

# A Retrospective Risk Analysis of Factors Associated with Prolonged Hospitalization in Adult Patients Undergoing Non-surgical Treatment for Appendiceal Abscess

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**Abstract:** Background: The aim of the present study was to investigate risk factors and predictive factors for prolonged hospitalization in adults undergoing non-surgical treatment for appendiceal abscess. Patients and Methods: A retrospective study was conducted of consecutive patients who underwent treatment following a diagnosis of appendicitis in a single institution. Between January 2008 and May 2019, 756 adult patients who were diagnosed with acute appendicitis, 101 of these patients (13.4%) had an appendiceal abscess and were treated as inpatients. The treatments of these patients were as follows: non-surgical treatment alone (n=45), emergency operation (n=50) and conversion to emergency operation due to failure of the initial conservative therapy (n=6). The present study analyzed the 45 patients managed with non-surgical treatment alone. The patients were divided, based on the median length of the hospital stay (nine day), into the shorter hospital stay and longer hospital stay groups. The risk factors and predictive factors for prolonged hospitalization were examined in the two groups. Results: Twenty-four patients were classified into the shorter hospital stay group and 21 were classified into the longer hospital stay group. A univariate analysis demonstrated that the body temperature on post-admission days 2 ( $P=0.012$ ) and 3 ( $P=0.008$ ), were significantly associated with the length of hospital stay. A multivariate logistic regression analysis using that the body temperature on post-admission day 3 tended to be associated with prolonged hospitalization (odds ratio=8.574, 95% confidence interval=0.973-75.525;  $P=0.053$ ). The cut-off value of the body temperature on day 3, determined by an ROC curve analysis, was 37.05°C. This cut-off value showed 66.7% accuracy, 57.1% sensitivity and 75.0% specificity. Conclusion: The body temperature on post-admission day 3 might be a potential risk factor and predictive marker for prolonged hospitalization in patients who receive non-surgical treatment for appendiceal abscess.

**Keywords:** Appendiceal Abscess, Appendicular Abscess, Non-Surgical Treatment, Appendicitis, Interval Appendectomy

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## 1. Introduction

Appendicitis is one of the most common surgical emergencies and appendectomy has been established as a standard treatment for appendicitis. However, 3.3–9.7% of patients experience complicated appendicitis with abscess formation at the initial diagnosis [1-3]. If an emergency

operation is performed in such cases, extended organ resection, including ileocecal resection or conversion from laparoscopic surgery to laparotomy might be necessary, and postoperative complications (e.g., wound infection, abdominal abscess, or intestinal adhesion) may occur [4-9]. Thus, elective interval appendectomy following initial non-surgical treatment, including antibiotic therapy and/or percutaneous drainage has recently come to be widely

accepted instead of the traditional emergency operation [4, 5]. However, non-surgical treatment with the aim of performing elective interval appendectomy sometimes might be unsuccessful and can cause prolonged hospitalization and impair the patient's quality of life [2, 10]. Thus, it is important to understand the risk factors and predictive factors for prolonged hospitalization in patients who receive non-surgical treatment for appendiceal abscess.

The aim of the present study was to identify the risk factors and predictive factors for prolonged hospitalization in adults undergoing non-surgical treatment for appendiceal abscess.

## 2. Methods

### 2.1. Patients

A retrospective study was conducted for consecutive patients diagnosed with appendicitis who were treated in a single institution at the Department of Surgery, Saga Medical Center Koseikan, between January 2008 and May 2019. During this period, 756 adult patients were diagnosed with acute appendicitis in our department of surgery. A consort diagram is shown in Figure 1. Among all of the patients, 101 patients (13.4%) patients presented with an appendiceal abscess and were treated as inpatients. Among these patients, 51 patients were initially managed with non-surgical treatment, whereas the remaining 50 patients underwent an emergency operation. Among the patients initially managed with non-surgical treatment, conversion to an emergency operation due to failure of the conservative therapy was required in six cases. The present study analyzed the cases of 45 patients for whom non-surgical treatment was successful. The medical records of all patients were reviewed in detail. All patients and their families were informed about the treatment and gave their informed broad consent for this study. Appendicitis with appendiceal abscess was confirmed by a physical examination, blood test and contrast abdominal computed tomography (CT). If there were no signs of peritonitis, sepsis, shock, and/or organ failure, non-surgical treatment was considered. During the non-surgical treatment, if signs of peritonitis and/or a worsening of symptoms were observed, conversion to emergency operation was considered. Abscess drainage was decided by the doctor-in-charge depending on the patient's condition and/or a worsening of symptoms and laboratory data. If there was no worsening of symptoms and the patient was able to eat solid food, then the patient was discharged from hospital with/without treatment with oral antibiotics. The following data were collected from the prospectively maintained comprehensive database or medical records: sex, age, body mass index, previous history, current smoking habit, physical examination, CT parameters (identification of appendix, appendicolith, abscess diameter), types of antibiotics used for treatment, blood test results, body temperature, percutaneous abscess drainage and hospital stay. Continuous variables were expressed as the median and range (minimum,

maximum). For the purpose of this study, the patients managed with non-surgical treatment alone were divided, based on median length of the hospital stay, into the shorter hospital stay and longer hospital stay groups. The cut-off value for the length of hospital stay was nine days. The medical ethics committee of Saga Medical Center Koseikan reviewed and approved this study design (permission number: 19-07-01-04).

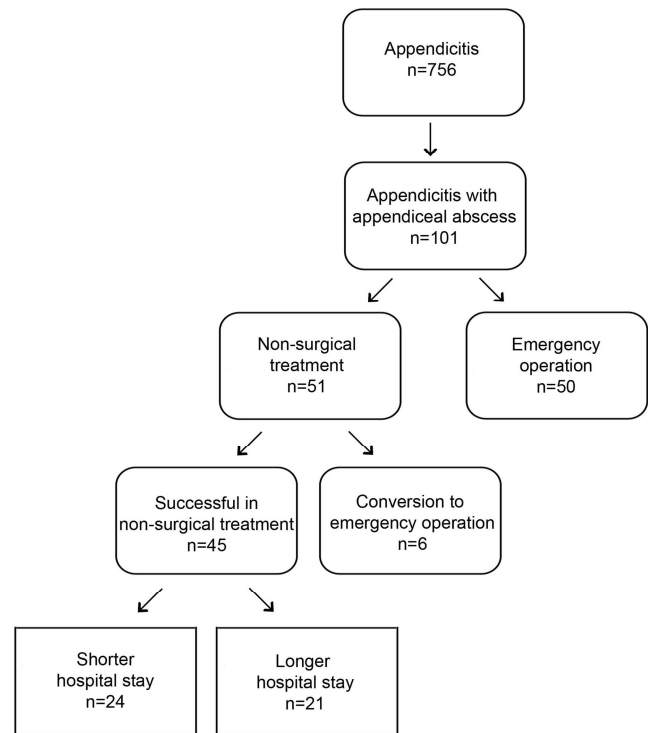


Figure 1. A consort diagram of this study.

### 2.2. Statistical Analyses

For the univariate analyses, continuous variables were compared between the groups by the Mann-Whitney U test, while Fisher's exact test was used for the comparison of binary variables. Receiver operation characteristics (ROC) analyses were performed and the area under the curve (AUC) was calculated to examine the capability of potential markers. Continuous variables were converted into binary variables based on optimal cut-off values determined by ROC analyses. A multiple logistic regression analysis was performed to identify factors that were independently associated with a prolonged hospital stay. The data were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). P values of <0.05 were considered to indicate statistical significance. All analyses were performed using SPSS version 25.0. (IBM Corp, Armonk, NY, USA).

## 3. Results

The study population included 28 (62%) male patients and 17 (38%) female patients. The age of the patients ranged from 15 to 94 years. In all patients, a peri-appendiceal

abscess measuring 14.0 to 110.0 mm in size was detected by enhanced computed tomography.

Table 1 shows the results of the univariate analysis of

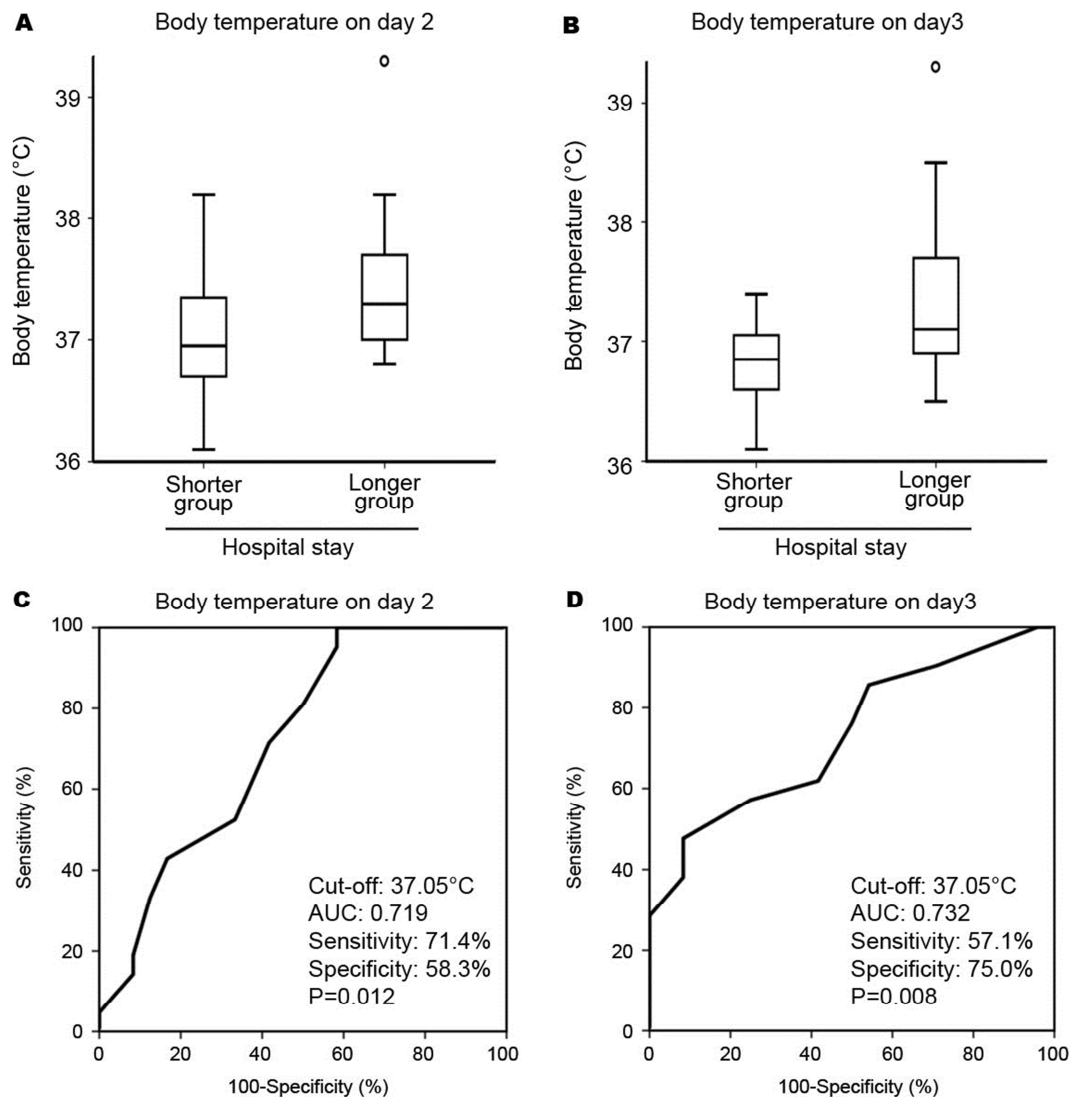
patient-related factors. Twenty-four and 21 patients were classified into the shorter and longer hospital stay groups, respectively.

**Table 1.** A univariate analysis of patient -related factors.

	Shorter hospital stay (n=24)	Longer hospital stay (n=21)	P-value
Gender (male: female)	16:8	12:9	0.552
Age (years: median (min, max))	52.0 (21, 88)	59 (15, 94)	0.991
Body mass index (kg/m <sup>2</sup> : median (min, max))	23.2 (17.0, 31.2)	22.8 (20.5, 41.9)	0.601
Previous history			
Cardiovascular disease (yes: no)	2:22	5:16	0.225
Diabetes mellitus (yes: no)	1:23	1:20	1.000
Current Smoking (yes: no)	6:18	5:16	1.000
Pre-hospital symptom duration (days: median [min, max])	3 [0, 25]	2 [0, 19]	0.296
Physical examination			
Tenderness (yes: no)	24:0	20:1	0.467
Muscular defense (yes: no)	4:20	6:15	0.476
Rebound tenderness (yes: no)	11:13	9:12	1.000
CT parameters			
Appendicolith (yes: no)	7:17	6:15	1.000
Being able to identify the appendix (yes: no)	5:19	3:18	0.750
Abscess size (mm: median (min, max))	33.5 (14.0, 110.0)	31.0 (17.0, 65.0)	0.641
Antibiotics			
TAZ/PIPC based	11	6	0.454
SBT/ ABPC based	5	7	
CMZ based	3	5	
LVFZ based	4	3	
Other	1	0	
Hemoglobin (g/dl: median (min, max))	13.8 (10.7, 15.8)	14.4 (10.3, 18.0)	0.119
Albumin (g/dl: median (min, max))	3.8 (2.7, 4.6)	3.8 (2.5, 5.0)	0.971
White blood cells (/μl: median (min, max))			
Pretreatment	11900 (5100, 21000)	14400 (4400, 22500)	0.357
Post admission day 1	9600 (4000, 18700)	12700 (2900, 18700)	0.289
Post admission day 3	6450 (3800, 12400)	9350 (3200, 18200)	0.065
C-reactive protein (mg/dl: median (min, max))			
Pretreatment	12.5 (0.2, 28.6)	12.3 (0.2, 28.3)	0.716
Post admission day 1	12.9 (0.7, 23.6)	13.7 (5.1, 28.6)	0.196
Post admission day 3	9.1 (0.3, 22.1)	11.8 (1.8, 26.9)	0.208
Body temperature (°C: median (min, max))			
Pretreatment	37.4 (36.3, 39.3)	37.6 (36.4, 39.8)	0.316
Post admission day 1	37.4 (36.4, 39.3)	37.7 (36.5, 39.2)	0.305
Post admission day 2	37.0 (36.1, 38.2)	37.3 (36.8, 39.3)	0.012
Post admission day 3	36.9 (36.1, 37.4)	37.1 (36.5, 39.3)	0.008
Percutaneous abscess drainage (yes: no)	1:23	6:15	0.039
Antibiotics change due to disease progression (yes: no)	1: 23	11: 10	<0.001
Hospital stay (days)	7.5 (4, 9)	15 (10, 23)	<0.001

A univariate analysis demonstrated the pre-hospital symptom duration, the presence of abdominal symptoms (tenderness, muscular defense and rebound tenderness), the CT findings of the appendix (the detection of an appendicolith, being able to identify the appendix on CT images, and the abscess size), the type of antibiotics administered, the white blood cell count and the C-reactive protein level to not be associated with the length of the hospital stay. In contrast, body temperature on post-admission days 2 ( $P=0.012$ ) and 3 ( $P=0.008$ ), were significantly associated with the length of hospital stay (Figure 2A, 2B).

Percutaneous abscess drainage ( $P=0.039$ ) and change of antibiotics due to disease progression ( $P<0.001$ ) were performed significantly more frequently in the longer hospital stay group. A multivariate logistic regression analysis that included the body temperature on post-admission days 2 and 3 was performed to identify factors independently associated with a prolonged hospital stay. The analysis revealed that the body temperature on post-admission day 3 tended to be associated with a prolonged hospital stay (odds ratio=8.574, 95% confidence interval=0.973-75.525;  $P=0.053$ ) (Table 2).



**Figure 2.** Relationship between body temperature after admission and hospital stay.

**Table 2.** A multivariate analysis of patient -related factors.

Parameters	multivariate analysis	
	OR (95% C. I.)	P-value
Body temperature on post admission day 2	1.560 (0.300-8.124)	0.597
Body temperature on post admission day 3	8.574 (0.973-75.525)	0.053

ROC curve analyses were then performed to determine the cut-off values of body temperature on post-admission day 2 and 3 that best predicted a prolonged hospital day. A body temperature of 37.05°C on post-admission days 2 and 3 was determined based on the area under the curve (AUC) (Figure 2C, 2D). The ROC analysis demonstrated that this value showed 66.4% accuracy, 71.4% sensitivity, and 58.3% specificity on post-admission day 2 and 66.7% accuracy, 57.1% sensitivity, and 75.0% specificity on post-admission day 3.

## 4. Discussion

A recent study reported that elective interval appendectomy for appendiceal abscess after non-surgical

treatment is widely accepted strategy [4, 5]. Non-surgical treatment for appendiceal abscess is reported to be associated with a relatively highly success rate of 74-76% [2, 11]. However, prolonged hospitalization following the failure of the non-surgical treatment can still be an issue [1, 2, 10-13]. Even though effective antibiotic regimens and procedures for abscess drainage have been established, the failure of non-surgical treatment due to a delaying in changing antibiotics or introducing abscess drainage may lead to prolonged hospitalization, causing an impaired quality of life for the patient and resulting in increased medical costs. The best strategy for appendiceal abscess in adults is still debatable. Even if non-surgical treatment is successful and allows the avoidance of conversion to emergency surgery in most cases, prolonged hospitalization itself can still be a disadvantage for

the patient. Thus, the identification of risk factors and predictive factors for prolonged hospitalization due to appendiceal abscess in patients undergoing non-surgical treatment is important for optimizing the treatment strategy.

The risk factors and predictive factors for the failure of non-surgical treatment resulting in an emergency operation has been previously reported [2]. However, this kind of study mainly only aims to examine the factor for the failure of non-surgical treatment followed by conversion to emergency operation. Our study focused on patients with appendiceal abscess who were managed with non-surgical treatment alone. Cases in which conversion to an emergency operation was required were excluded because only 6 patients required conversion to surgery, and this number was considered too small to analyze. In addition—in a broad sense—it was also considered that cases involving prolonged hospitalization for non-surgical treatment should be considered as cases of non-surgical treatment failure.

In this study, a higher body temperature on post admission day 3 was significantly associated with prolonged hospitalization in the univariate analysis and a borderline significant association was observed in the multivariate analysis. In this series, antibiotics were changed and/or percutaneous abscess drainage was performed due to disease progression in 52% (11/21) and 29% (6/21) of the patients in the longer hospitalization group, respectively. Among these cases, the treatment strategy was changed on post-admission day 2-12 (median: day 4) and day 0-12 (median: day 4), respectively. The ROC curve analysis demonstrated that the cut-off value for the body temperature on post-admission day 3 to predict prolonged hospitalization was 37.05°C. Taken together, these results indicate that changing the treatment strategy when a patient presents a body temperature of >37.05°C on post-admission day 3 has the potential to be shorten the hospital stay.

Previous reports have demonstrated that the abscess size can be an important factor for treatment results in appendicitis and diverticulitis. Regarding the risk factors for conversion to an emergency operation following unsuccessful initial non-surgical treatment, Sadakari *et al.* reported that an abscess size of >40 mm could predict failure of non-surgical treatment resulting in an emergency operation in patients with appendiceal abscess [2]. Kim *et al.* analyzed unfavorable clinical outcomes of acute right colonic diverticulitis and revealed that an abscess of >4 cm was a significant predictor of a prolonged hospital stay [14]. In addition, Mali *et al.* reported that diverticulitis with abscess was mostly treated with antibiotics alone if the size was <40 mm, with a high treatment success rate (87%), and found that the abscess size was correlated with emergency surgery or prolonged hospitalization [15]. As for our study, if an abscess size of 4 cm was used as the cut off value in our study, abscesses of >4 cm in diameter were seen in 48% of the patients with a shorter hospital stay and 42% of the patients with a longer hospital stay; this difference was not statistically significant. The reasons for this discrepancy are not clear; however, it may have been due to the small number

of patients. Thus, further analyses will be needed in future studies.

The present study was associated with some limitations. First, the study was conducted at a single institution with a relatively small number of subjects. Thus, further studies will be needed to confirm the utility of body temperature on post-admission day 3 as a predictive marker for prolonged hospitalization in patients with appendiceal abscess who are managed with conservative therapy. In addition, the diagnostic accuracy still needs to be improved. Therefore, another novel risk factor or predictive factor for prolonged hospitalization should be identified in patients managed with non-surgical treatment for appendiceal abscess.

In conclusion, the body temperature on post-admission day 3 might have potential application as a predictive marker for prolonged hospitalization for patients with appendiceal abscess who are managed by conservative therapy.

## Author Contributions

M Hiraki and T Toshiya mainly designed this study. M Hiraki, T Tanaka, K Yamada, K Kitahara treated the patients. M Hiraki T Tanaka, and Yamada collected data. M Hiraki and E Sadashima (specialist in statistics) analyzed the data. M Hiraki, T Tanaka, T Manabe and H Noshiro interpreted the result and wrote the manuscript. All the authors met the following criteria. The authors made substantial contributions to the conception and design, and/or acquisition of data, and/or analysis and interpretation of data, participated in drafting the article or revising it critically for important intellectual content, and gave final approval of the version to be published.

## Conflicts of Interest

The authors declare no conflict of interest in association with the present study.

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