acute appendicitis test positive for SARS-CoV-2 before surgery at your hospital (percentage)?	698	0%	68.1%
		1-5%	27.5%
		5-10%	3.3%
		>10%	1.1%
Did any patient referred for acute appendicitis later test positive for SARS-CoV-2 at your hospital (percentage)?	691	0%	71.8%
		1-5%	21.3%
		5-10%	2.8%
		>10%	4.1%
How many patients with acute appendicitis are referred to your hospital in one month (before COVID-19 pandemic)?	699	<5	13.3%
		5-10	26.9%
		10-20	27.0%
		>20	32.8%
How many patients with acute appendicitis have been referred to your hospital during the last month (during COVID-19 pandemic)?	699	<5	39.3%
		5-10	33.5%
		10-20	16.7%
		>20	10.5%
Would you agree that patients admitted with acute appendicitis had more aggressive presentation during COVID-19 pandemic?	701	Yes	34.3%
		No	26.5%
		Unsure	39.2%
In percentage, in how many patients with uncomplicated acute appendicitis (no abscess) a non-operative management with antibiotics is usually used at your hospital (before COVID-19 pandemic)?	701	<25%	79.3%
		26-50%	11.8%
		51-75%	6.6%
		76-100%	2.3%
In percentage, in how many patients with uncomplicated acute appendicitis (no abscess) a non-operative management with antibiotics is currently used at your hospital (during COVID-19 pandemic)?	697	<25%	60.1%
		26-50%	16.2%
		51-75%	11.6%
		76-100%	12.1%
In percentage, how many patients with uncomplicated acute appendicitis	696	<25%	78.2%

(no abscess) treated conservatively with antibiotics were sent home and followed-up at the outpatient clinic at your hospital before COVID-19 pandemic?		26-50%	10.9%
		51-75%	5.7%
		76-100%	5.2%
In percentage, how many patients with uncomplicated acute appendicitis (no abscess) treated conservatively with antibiotics are currently sent home and followed-up at the outpatient clinic at your hospital (during COVID-19 pandemic)?	692	<25%	67.5%
		26-50%	12.9%
		51-75%	9.8%
		76-100%	9.8%
In percentage, how many patients with complicated acute appendicitis (with abscess) usually undergo conservative treatment with antibiotics +/- percutaneous drainage at your hospital (before COVID-19 pandemic)?	695	<25%	77.3%
		26-50%	10.8%
		51-75%	5.6%
		76-100%	6.3%
In percentage, how many patients with complicated acute appendicitis (with abscess) currently undergo conservative treatment with antibiotics +/- percutaneous drainage at your hospital (during COVID-19 pandemic)?	690	<25%	68.4%
		26-50%	12.5%
		51-75%	9.3%
		76-100%	9.8%
In percentage, how many patients with acute appendicitis treated with surgery usually undergo open appendectomy at your hospital (before COVID-19 pandemic)?	698	<25%	73.6%
		26-50%	8.7%
		51-75%	8.6%
		76-100%	9.1%
In percentage, how many patients with acute appendicitis treated with surgery currently undergo open appendectomy at your hospital (during COVID-19 pandemic)?	695	<25%	53.8%
		26-50%	13.7%
		51-75%	9.8%
		76-100%	22.7%