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## ORIGINAL ARTICLE

# Complicated appendicitis are common during the epidemic period of 2019 novel coronavirus (2019-nCoV)



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## ABSTRACT

**Objectives:** To assess the prevalence of complicated appendicitis (including gangrene, abscess and perforation) after the outbreak of the 2019-nCoV epidemic and to identify the risk factors associated with complicated appendicitis.

**Methods:** Two groups were established in the study consisting of: one group for cases of acute appendicitis before the 2019-nCoV epidemic (before January 1, 2020; pre-epidemic group) and another group for those after the epidemic outbreak (after January 1, 2020; epidemic group). These two groups were compared in terms of demographic and clinical characteristics, prevalence of complicated appendicitis, and treatment intention. A multivariate analysis model using binary logistic regression was constructed. **Results:** A total of 163 patients were included in this study, with 105 in the pre-epidemic group and 58 in the epidemic group. In the epidemic group, the interval from the onset of symptoms to admission was 65.0 h, which is significantly longer than the 17.3 h interval noted in the pre-epidemic group ( $P < 0.001$ ). The prevalence of complicated appendicitis after the epidemic outbreak was significantly higher than before the outbreak (51.7% vs. 12.4%,  $P < 0.001$ ). In addition, the epidemic group had a lower score of patient's intention to seek treatment than the pre-epidemic group ( $9.5 \pm 2.7$  vs.  $3.4 \pm 2.6$ ,  $P < 0.001$ ). Based on the multivariate analysis, the risk factors for complicated appendicitis included the time from symptoms onset to admission (OR = 1.075) and the patients' intention to receive treatment (OR = 0.541). **Conclusion:** Complicated appendicitis was more common in patients with acute appendicitis after the outbreak of the 2019-nCoV epidemic.

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## 1. Introduction

In December 2019, an outbreak of the 2019 novel coronavirus (2019-nCoV) infection occurred in Wuhan, the capital city of Hubei province, China.<sup>1,2</sup> Human-to-human transmission has been confirmed, and the virus eventually spread rapidly across the country and the world. As of April 10, 2020, more than 1.6 million

laboratory-confirmed cases had been documented worldwide. Until now, there is no specific antiviral therapy available. Over the past few months, almost all the people in epidemic areas have been advised to observe social distancing by staying at home.

Acute appendicitis is the most common etiology of emergency abdominal surgery worldwide, with appendectomy being its gold standard treatment modality. Most patients with acute appendicitis are subjected to appendectomy which requires a relatively short time of recovery.<sup>3–5</sup> Without timely and effective intervention, unexpected serious consequences may arise due to acute complicated appendicitis, which is defined as the presence of either a gangrene, abscess or perforation.<sup>6</sup>

The 2019-nCoV pandemic has severely affected human life and well-being. To a lot of people, hospitals may be the most “dangerous places”, where the probability of being infected by the

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novel coronavirus is much higher. For patients presenting with acute appendicitis, delay in seeking treatment during the epidemic may exist. Delayed presentation for medical care has traditionally been regarded as a risk factor for complicated appendicitis.<sup>7,8</sup> Therefore, this study attempted to evaluate the prevalence of complicated appendicitis during the current outbreak, and to determine the risk factors linked with complicated appendicitis.

## 2. Patients and methods

The relevant data were retrospectively collected in a database of hospitalized patients diagnosed with acute appendicitis at our institution between June 2019 and April 2020. Inclusion criteria: (1) subjects with suspected acute appendicitis based on history and physical examination results, then confirmed by abdominal color doppler ultrasound or plain computed tomography (CT) scans. For patients with suspected periappendiceal abscesses, enhanced CT scans of the lower abdomen were further performed; (2) age greater than or equal to 18. Exclusion criteria: patients with a history of mental illness. Due to the retrospective nature of the study, obtaining informed consent was not applicable. Acute complicated appendicitis was defined as the presence of either gangrenous appendicitis (determined from pathological results), perforated appendicitis (assessed from surgical findings) or periappendiceal abscess (based on enhanced CT scans). After the outbreak of the 2019-nCoV, all the patients were routinely examined by chest CT scans and viral nucleic acid amplification testing from throat swab samples. The nucleic acid amplification test results came out within 12 h after admission.

The patients' data such as age, sex, BMI, educational level, marital status, expense source, family support to visit a hospital, time interval from the manifestation of first clinical symptoms to hospital admission, preoperative clinical findings, history of antibiotic use before admission, presence or absence of complicated appendicitis and the patient's willingness to seek medical treatment in the hospital were collected from electronic clinical records and patients visit records. The patients' intention treatment scores were obtained through telephone, email, QQ and WeChat follow-up in the pre-epidemic group. Two groups were created in the study: a group comprising cases of acute appendicitis before the 2019-nCoV epidemic (before January 1, 2020; pre-epidemic group) and another one composed of cases after the 2019-nCoV epidemic (after January 1, 2020; epidemic group). Finally, 163 patients were enrolled in this study, with 105 patients in the pre-epidemic group and 58 patients in the post-epidemic group. No 2019-nCoV infection was found within the patients included.

## 3. Statistics

Data analysis was performed using the SPSS version 13.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as the mean (standard deviation), and Categorical variables were expressed as n (%). Comparison between the two groups was conducted using the Mann–Whitney test for continuous variables, and the Chi-square test or Fisher's exact test for categorical variables. Binary logistic regression was implemented to calculate odds ratios (OR) and 95% CI for evaluation of the correlation between the risk factors and complicated appendicitis. The statistical significance was set by  $P < 0.05$ .

## 4. Results

### 4.1. Demographic and clinical characteristics

There were no statistical differences detected in terms of the

demographic and clinical characteristics between the two groups with respect to age, sex, BMI, marital status, educational level, expense source, preoperative clinical findings (body temperature, WBC count and CRP), and family support. Nevertheless, the average time interval from the onset of symptoms to admission in the epidemic group was 65.0 h, which is considerably longer than the average 17.3 h documented in the pre-epidemic group ( $P < 0.001$ ) (Table 1).

### 4.2. Prevalence of complicated appendicitis and patients' willingness to receive medical treatment

The correlation between the prevalence of complicated appendicitis and patients' willingness to receive treatment is presented in Table 2. Seventeen patients in the epidemic group requested non-surgical treatment modalities, compared with twelve patients in the pre-epidemic group ( $P = 0.004$ ). Regarding the cases of complicated appendicitis, the prevalence of periappendiceal abscesses, perforations and gangrenes was higher in the epidemic group than in the pre-epidemic group (20.7% vs. 4.8%,  $P = 0.001$ , 17.2% vs. 4.8%,  $P = 0.003$  and 13.8% vs. 3.8%,  $P = 0.020$ , respectively). Moreover, the epidemic group had a lower score of treatment intention compared to the pre-epidemic group ( $9.5 \pm 2.7$  vs.  $3.4 \pm 2.6$ ,  $P < 0.001$ ).

### 4.3. Predictors related to complicated appendicitis after the 2019-nCoV outbreak

It could be derived from the univariate analysis that risk factors influencing the formation of complicated appendicitis were age ( $P = 0.004$ ), time interval between the onset of symptoms and admission ( $P < 0.001$ ), the patients' intention to receive treatment score ( $P < 0.001$ ), and the expense source ( $P = 0.029$ ). Gender, Body mass index (BMI), marital status, educational level, presence of family support, and treatment options were not risk factors. Meanwhile in the multivariate analysis, the risk factors for the occurrence of complicated appendicitis were the time interval from the onset of symptoms to admission ( $P = 0.005$ , odds ratio = 1.075) and the patients' intention to receive treatment score ( $P = 0.007$ , odds ratio = 0.541) (Table 3).

## 5. Discussion

The 2019-nCoV epidemic represents a global public health threat and severely affects human life and welfare. Extensive measures to curb person-to-person transmission have been implemented to control this deadly virus. Presently, China's prevention and control protocols put in place to behead the spread of this emerging virus have achieved favorable results nationwide. However, the global spread keeps rising at an alarming rate. "Staying home" might be one of the most effective means to prevent transmission of the virus. In this study, the occurrence of delays in seeking medical attention for acute appendicitis after the outbreak was observed compared with the cases before the outbreak, as reflected by the significant difference in the treatment intention score and the time interval from the first clinical symptoms to admission. Additionally, more patients asked for non-surgical treatment strategies after the outbreak as compared with the cases before the outbreak. Non-operative treatment with antibiotics could be appropriate in certain patients.<sup>9,10</sup> On the other hand, non-operative management might not be suitable for elderly patients because of the high rate of complicated appendicitis.<sup>11</sup> In any event, delays in receiving treatment may be hazardous.

Several risk factors probably contribute to the development of complicated appendicitis. Dhillon et al found a close relationship

**Table 1**  
Clinical Characteristics of Patients with acute appendicitis before and after the epidemic situation.

	Epidemic group (n = 58)	Pre-epidemic group (n = 105)	P
Age (years), mean (SD)	42.8 (15.0)	41.6 (16.2)	0.671
Female, n (%)	18 (31.0)	49 (46.7)	0.052
BMI (kg/m <sup>2</sup> ), mean (SD)	22.2 (2.4)	21.9 (2.1)	0.425
Educational level, n (%)			0.259
High school or above	50 (86.2)	83 (79.0)	–
Less	8 (13.8)	22 (21.0)	–
Marital status, n (%)			0.876
Married	45 (77.6)	85 (81.0)	–
Divorced/Widowed	4 (6.9)	6 (5.7)	–
Never married	9 (15.5)	14 (13.3)	–
Expense source, n (%)			0.461
No insurance	16 (27.6)	21 (20.0)	
Social insurance	30 (51.7)	64 (61.0)	
Commercial insurance	12 (20.7)	20 (19.0)	
Preoperative clinical findings			
Onset of symptoms (hours ago) <sup>a</sup> , mean (SD)	65.0 (25.3)	17.3 (12.1)	<0.001
Body temperature (°C), mean (SD)	37.3 (0.7)	37.4 (0.8)	0.918
WBC (X10 <sup>9</sup> /L)	15.7 (3.0)	16.4 (3.0)	0.223
CRP (mg/L)	81.5 (25.0)	85.3 (29.0)	0.335
Family support to visit a hospital, n (%)			0.098
Yes	53 (91.4)	103 (95.2)	–
No	5 (8.6)	2 (4.8)	–
History of antibiotic use before admission, n (%)	32 (55.2)	13 (12.4)	<0.001

<sup>a</sup> Time from onset of symptoms to admission.

**Table 2**  
The prevalence of complicated appendicitis and willingness to receive treatment of these patients.

	Epidemic group (n = 58) <sup>a</sup>	Pre-epidemic group (n = 105)	P
Complicated appendicitis, n (%)			
Overall	30 (51.7)	13 (12.4)	<0.001
Periappendiceal abscess	12 (20.7)	5 (4.8)	0.001
Perforated <sup>b</sup>	10 (17.2)	4 (3.8)	0.003
Gangrenous	8 (13.8)	4 (3.8)	0.020
Treatment options that patients requested <sup>b</sup> , n (%)			0.004
Operation	41 (70.7)	93 (88.6)	
Non-operation	17 (29.1)	12 (11.4)	
Score of the intention to receive treatment <sup>c</sup> , mean (SD)	3.4 (2.6)	9.5 (2.7)	<0.001

<sup>a</sup> For acute appendicitis with gangrene and perforation, we classified it as perforation.

<sup>b</sup> This was just the patients' personal request. The final treatment plan was determined according to the comprehensive evaluation.

<sup>c</sup> A score of 0 means "don't want to go to the hospital for treatment", and a score of 10 represents "really want".

<sup>d</sup> Finally, 44 patients underwent appendectomy, and 14 received conservative treatment. All patients with periappendiceal abscess were initially treated 'conservatively' with intravenous antibiotics.

**Table 3**  
Risk factors of acute appendicitis complicated with periappendiceal abscess after the outbreak of 2019-nCoV by multivariate logistic regression analysis.

Variable	P	OR	95% C.I. for EXP(B)	
			Lower	Upper
Onset of symptoms (hours ago) <sup>a</sup>	0.005	1.075	1.022	1.131
The treatment intention score	0.007	0.541	0.346	0.846

<sup>a</sup> Time from onset of symptoms to admission.

between age and the prevalence of complicated appendicitis<sup>11</sup> (reviewer #2, comment #1). Naderan et al reported that complicated appendicitis occurred more in married patients, elder patients, and patients with lower levels of education or with a longer interval from the onset of symptoms to admission.<sup>7</sup> Our results indicated that patients with acute appendicitis were more likely to be complicated with gangrene, abscess formation or perforation after the epidemic; the binary logistic regression model suggested that an increase in the interval between the onset of symptoms and admission, as well as a decrease in the patients' willingness to receive medical treatment both correlate with increased odds of developing complicated appendicitis. Withal, we failed to suggest

any associations between the age, marital status, educational level and the prevalence of complicated appendicitis. This may be explained by the fact that the impact of the current epidemic on people is universal and enormous. Delayed admission to the hospital is the principal risk factor of complicated appendicitis.

The decrease in the intention of treatment might be a factor of intentional treatment delay by the patients, which leads to a prolongation of the time from manifestation of the first clinical symptoms to hospital admission. Nonetheless, there might also be situations where the shortage of medical resources could not satisfy the patients' wishes to receive treatment during the epidemic period. Consequently, we used the score of treatment intention and the time from onset of the first clinical symptoms to admission to evaluate patients' delayed hospital visits. As of April 10, 2020, there were 100 confirmed 2019-nCoV cases in our city, with 1 death. No obvious shortage of medical facilities and resources was observed (reviewer #1, comment #1). In our study, the overwhelming majority of the patients received surgical intervention, except for those who had periappendiceal abscesses, as displayed in Table 2. We did not think too much about the changes in the patients' treatment options after admission since in-hospital delay to appendectomy was not a risk factor for complicated

appendicitis<sup>12</sup> (reviewer #1, comment #2). As mentioned earlier, the willingness of patients with appendicitis to receive treatment was lower in the epidemic group than in the pre-epidemic group. Notwithstanding, we discovered that there was no difference in “family support to visit a hospital”. It might be explained by the fact that there was no restriction for the family to visit patients in the hospital and the aggravation of the disease without timely treatment. Furthermore, no difference in body temperature, WBC count, and CRP was observed between the two groups. This might be attributed to the use of antibiotics prior to hospital admission (epidemic group: 55.2%; pre-epidemic group: 12.4%;  $P < 0.001$ ). Quite a few patients chose to take antibiotics themselves or received antibiotic therapy in outpatient or private clinics before being hospitalized for further treatment.

During the current epidemic, special attention should be paid to the prevention and control of 2019-nCoV. Each patient visiting the hospital should be requested to put on a surgical mask. A complete medical history should be collected with emphasis on respiratory symptoms and the epidemiological history of the patient, the families, and visitors during the previous 14 days, and measurement of the body temperature on presentation should be mandatory. Meanwhile, people for whom the coronavirus infection has not been excluded should be restricted from visiting patients.<sup>13</sup> In this study, more than half of the patients were diagnosed with complicated appendicitis. We recommend intervention after admission, due to the increased risk in 2019-nCoV infection and restricted use of antibiotics in our hospital’s outpatient and emergency departments. Prior to admission, every patient was routinely examined by urgent chest CT scans and viral nucleic acid amplification testing. Patients with suspected 2019-nCoV infections should be admitted to a single isolation room with protection.<sup>13</sup> It would be advisable to urgently equip at least one operating room with a negative-pressure system to be used. Moreover, it was recommended to perform open appendectomy and avoid using ultrasonic scalpels to prevent aerosol spread of the virus. All team members should be well trained with knowledge and skills concerning the prevention of 2019-nCoV infections.

Some limitations of the present study should be pointed out. First and foremost, this study has a retrospective design and a relatively small sample size. Second, we used certain variables that seemed to be valuable but were not reported in other studies. Furthermore, including so many variables in the binary logistic regression model necessitates even larger sample sizes. Third, the patients’ intention of treatment was based on a consensus which would lead to a conflict of intention in sharing the decision making process, which might limit the power of the study. Not only that, the intention of treatment and onset of the symptoms might lead to potential concordance of the variables and potential overfitting in

the multivariate analysis. Finally, the epidemic broke out in December 2019, and it was controversial that we regarded January 1, 2020 as the cut-off point.

## 6. Conclusion

Complicated appendicitis was more common in people with acute appendicitis after the outbreak of the 2019-nCoV epidemic. In some areas, patients exhibited a low willingness to receive treatment and a long time interval from the onset of symptoms to admission albeit there was no obvious shortage of medical resources, which were identified as the principal risk factors for the subsequent development of complicated appendicitis.

## Declaration of competing interest

All the authors declare that they have no conflict of interest.

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