emergency care and medicine

MDPI

Article

Outcomes of Acute Appendicitis During the COVID-19 Pandemic

Ning Lu *, Imad S. Dandan, Gail T. Tominaga, Frank Z. Zhao, Fady Nasrallah, James Schwendig, Hung Truong, Anthony Ferkich, Matthew R. Castelo, Dunya Bayat and Walter L. Biffl

Trauma and Acute Care Surgery, Scripps Memorial Hospital La Jolla, La Jolla, CA 92037, USA; tominaga.gail@scrippshealth.org (G.T.T.); zhao.frank@scrippshealth.org (F.Z.Z.); nasrallah.fady@scrippshealth.org (F.N.); bayat.dunya@scrippshealth.org (D.B.); biffl.walter@scrippshealth.org (W.L.B.)

* Correspondence: lu.ning@scrippshealth.org; Tel.: +1-858-626-6362; Fax: +1-858-626-6354

Abstract: Background/Objectives: During the early phase of the coronavirus disease 2019 (COVID-19) pandemic, people were advised to stay at home and the American College of Surgeons suggested the nonoperative management (NOM) of uncomplicated appendicitis. We hypothesized that patients presented with more cases of complicated appendicitis during the early phase of COVID-19 compared with the previous year; we further hypothesized that more patients had NOM. **Methods**: Adults diagnosed with appendicitis were retrospectively reviewed from electronic medical records throughout a single county-wide hospital system. The pre-pandemic period (3 January 2019–30 June 2019, PRE) was compared with the pandemic period (3 January 2020–30 June 2020, POST). The primary outcome was AAST grade of appendicitis. **Results**: There were 278 cases of appendicitis in PRE and 269 in POST. The rate of complicated appendicitis (grades II–V) was higher in POST (39% vs. 30%, $p = 0.0375$), most prominently in the northern hospitals in the county (41% vs. 27%, $p = 0.004$), with non-operative management in six (3.2%) cases. Grades III–V, consistent with perforation, were seen in 33% of POST vs. 27% of PRE cases ($p = 0.098$). Grade I appendicitis was managed non-operatively in only six (1.6%) patients. There were fewer readmissions in POST (4% vs. 8%, $p = 0.0427$) and no mortalities during the study period. **Conclusions**: There was a significant increase in presentation with complicated appendicitis during the early phase of the COVID-19 pandemic in the northern hospitals in the county. There was no increase in NOM of uncomplicated appendicitis and no change in hospital LOS but there were fewer readmissions during COVID-19.

Keywords: COVID-19; appendicitis; pandemic; non-operative management

check for updates

Academic Editor: Raimundas Lunevicius

Received: 8 January 2025
Revised: 29 January 2025
Accepted: 7 February 2025
Published: 17 February 2025

Citation: Lu, N.; Dandan, I.S.; Tominaga, G.T.; Zhao, F.Z.; Nasrallah, F.; Schwendig, J.; Truong, H.; Ferkich, A.; Castelo, M.R.; Bayat, D.; et al. Outcomes of Acute Appendicitis During the COVID-19 Pandemic. *Emerg. Care Med.* **2025**, *2*, 8. https://doi.org/10.3390/ecm2010008

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

On 19 March 2020, the Governor of the State of California decreed a statewide lockdown due to the coronavirus disease 2019 (COVID-19) pandemic. Around this time, there was a 50% reduction in emergency room visits [1]. This could not be explained by the lockdown per se but appeared to be related in part to patient avoidance of healthcare facilities for fear of contracting COVID-19, concerns of insufficient hospital resources [1,2], changes in healthcare delivery, resource allocation, patient care protocols, and the global problem [3]. Around this time, there were also concerns about hospital overcrowding and the transmission of COVID-19 infection to healthcare teams. These concerns were not only local but extended both nationwide and globally. The American College of Surgeons (ACS) issued guidance on the management of emergency general surgery [4], emphasizing prompt, appropriate management of surgical problems and minimizing hospital

length of stay (LOS). Given additional concerns over the transmission of the virus during laparoscopic surgery, the ACS suggested the non-operative management (NOM) of uncomplicated appendicitis [4].

Acute appendicitis has a lifetime incidence of 7% [5]. This results in 86–100 cases per 100,000 patients per year, with perforated appendicitis occurring in up to 19% of these patients [6,7]. In the United States, appendectomy is the standard treatment of acute appendicitis and it is one of the most common emergency general surgery operations performed annually in the U.S. [8,9]. Patients with complicated appendicitis—defined as appendicitis that has advanced to perforation, the formation of an inflammatory mass (phlegmon), or the formation of an abscess—have worse outcomes compared to those who have uncomplicated appendicitis [10]. Surgical complications, conversion to open surgery, hospital LOS, and postoperative infections are all greater in complicated compared with uncomplicated appendicitis [10]. While it has been shown that in-hospital delays in appendectomy do not necessarily change perforation rates with prompt presentation, there are higher rates of surgical site infections [11,12]. However, the overall duration of symptoms is associated with an increased risk of perforation [13]. The COVID-19 pandemic carried the potential of exacerbating these risks previously detailed in the literature.

Initial findings from the literature report that in the early phases of the pandemic, patients with suspected appendicitis may have delayed seeking medical attention, resulting in a more advanced stage of the disease upon presentation [14]. Thus, the aim of this study was to evaluate the effects of the COVID-19 pandemic on the rate of complicated appendicitis, management strategies, and patient outcomes in a single county in southern California. We hypothesized that a greater percentage of patients with appendicitis presented with complicated appendicitis at the time of treatment during the initial phase of COVID-19 compared with the previous year and that more patients had NOM.

2. Materials and Methods

We retrospectively reviewed all cases of appendicitis in adults in a single county-wide hospital system in southern California. There are five acute care hospitals in the system: two in the southern half of the county and three in the northern half. Participants consisted of individuals aged 18 years and older who were admitted to any of the five hospitals within the hospital system for acute appendicitis during the pre-pandemic period (1 March 2019–30 June 2019, PRE) or the pandemic period (1 March 2020–30 June 2020, POST). "Acute appendicitis" was identified in the electronic medical record (EMR) by any of the following diagnoses: acute appendicitis with generalized peritonitis, with or without abscess; acute appendicitis with localized peritonitis, without perforation or gangrene; acute appendicitis with localized peritonitis and gangrene, without perforation; acute appendicitis with perforation and localized peritonitis, with or without abscess; appendicitis with NOM; unspecified acute appendicitis; other acute appendicitis; other acute appendicitis without perforation, with or without gangrene; other appendicitis; and unspecified appendicitis. This retrospective study was exempted from full review by the local Institutional Review Board due to the deidentified nature of the data.

Data from the EMR were retrospectively reviewed. Demographic information included gender, age, race, and body mass index. Imaging, operative reports, and pathology reports were reviewed by board-certified general surgeons who assigned the grade of appendicitis according to the American Association for the Surgery of Trauma (AAST) grading scale (Table 1) [15–17]. Other variables such as primary and secondary diagnoses, disposition, mortality, hospital and intensive care unit LOS, complications, comorbidities, COVID-19 test results, and operations and procedures performed were analyzed.

Table 1. American Association for the Surgery of Trauma (AAST) Appendicitis grading scale [15].

AAST Grade	Description	Clinical Criteria	Imaging Criteria (CT Findings)	Operative Criteria	Pathologic Criteria
I	Acutely inflamed appendix, intact	Pain, leukocytosis and right lower quadrant (RLQ) tenderness	Inflammatory changes localized to appendix +/− appendiceal dilation +/− contrast non-filling	Acutely inflamed appendix, intact	Presence of neutrophils at the base of crypts, submucosa +/− in muscular wall
II	Gangrenous appendix, intact	Pain, leukocytosis and RLQ tenderness	Appendiceal wall necrosis with contrast non-enhancement +/− air in appendiceal wall	Gangrenous appendix, intact	Mucosa and muscular wall digestion; not identifiable on hematoxylin and eosin stain (H & E)
III	Perforated appendix with local contamination	Pain, leukocytosis and RLQ tenderness	Above with local periappendiceal fluid +/− contrast extravasation	Above, with evidence of local contamination	Gross perforation or focal dissolution of muscular wall
IV	Perforated appendix with periappendiceal phlegmon or abscess	Pain, leukocytosis and RLQ tenderness; may have palpable mass	Regional soft tissue inflammatory changes, phlegmon or abscess	Above, with abscess or phlegmon in region of appendix	Gross perforation
V	Perforated appendix with generalized peritonitis	Generalized peritonitis	Diffuse abdominal or pelvic inflammatory changes +/− free intra-peritoneal fluid or air	Above, with addition of generalized purulent contamination away from appendix	Gross perforation

The primary outcome measure was the grade of appendicitis according to the AAST grading scale. Secondary outcomes included rate of operative intervention, rate of interventional radiology procedure, complications, mortality, and hospital LOS.

All baseline characteristics were summarized with descriptive statistics. Categorical variables were reported as counts with proportions (%) and compared using Fisher exact tests or Pearson chi-squared tests, as appropriate. Continuous variables were summarized as means with standard deviations (SDs) or medians with interquartile ranges (IQRs) and compared using two-sample *t*-tests and Wilcoxon rank-sum tests, respectively. Significance was set at p-value < 0.05. Statistical analyses were performed using R statistical computing software (R4.3.3).

3. Results

Of 547 total cases of appendicitis during the study period, 278 (51%) were in PRE and 269 (49%) were in POST. There were no significant differences in age or gender (Table 2). The rate of complicated appendicitis (grades II–V) was higher in POST (39% vs. 30%, $p = 0.0375$), most prominently in the northern hospitals in the county (41% vs. 27%, $p = 0.004$). Grades III–V, consistent with perforation, were seen in 33% of POST vs. 27% of PRE cases ($p = 0.098$), although this difference did not meet statistical significance (Table 2). There was no difference in the duration of symptoms prior to presentation (Table 2).

In total, 99% of PRE and 97% of POST patients were managed operatively ($p = 0.07$). Grade I appendicitis was managed with NOM in only 6 (1.6%) of 359 patients and all 6 of these cases were in POST ($p = 0.023$). Patients with complicated appendicitis underwent NOM in six (3%) cases and this proportion did not change over time. Median LOS did not change between the time periods ($p = 0.548$). There were fewer readmissions in POST (4% vs. 8%, $p = 0.0427$). There were no mortalities during the study period (Table 3).

Table 2. Demographics and AAST grading for PRE and POST.

Characteristic	PRE	POST	*p*-VALUE
N (%)	278 (51)	269 (49)	--
Mean Age (SD)	44 (17.1)	45 (16.5)	0.9135
Males, N (%)	139 (50)	140 (52)	0.6325
Hispanic, N (%)	78 (28)	66 (25)	0.3497
White Non-Hispanic, N (%)	153 (55)	162 (60)	0.2197
Black, N (%)	6 (2)	5 (2)	0.803
Other Race, N (%)	41 (15)	36 (13)	0.6462
COVID Test, N (%)	0	191 (71)	--
COVID-19-Positive, N (%)	0	4 (2)	--
Mean BMI (SD)	27.2 (5.4)	27.8 (6.5)	0.2067
Median BMI (IQR)	26.5 (23.3, 30)	26.5 (23.2, 30.7)	0.4558
Mean Time to Presentation (Hours)	59.9 (187.6)	60.7 (254.8)	0.9652
Median Time to Presentation (Hours)	24 (13, 48)	24 (13, 49.25)	0.9042
Time to Presentation <24 h, N (%)	111 (40)	106 (40)	0.9013
Time to Presentation 24–48 h, N (%)	103 (37)	94 (35)	0.6083
Time to Presentation >48 h, N (%)	63 (23)	68 (25)	0.4726
Uncomplicated: Grade I, N (%)	194 (70)	165 (61)	0.0375
Complicated: Grades II–V, N (%)	84 (30)	104 (39)	0.0375
Northern Hospital Complicated: Grades II–V, N (%)	51 (27)	79 (41)	0.0044
Perforated: Grades III–V, N (%)	74 (27)	89 (33)	0.0982
Median Grade (IQR)	1 (1, 3)	1 (1, 3)	0.04668

SD, standard deviation; IQR, interquartile range; BMI, body mass index. Bold indicates significance ($p < 0.05$).

Table 3. Operative versus non-operative management and other outcomes for PRE and POST.

	PRE	POST	*p*-VALUE
N (%)	278 (51)	269 (49)	--
Mean LOS (SD)	3 (2.2)	3 (3.7)	0.6672
Median LOS (IQR)	2 (2, 4)	2 (2, 3)	0.5475
Operative, N (%)	275 (99)	260 (97)	0.0704
Non-operative, N (%)	3 (1)	9 (3)	0.0704
Non-operative Grade I, N (%)	0	6 (4)	0.0234
Non-operative Grades II–V, N (%)	3 (4)	3 (3)	1.000
Median Grade (IQR)	1 (1, 3)	1 (1, 3)	0.04668
Total to ICU, N (%)	4 (1)	3 (1)	small sample
Intra-abdominal Infection, N (%)	17 (6)	9 (3)	0.128
SSI, N (%)	4 (1)	0	small sample
Readmission, N (%)	23 (8)	11 (4)	0.0427
SBO/Ileus, N (%)	21 (8)	25 (9)	0.4636
Anemia, N (%)	5 (2)	6 (2)	0.719

LOS, length of stay; SD, standard deviation; IQR, interquartile range; ICU, intensive care unit; SBO, small bowel obstruction; SSI, surgical site infection. Bold indicates significance ($p < 0.05$).

4. Discussion

While many hospital systems noted a decrease in patients presenting with appendicitis during the COVID-19 pandemic [18–21], we noted similar numbers in PRE and POST. Tankel et al. [20] reported that their pre-pandemic and post-pandemic populations did not have any different rates of complicated appendicitis (incidence or proportion), operative

management, or LOS and theorized that the significant decrease in patients presenting with appendicitis may represent successful resolution of mild appendicitis treated by patients at home. However, it is difficult to apply that theory to the population within our study given the stable presentation of patients with acute appendicitis.

We did note a significantly lower rate of uncomplicated (Grade I) appendicitis (70% PRE vs. 61% POST) and significantly higher rate of complicated (Grades II–V) appendicitis (30% PRE vs. 39% POST). This was also noted by multiple other studies during this time period [19–26]. Andersson et al. [27] performed a meta-analysis of 100,059 patients and determined that the increased proportion of complicated appendicitis during the pandemic was due to a decrease in the incidence of uncomplicated appendicitis. However, for our study population, as well as many others [19,22,23,25,26], the incidence (not just the proportion) of complicated appendicitis increased during the study period. This was most pronounced in the northern hospitals, whose populations have a more affluent socioeconomic status. Differences in healthcare accessibility, regional referral patterns, and local hospital protocols may also contribute to this geographic variation. There was no difference in rates of perforation or postoperative complications, except a decrease in re-admission in POST.

The question remains: Why was there more complicated appendicitis? For our population, there was no significant difference in the duration of symptoms prior to patient presentation for PRE vs. POST. However, Burgard et al. [18] noted that during the COVID-19 pandemic, 61% of patients (compared to 26% of patients pre-pandemic) had symptoms for >48 h. An et al. [22] and Nguyen et al. [24] also noted an increased duration of symptoms in the pandemic group. Given the association of the duration of symptoms at presentation with a higher rate of perforation [13], it would seem that a delay in presentation resulted in higher grades of appendicitis. However, a difference in the duration of symptoms prior to presentation was not found by Orthopoulous et al. [19] or Tankel et al. [20]. Given the inconsistent data regarding whether patients were presenting later during the COVID-19 pandemic, it remains challenging to elucidate the precise etiology of more cases of complicated appendicitis during this period. It is possible that COVID-19 illness is associated with an altered pathophysiology of appendicitis, with more rapid advancement to perforation. This requires further study.

We did find a significantly higher rate of NOM for uncomplicated (Grade I) acute appendicitis. Given the ACS recommendations of NOM for uncomplicated appendicitis [4] during the early stages of the pandemic, this was expected. It has been established in many studies [28,29], most recently in the CODA Trial [30], that NOM is non-inferior to the operative management of appendicitis. Briefly, the CODA Trial was a large, pragmatic, randomized, controlled study that enrolled over 1500 patients with acute appendicitis to receive either antibiotics or appendectomy. It demonstrated that nonoperative management was non-inferior to surgery for uncomplicated appendicitis but also revealed that nearly 30% of patients assigned to antibiotics required an appendectomy within 90 days. This supports the expanding role of NOM for uncomplicated cases while highlighting the complexities and individualized considerations inherent in managing acute appendicitis. In a meta-analysis of fourteen studies utilizing NOM during the COVID-19 pandemic, 50% of the 2140 patients underwent NOM, with lower rates of complications compared to appendectomy [31]. In a meta-analysis of 11 studies and 18,084 patients with acute appendicitis (including 4242 patients during the COVID-19 pandemic), 16% of patients received NOM during the pandemic, compared to 13% pre-pandemic. Further, there was no difference in median LOS in the present study, although differences in LOS appear to vary in other studies. Burgard et al. [18] noted LOS > 2 days in 63% of patients during the COVID-19 pandemic, compared to 32% pre-pandemic. In alignment with our study,

Kohler et al. [21] and Tankel et al. [20] also did not note any significant difference in LOS. As for the lower rates of NOM for Grade I appendicitis in the POST period, one plausible explanation is that established surgical practice norms and patient preferences have historically favored an operative approach for all presentations of acute appendicitis. The temporal shift in management practices observed in the POST period may reflect evolving institutional protocols introduced during the pandemic, which encouraged the more selective use of NOM.

As health systems nationwide continue to adapt to evolving public health challenges, our findings underscore the indirect impact of the COVID-19 pandemic on acute surgical conditions. The persistence of COVID-19 infections makes this a relevant issue. Our observed decrease in readmissions, while potentially positive, raises questions about postoperative care practices and patient behavior during a public health crisis. Moreover, the increase in the incidence of complicated appendicitis presentations during the early phase of the pandemic may point to potential gaps in access to timely care in this setting, as well as issues related to resource allocation and healthcare delivery [31–34]. Further research is necessary to identify the contributing factors to these findings. Such inquiries could inform postoperative care protocols that may improve trauma patient management in both public health emergencies and routine clinical practice.

The main limitation of this study is the inability to discern whether patients would have presented to the hospital earlier had there not been a pandemic. This is due to the retrospective nature of this study. Given the reliance on the EMR, the findings of the present study may be limited by data entry errors or variations over the study period. Additionally, since we were not able to delineate a difference in the duration of symptoms between PRE and POST, we cannot say with certainty that these patients had any delay in seeking medical care. NOM protocols may have had slight variations among centers included in this study, but, nevertheless, our sample size benefitted from the inclusion of multiple sites. The lack of long-term data is also a limitation of the present study, in addition to the single-county study design and lack of granularity regarding non-operative management strategies. Despite these limitations, the rigor of the present study was strengthened by multisite data collection over a 15-month period at the height of the COVID-19 pandemic.

5. Conclusions

The incidence and proportion of complicated appendicitis increased during the early phase of the COVID-19 pandemic within our healthcare system. This increase was most pronounced in the northern hospitals of the county, whose population has a more affluent socioeconomic status compared to the southern hospitals. It remains unclear if the increase in complicated appendicitis was due to delays in seeking care resulting in an increased incidence of complicated cases or if it was simply due to fewer presentations of uncomplicated appendicitis that resolved at home. Additionally, while there was an increase in NOM, there was no change in hospital LOS and no change in complications between PRE and POST. NOM and appendectomy are safe strategies for the management of acute appendicitis during a pandemic when the risks of the pandemic disease are not yet known. However, given the incidence of subsequent appendectomy within 90 days, as noted in the CODA trial, appropriate counseling should be given to the patient regarding all treatment methodologies. Overall, it is possible that complicated appendicitis cases may have increased after the pandemic due to patients' avoidance of hospital visits for fear of contracting COVID-19. Further evidence is necessary to confirm these findings.

Author Contributions: Conceptualization, N.L. and W.L.B.; Data curation, M.R.C.; Formal analysis, M.R.C.; Investigation, M.R.C.; Methodology, N.L., M.R.C. and W.L.B.; Project administration, N.L. and W.L.B.; Supervision, W.L.B.; Writing—original draft, N.L., I.S.D., G.T.T., F.Z.Z., F.N., J.S., H.T.,

A.F., D.B. and W.L.B.; Writing—review and editing, N.L., I.S.D., G.T.T., F.Z.Z., F.N., J.S., H.T., A.F., M.R.C., D.B. and W.L.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the deidentified nature of the data.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data that support the findings of this work are available upon reasonable request from the corresponding author, N.L.

Conflicts of Interest: The authors have no conflicts of interest to declare.

References

1. Wong, L.E.; Hawkins, J.E.; Langness, S.; Iris, P.; Sammann, A. Where Are All the Patients? Addressing Covid-19 Fear to Encourage Sick Patients to Seek Emergency Care. *NEJM Catal. Innov. Care Deliv.* **2020**, *12*.
2. Boserup, B.; McKenney, M.; Elkbuli, A. The impact of the COVID-19 pandemic on emergency department visits and patient safety in the United States. *Am. J. Emerg. Med.* **2020**, *38*, 1732–1736. [CrossRef] [PubMed] [PubMed Central]
3. Lazzerini, M.; Barbi, E.; Apicella, A.; Marchetti, F.; Cardinale, F.; Trobia, G. Delayed access or provision of care in Italy resulting from fear of COVID-19. *Lancet Child Adolesc. Health* **2020**, *4*, e10–e11. [CrossRef]
4. American College of Surgeons. COVID 19: Elective Case Triage Guidelines for Surgical Care. 2020. Available online: https://www.facs.org/media/33km00ma/guidance_for_triage_of_nonemergent_surgical_procedures_general_surgery.pdf (accessed on 20 September 2020).
5. Addis, D.; Shaffer, N.; Fowler, B.; Tauxe, R. The epidemiology of appendicitis and appendectomy in the United States. *Am. J. Epidemiol.* **1990**, *132*, 910–925. [CrossRef]
6. Korner, S.; Sondenaa, K.; Soreide, J.; Andersen, E.; Nysted, A.; Lende, T.H.; Kjellevold, K.H. Incidence of acute nonperforated and perforated appendicitis: Age-specific and sex-specific analysis. *World J. Surg.* **1997**, *21*, 313–317. [CrossRef] [PubMed]
7. Ferris, M.; Quan, S.; Kaplan, B.S.; Molodecky, N.; Ball, C.G.; Chernoff, G.W.; Bhala, N.; Ghosh, S.; Dixon, E.; Ng, S.; et al. The Global Incidence of Appendicitis: A Systematic Review of Population-based Studies. *Ann. Surg.* **2017**, *266*, 237–241. [CrossRef] [PubMed]
8. Flum, D.R. Acute Appendicitis—Appendectomy or the "Antibiotics First" Strategy. *N. Engl. J. Med.* **2015**, *372*, 1937–1943. [CrossRef] [PubMed]
9. Weiss, A.; Elixhauser, A.; Andrews, R. *Characteristics of Operating Room Procedures in U.S. Hospitals, 2011: Statistical Brief #170*; Agency for Healthcare Research and Quality: Rockville, MD, USA, 2006.
10. Davies, G.; Dasbach, E.; Teutsch, S. The burden of appendicitis-related hospitalizations in the United States in 1997. *Surg. Infect.* **2004**, *5*, 160–165. [CrossRef]
11. Andersson, R. The natural history and traditional management of appendicitis revisited: Spontaneous resolution and predominance of prehospital perforations imply that a correct diagnosis is more important than an early diagnosis. *World J. Surg.* **2007**, *31*, 86–92. [CrossRef] [PubMed]
12. Teixeira, P.G.; Sivrikoz, E.; Inaba, K.; Talving, P.; Lam, L.; Demetriades, D. Appendectomy Timing: Waiting Until the Next Morning Increases the Risk of Surgical Site Infections. *Ann. Surg.* **2012**, *256*, 538–543. [CrossRef] [PubMed]
13. Kearney, D.; Cahill, R.A.; O'Brien, E.; Kirwan, W.O.; Redmond, H.P. Influence of delays on perforation risk in adults with acute appendicitis. *Dis. Colon Rectum* **2008**, *51*, 1823–1827. [CrossRef] [PubMed]
14. Rosenthal, M.G.; Fakhry, S.M.; Morse, J.L.; Wyse, R.J.; Garland, J.M.; Duane, T.M.; Slivinski, A.; Wilson, N.Y.; Watts, D.D.; Shen, Y.; et al. Where Did All the Appendicitis Go? Impact of the COVID-19 Pandemic on Volume, Management, and Outcomes of Acute Appendicitis in a Nationwide, Multicenter Analysis. *Ann. Surg.* **2021**, *2*, e048. [CrossRef] [PubMed]
15. Acute Appendicitis. Data Dictionaries for AAST Grading System for EGS Conditions. Available online: https://www.aast.org/resources-detail/egs (accessed on 20 September 2020).
16. Shafi, S.; Aboutanos, M.; Brown, C.V.; Ciesla, D.; Cohen, M.J.; Crandall, M.L.; Inaba, K.; Miller, P.R.; Mowery, N.T.; American Association for the Surgery of Trauma Committee on Patient Assessment and Outcomes. Measuring anatomic severity of disease in emergency general surgery. *J. Trauma. Acute Care Surg.* **2014**, *76*, 884–887. [CrossRef] [PubMed]
17. Hernandez, M.C.; Aho, J.M.; Habermann, E.B.; Choudhry, A.J.; Morris, D.S.; Zielinski, M.D. Increased anatomic severity predicts outcomes: Validation of the American Association for the Surgery of Trauma's Emergency General Surgery score in appendicitis. *J. Trauma. Acute Care Surg.* **2017**, *82*, 73–79. [CrossRef] [PubMed] [PubMed Central]

18. Burgard, M.; Cherbanyk, F.; Nassiopoulos, K.; Malekzadeh, S.; Pugin, F.; Egger, B. An effect of the COVID-19 pandemic: Significantly more complicated appendicitis due to delayed presentation of patients! *PLoS ONE* **2021**, *16*, e0249171. [CrossRef] [PubMed]
19. Orthopoulos, G.; Santone, E.; Izzo, F.; Tirabassi, M.; Pérez-Caraballo, A.M.; Corriveau, N.; Jabbour, N. Increasing incidence of complicated appendicitis during COVID-19 pandemic. *Am. J. Surg.* **2021**, *221*, 1056–1060. [CrossRef] [PubMed] [PubMed Central]
20. Tankel, J.; Keinan, A.; Blich, O.; Koussa, M.; Helou, B.; Shay, S.; Zugayar, D.; Pikarsky, A.; Mazeh, H.; Spira, R.; et al. The Decreasing Incidence of Acute Appendicitis During COVID-19: A Retrospective Multi-centre Study. *World J. Surg.* **2020**, *44*, 2458–2463. [CrossRef] [PubMed] [PubMed Central]
21. Köhler, F.; Müller, S.; Hendricks, A.; Kastner, C.; Reese, L.; Boerner, K.; Flemming, S.; Lock, J.F.; Germer, C.T.; Wiegering, A. Changes in appendicitis treatment during the COVID-19 pandemic—A systematic review and meta-analysis. *Int. J. Surg.* **2021**, *95*, 106148. [CrossRef] [PubMed] [PubMed Central]
22. An, S.; Kim, H.R.; Jang, S.; Kim, K. The Impact of the Coronavirus Disease—19 Pandemic on the Clinical Characteristics and Treatment of Adult Patients with Acute Appendicitis. *Front. Surg.* **2022**, *9*, 878534. [CrossRef] [PubMed] [PubMed Central]
23. Bowen, J.M.; Sheen, J.R.C.; Whitmore, H.; Wright, C.; Bowling, K. Acute appendicitis in the COVID-19 era: A complicated situation? *Ann. Med. Surg.* **2021**, *67*, 102536. [CrossRef] [PubMed] [PubMed Central]
24. Nguyen, H.V.; Tran, L.H.; Ly, T.H.; Pham, Q.T.; Pham, V.Q.; Tran, H.N.; Trinh, L.T.; Dinh, T.T.; Pham, D.T.; Mai Phan, T.A. Impact of the COVID-19 Pandemic on the Severity and Early Postoperative Outcomes of Acute Appendicitis. *Cureus.* **2023**, *15*, e42923. [CrossRef] [PubMed] [PubMed Central]
25. Kupietzky, A.; Finkin, M.; Dover, R.; Eliezer Lourie, N.E.; Mordechai-Heyn, T.; Juster, E.Y.; Mazeh, H.; Mizrahi, I. Higher Rates of Complicated Appendicitis During the COVID-19 Pandemic: A Year-to-Year Analysis. *J. Surg. Res.* **2023**, *290*, 304–309. [CrossRef] [PubMed] [PubMed Central]
26. Santone, E.; Izzo, F.; Lo, K.; Pérez Coulter, A.M.; Jabbour, N.; Orthopoulos, G. Long-term results on the severity of acute appendicitis during COVID-19 pandemic. *Surg. Open Sci.* **2022**, *9*, 1–6. [CrossRef] [PubMed] [PubMed Central]
27. Andersson, R.E.; Agiorgiti, M.; Bendtsen, M. Spontaneous Resolution of Uncomplicated Appendicitis may Explain Increase in Proportion of Complicated Appendicitis During Covid-19 Pandemic: A Systematic Review and Meta-analysis. *World J. Surg.* **2023**, *47*, 1901–1916. [CrossRef] [PubMed] [PubMed Central]
28. Varadhan, K.K.; Neal, K.R.; Lobo, D.N. Safety and efficacy of antibiotics compared with appendicectomy for treatment of uncomplicated acute appendicitis: Meta-analysis of randomised controlled trials. *BMJ* **2012**, *344*, e2156. [CrossRef] [PubMed]
29. Salminen, P.; Paajanen, H.; Rautio, T.; Nordström, P.; Aarnio, M.; Rantanen, T.; Tuominen, R.; Hurme, S.; Virtanen, J.; Mecklin, J.P.; et al. Antibiotic Therapy vs. Appendectomy for Treatment of Uncomplicated Acute Appendicitis: The APPAC Randomized Clinical Trial. *JAMA* **2015**, *313*, 2340–2348. [CrossRef]
30. CODA Collaborative. A Randomized Trial Comparing Antibiotics with Appendectomy for Appendicitis. *N. Engl. J. Med.* **2020**, *383*, 1907–1919. [CrossRef] [PubMed]
31. Emile, S.H.; Hamid, H.K.S.; Khan, S.M.; Davis, G.N. Rate of Application and Outcome of Non-operative Management of Acute Appendicitis in the Setting of COVID-19: Systematic Review and Meta-analysis. *J. Gastrointest. Surg.* **2021**, *25*, 1905–1915. [CrossRef] [PubMed] [PubMed Central]
32. El Nakeeb, A.; Emile, S.H.; AbdelMawla, A.; Attia, M.; Alzahrani, M.; ElGamdi, A.; Nouh, A.E.; Alshahrani, A.; AlAreef, R.; Kayed, T.; et al. Presentation and outcomes of acute appendicitis during COVID-19 pandemic: Lessons learned from the Middle East-a multicentre prospective cohort study. *Int. J. Colorectal Dis.* **2022**, *37*, 777–789. [CrossRef]
33. Taşçı, A.; Gürünlüoğlu, K.; Yıldız, T.; Arslan, A.K.; Akpınar, N.; Çin, E.S.; Demircan, M. Impact of COVID-19 pandemic on pediatric appendicitis hospital admission time and length of hospital stay. COVID-19 pandemi sürecinin çocuk apandisitlerinde hastane başvuru süresi ve hastane kalış süresine etkileri. *Ulus Travma Acil Cerrahi Derg.* **2022**, *28*, 1095–1099. [CrossRef] [PubMed]
34. Gürünlüoglu, K.; Zararsiz, G.; Aslan, M.; Akbas, S.; Tekin, M.; Gürünlüoglu, S.; Bag, H.G.; Cin, E.S.; Macit, B.; Demircan, M. Investigation of Serum Interleukin 6, High-Sensitivity C-Reactive Protein and White Blood Cell Levels during the Diagnosis and Treatment of Paediatric Appendicitis Patients Before and during the COVID-19 Pandemic. *Afr. J. Paediatr. Surg.* **2023**, *20*, 130–137. [CrossRef] [PubMed]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.