Predictors of Clinical Outcomes in Acute Appendicitis: A Retrospective Study

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ABSTRACT

Introduction: Acute appendicitis is one of the most common causes of intra-abdominal emergency surgery worldwide. This study was conducted to contribute to global databases by presenting data from our institution, which consist of multi-racial population. We aimed to evaluate the presentation, diagnosis, and management of acute appendicitis and post-operative outcome in our institution and evaluate the risks factors associated with severe complications and prolonged length of stay (LOS).

Materials and Methods: We performed a retrospective analysis using multivariate regression analysis of all patients who underwent appendectomy (2009–2014) in our institution. The primary outcomes included demographics, presentation, and perioperative management, and the secondary outcomes included risk factors associated with prolonged LOS.

Results: Of the 1185 patients, the mean age was 36.4 years, and 940 (79.3%) were male. Majority (98.1%) of patients were ASA (American Society of Anaesthesiologists) 1 or 2. Most of them (83.9%) were from the four racial subgroups (Chinese, Malay, Bangladeshi, and Indian). There was no racial variation in the diagnosis and presentation of disease. The mean duration of symptoms was 1.8 days. The history was commonly a localised or migratory abdominal pain associated with anorexia, nausea, vomiting, and fever. The commonest physical findings were right-sided abdominal tenderness associated with rebound and guarding. About 42.9% of the patients underwent pre-operative CT scan to establish the diagnosis of appendicitis prior to surgery, whilst 57.1% underwent surgery on clinical diagnosis and blood investigation (NWR and CRP). An open appendectomy was performed in 13.2% of the patients. The conversion rate of laparoscopic appendectomy was 4.9% (n = 50). The mean length of hospital stay was 3.6 days. On multivariate Cox regression, patients of Burmese and Thai descent were independently associated with a prolonged LOS. The post-operative morbidity was 5.5%. The 30-day readmission rate was 2.4%. There was no mortality in our study.

Discussion: Our study showed that pre-operative diagnosis of acute appendicitis can be made accurately by classical clinical presentation or by imaging. Independent risk factors associated with increased LOS included increased age, male gender, prolonged duration of symptoms pre-admission, fever, generalised tenderness, and prolonged operative time. The effect of race on LOS has been observed in the literature for other surgical procedures. The prolonged LOS found in Burmese and Thai patients contribute to the possibility of intrinsic racial differences in the post-surgery recovery. However, the numbers are small and therefore prone to type I error. Compared to the open approach, the use of laparoscopic appendectomy was associated with shorter LOS. This has similar outcomes to those reported in the literature.

Conclusion: The identification of risks factors could help surgical team to predict the clinical outcomes and develop risk reduction strategy in post-operative care of these patients.

KEYWORDS:
Predictors of clinical outcomes in acute appendicitis

INTRODUCTION

Acute appendicitis is one of the most common causes of acute abdomen, with a lifetime risk of 8%.[1] Worldwide, acute appendicitis is associated with higher healthcare costs. If left untreated, this may result in the perforation of the appendix with a localised abscess or generalised peritonitis, with ensuing morbidities and mortality.[2] In the United States, hospitalisations attributed to acute appendicitis cost $3 billion dollars per year.[3] In low- to middle-income countries, appendicitis is a common and treatable condition but often carries a high fatality rate in the absence of safe and essential surgical care.[4]

Although the diagnosis of acute appendicitis may be clinically aided by scoring system, the increasing use of modern imaging (such as ultrasound, computed tomography (CT) scan, and magnetic resonance imaging (MRI)) is observed in the developed countries. Its management has evolved from open appendectomy to the use of minimally invasive surgery and non-operative management (by antibiotics). In recent times, even the effect of the COVID-19 pandemic on the clinical course of appendicitis has been studied.[1]

Singapore is a multi-racial city state of 5.7 million people.[5] The 2021 Population Census indicated a local citizen population of three predominant racial groups (Chinese,

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Malays, and Indians), and a 30% foreign population drawn from neighbouring countries, which includes Thais, Burmese, Bangladeshis, Subcontinental Indians, and Mainland Chinese. This study was conducted to contribute to global databases by presenting data from our institution, which consist of multi-racial south Asian population. We aimed to evaluate the presentation, diagnosis, and management of acute appendicitis and post-operative outcome in our institution and evaluate the risks factors associated with severe complications and prolonged length of stay (LOS).

MATERIALS AND METHODS

A retrospective analysis of all patients who underwent surgery for acute appendicitis from September 2009 to November 2014 at a single institution (Alexandra Hospital) was conducted. The study protocol (DSRB Reference: 2015/00313) was assessed and approved by the Ethics Committee of the National Healthcare Group (NHG) Institutional Review Board (IRB). All patients received same level of care at the point of admission regardless of demographics, immigration status, and insurance status. Demographic data included the patient's race, age, and gender. Race was divided into Chinese, Malay, Indian, Thai, Burmese, and Bangladeshi. Persons falling into categories outside of these main groups were collectively termed 'Others', as there were insufficient numbers per race to form groups for meaningful statistical analysis. Comorbidities were recorded. Patients were also scored based on their American Society of Anaesthesia (ASA) status.

The patient's duration of symptoms was recorded in days. The patient's symptom of abdominal pain was divided into five groups: classical migratory pain from midline to right iliac fossa (RIF), localised pain at the RIF, generalised pain, periumbilical pain, and atypical pain. Patients who had atypical pain had abdominal pain that did not conform to any of the other four groups. The patient's symptoms of fever, nausea, diarrhoea, vomiting, anorexia, and dysuria were also recorded. The patient's sign of abdominal tenderness was also divided into five groups: right-sided tenderness, generalised tenderness, suprapubic tenderness, absence of tenderness, and atypical tenderness. Patients who had atypical tenderness had abdominal tenderness that did not conform to any of the other four groups. In addition, the presence of rebound tenderness, localised guarding and a palpable mass were also recorded. Two biochemical investigations were recorded: the neutrophil to WBC ratio (NWR) and C-reactive protein (CRP) levels. Whether a computed tomography (CT) scan was performed was also recorded. In our institution, all CT scans are performed with IV contrast unless contraindicated.

All patients in our institution with a suspected clinical diagnosis (or confirmed by imaging) of acute appendicitis will be offered surgery (with laparoscopic approach preferred). The decision to perform open appendectomy (or laparotomy) was up to the discretion of the surgical team. All residents were trained and encouraged to perform laparoscopy where possible. Open surgery was done in cases where patients were unstable and septic, where adhesion would be encountered (e.g., previous history of laparotomy), or where laparoscopic skills were not available. Patients who opted for antibiotics and underwent surgery (delayed appendectomy) and those with chronic appendicitis were excluded from the study. Therefore, operative parameters were the approach to surgery: open, laparoscopic, and laparoscopic converted to open surgery. All operating theatres dedicated to general surgery are equipped with laparoscopic stack system and laparoscopic instruments throughout the day and night. All patients received a single dose of broad-spectrum antibiotics intravenously at induction. The continuation of antibiotics beyond surgery was determined by the presence of sepsis and Mannheim Peritonitis Index, which may take up to seven days (orally or intravenously). The duration of surgery was recorded in minutes. The time of surgery was categorised into '08:00–16:59', '17:00–23:59', and '00:00–07:59' to represent office hours, after office hours, and overnight procedures, respectively.

The Mannheim Peritonitis Index (MPI) was also scored following laparotomy.[6] This index uses eight parameters of different weights to generate a composite score that predicts for mortality. The raw score on addition of the eight parameters is presented.

Outcome measures, which were relevant to our analysis, included the presence of surgical site infection (SSI), organ space infection (OSI), pneumonia, ileus, acute myocardial infarction (AMI), cerebrovascular accident (CVA), deep venous thrombosis (DVT), and pulmonary embolism (PE). Ileus was defined as failure to progress to normal diet on day 3 post-operation if the patient was still inpatient. Clavien-Dindo Classification for complications was calculated for each patient.[7] The patient's total LOS and 30-day readmission rates were also recorded. At the time of discharge, all patients were given a copy of medical discharge summary, medication, and instructions to return to the emergency department of our hospital in the event of deterioration and a return clinic appointment 2–6 weeks after surgery.

Statistical analysis

Continuous variables were expressed as means with standard deviation (SD), while categorical and ordinal variables were expressed as counts with percentages. Continuous variables were analysed with Kruskal-Wallis H test, while categorical and ordinal variables were analysed with χ^2 test.

Variables relating to demographics, presentation of appendicitis, and operative factors were considered for further analysis. Clavien-Dindo Classification scores were divided into none or mild complications (0–II) and severe complications (III–V). Univariate and multivariate logistic regression analyses were used to identify independent risk factors for worse outcomes following surgery based on Clavien-Dindo Classification. In addition, univariate and multivariate Cox regression analyses were used to identify independent factors for shorter LOS. In both these analyses, univariate values ($p < 0.10$) were included in multivariate regression analysis. Multiple collinearities were also verified using the variance inflation factor, and none of the multiple regressions were noted to be collinear (VIF<5). *P*-values of <0.05 were considered statistically significant. Statistical

analysis was performed using Stata version 14.2 (StataCorp LP, College Station, Texas, USA).

RESULTS

From September 2009 to November 2014, a total of 1185 patients underwent appendectomy at our institution. Most patients were young (mean age +/- SD= 36.4 ± 15.8 years), male (n= 940, 79.3%), healthy (98.1%, ASA 1 or 2), and of four racial subgroups (Chinese, Malay, Bangladeshi, and Indian; 83.9%).

The mean duration of symptoms was 1.8 +/- 1.5 days(+/- SD). The history was commonly a localised or migratory abdominal pain associated with anorexia, nausea, vomiting, diarrhoea, and fever. The commonest physical findings were right-sided abdominal tenderness associated with rebound and guarding.

Demographics and clinical presentation of our entire population are shown in Table I.

A diagnosis of appendicitis was established in 42.9% (n= 508) of the patients after CT scan of the abdomen and pelvis prior to surgery. Decision for surgery was made on the remaining 57.1% on clinical diagnosis and blood investigation (neutrophil–white blood cell ratio and C-reactive protein).

Majority of the appendectomy (82.0%; n = 972) was performed between office hours (08:00 hr to 17:00 hr) and up to 12 at midnight. Most patients (n = 1029, 86.8%) underwent laparoscopic appendectomy with a conversion rate of 4.9% (n = 50); the remaining 13.2% underwent open surgery up-front. The mean duration of operation was 94.3 ± 79.7 minutes (mean +/- SD).

The mean LOS was 3.6 (± 6.0 days, SD). The post-operative morbidity was 5.5%, (n = 65) with ileus as the commonest complication, followed by surgical site infection, organ space infection, pneumonia, and acute myocardial infarction. Serious complications (Clavien-Dindo Classification Grades III–IV) were reported in 19 patients (1.6%). The 30-day readmission rate was 2.4% (n = 29). There was no mortality in our study.

Management and treatment outcome of our patients with acute appendicitis are shown in Table II.

Risk factors for severe complications

A total of 19 patients (1.6%) suffered from severe complications. Variables input into univariate logistic regression were race, age, gender, ASA status, comorbidities, duration of symptoms, symptoms on presentation, signs on examination, NWR and CRP values, timing of surgery, approach of surgery, and duration of surgery. Variables with $p < 0.100$ were included in multivariate analysis. This included race, age, gender, all comorbidities, duration of symptoms, presence of fever and diarrhoea, and laparoscopic approach. CRP was excluded although it was statistically significant on univariate analysis as less than 25% of patients had a recorded CRP value. The proportion of patients who underwent laparoscopic conversion was noted to be statistically significant on univariate analysis but was excluded as this subset was entirely from the laparoscopic group and would have been collinear. Following multivariate analysis, only age (OR1.04/year, p=0.026, 95% CI 1.01–1.08) was an independent risk factor for severe outcomes. Compared to the open approach, the use of laparoscopic approach (OR 0.30, p=0.025, 95% CI 0.10–0.86) was an independent negative risk factor for severe outcomes. Data are not shown.

Risk factors for prolonged length of stay

Variables input into univariate Cox regression were race, age, gender, ASA status, comorbidities, duration of symptoms, symptoms on presentation, signs on examination, NWR and CRP values, timing of surgery, approach of surgery, and duration of surgery. Variables with p<0.100 were included in multivariate analysis. This included race, age, gender, ASA status, all comorbidities, duration of symptoms, distribution of abdominal pain, presence of fever or diarrhoea, distribution of abdominal tenderness, presence of rebound or abdominal mass, timing of surgery, approach of surgery, and duration of surgery. CRP and laparoscopic conversion were not included due to the reasons mentioned in the previous section. Following multivariate analysis, patients who were Burmese (HR1.56, p = 0.010, 95% CI 1.11–2.22) and Thai (HR1.52, p=0.019, 95% CI 1.08–2.17) were associated with an increased risk of prolonged hospital stay. In addition, age (HR1.01/year, p<0.0001, 95% CI 1.01–1.02), male gender (HR1.20, p=0.033, 95% CI 1.01–1.41), longer duration of symptoms (HR1.14/day, p<0.0001, 95% CI 1.09–1.18), presentation with fever (HR1.25, p=0.01, 95% CI 1.10–1.43), generalised abdominal tenderness (HR1.52, p=0.014, 95% CI 1.09–2.08), atypical abdominal tenderness (HR1.47, p=0.011, 95% CI 1.09–1.96), and prolonged duration of surgery (HR1.01/min, p<0.0001, 95% CI 1.01–1.01) were independent risk factors for prolonged LOS. We also noted that surgery performed after office hours (HR0.78, p<0.0001, 95% CI 0.69–0.90) and surgery performed overnight (HR0.77, p=0.003, 95% CI 0.65–0.92) were associated with a statistically significant reduction in the LOS.

A detailed analysis of univariate and multivariate regression is shown in Table III.

Analysis by race

There was a statistically significant difference in mean age at presentation between races in our study cohort (p=0.0001). Mean age of Indians was 29.3 (SD 8.2) years, while Chinese was 39.4 (SD 16.1) years, representing the youngest and oldest mean ages, respectively. There was also a statistically significant difference in gender amongst the various racial groups (p<0.0001). Mean duration of symptoms was shortest amongst Thais (1.7 days, SD 1.2) and longest amongst Malays (2.2 days, SD 1.9) (p=0.0353). A statistically significant difference in the utilisation of CT scans was also noted, with more than half of Chinese and Malay patients undergoing a CT scan (p<0.0001). Operative approach and conversion rate did not yield a statistically significant difference between racial groups, although there was a statistically significant difference in the duration of surgery, with Chinese, Malays, and Thais being much longer than their counterparts from other races (p<0.0001). We observed

Table I: Demographic characteristics of study population

Characteristics	Value
Age, mean ± SD	36.4 ± 15.8
Gender: Male N (%)	940 (79.3)
Race, N (%)	
Chinese	397 (33.5)
Malay	111 (9.4)
Indian	278 (23.4)
Bangladeshi	208 (17.6)
Burmese	40 (3.4)
Thai	37 (3.1)
Others	114 (9.6)
ASA, N (%)	
1 and 2	1162 (98.1)
3 and 4	23 (1.9)
Comorbidities, N (%)	
Ischaemic heart disease	9 (0.8)
Hypertension	71 (6.0)
Diabetes mellitus	39 (3.3)
Chronic obstructive pulmonary disease	1 (0.1)
Chronic kidney disease	3 (0.3)
Cancer	4 (0.3)
Duration of symptoms, mean ± SD (days)	1.8 ± 1.5
Abdominal pain, N (%)	
Migratory	320 (27.0)
Localised	565 (47.7)
Generalised	81 (6.8)
Periumbilical	87 (7.3)
Atypical	113 (9.5)
Other symptoms, N (%)	
Fever	409 (34.5)
Nausea	323 (27.3)
Vomiting	524 (44.2)
Anorexia	192 (16.2)
Diarrhoea	134 (11.3)
Dysuria	38 (3.2)
Abdominal tenderness, N (%)	
Right-sided	1013 (85.5)
Generalised	44 (3.7)
Suprapubic	22 (1.9)
Atypical	57 (4.8)
None	43 (3.6)
Other signs, N (%)	
Rebound	458 (38.6)
Guarding	413 (34.9)
Mass	14 (1.2)

SD, standard deviation
N, number
ASA, American Society of Anesthesiologists

higher MPI scores in Chinese and Malays and lower scores amongst Burmese and Bangladeshis. LOS was longest amongst Burmese at 5.0 (SD 10.9) days and shortest in Bangladeshis (2.6 days, SD 4.5) (p=0.0001). Readmission rates were similar amongst races. Five percentage (n=2) of Burmese patients suffered from complications of Clavien-Dindo Class III and above, whilst no patients amongst Thai and Bangladeshi groups suffered such severe complications (p=0.024). However, these numbers are small.

DISCUSSION

Our study population was predominantly young healthy male who presented with a relatively short duration of symptoms. The clinical presentation and physical findings were classical of acute appendicitis as reported in the literature.[8] There was no racial variation in the diagnosis and presentation of disease.

In our series, 42.9% underwent pre-operative CT scan and the decision to operate after a clinical diagnosis of acute appendicitis and blood investigation were common (57.1%). In contrast to the national audit in the Netherlands, nearly all patients underwent pre-operative imaging,[9] and in a prospective multicentre observational study across 44 countries worldwide, the use of imaging (US, CT, or both) was reported in 70% (with 30% CT scan, 70% US) of the patients.[10] In the United States, the Surgical Care and Outcomes Assessment programme (SCOAP) in Washington State demonstrates that 86% of patients underwent pre-operative imaging (of whom, 91% CT).[11] This can be explained by our younger study population, and the CT scan was increasingly performed only in patients who were older with higher ASA to rule out other pathologies that are more prevalent in the elderly.

Table II: Management and treatment outcome of patients with acute appendicitis

Variables	Value
Investigations	
Blood test, mean ± SD	
Neutrophil–white blood cell ratio (NWR)	0.81 ± 0.11
C-reactive protein (CRP)	102 ± 137
Imaging	
Computed tomography scan (CT scan), N (%)	508 (42.9)
Surgical approach, N (%)	
Open appendectomy	156 (13.2)
Laparoscopic appendectomy	1029 (86.8)
Laparoscopic appendectomy converted to open appendectomy	50 (4.9)
Duration of surgery, mean ± SD (minutes)	94.3 ± 79.7
Open appendectomy	89.6 ± 15.6
Laparoscopic appendectomy	96.4 ± 30.8
Time of surgery, N (%)	
08:00–16:59	448 (37.8)
17:00–23:59	524 (44.2)
00:00–07:59	213 (18.0)
Mannheim's Peritoneal Index Score (MPI), mean ± SD	7.5 ± 6.0
Outcomes, N (%)	
Surgical site infection (SSI)	21 (1.7)
Organ space infection (OSI)	9 (0.8)
Ileus	32 (2.7)
Pneumonia	2 (0.2)
Acute myocardial infarction	1 (0.1)
Clavien-Dindo Classification, N (%)	
Grades 0–II	1166 (98.4)
Grades III–IV	19 (1.6)
Length of stay, mean ± SD (days)	3.6 ± 6.8
30-day readmission, N (%)	29 (2.4)
Malignancy on histology, N (%)	7 (0.6)
Pathology including non-appendicitis and negative appendectomy, N (%)	99 (8.4)

SD, standard deviation
N, number

Our management of acute appendicitis was a laparoscopy-first approach as it has been shown to confer protective effect against severe complications such as less pain, lower incidence of SSI, decreased LOS, earlier return to work, and overall cost.[12] A national audit in the Netherlands showed that laparoscopy was predominant in 75% of appendectomy,[9] and in our series, 86.8% of the population. In a prospective multicentre observational study across 44 countries worldwide, more than half the cases were performed laparoscopically (51.7%), while 42.2% had open appendectomy.[10] This indicates that our practice in the adoption of laparoscopy for acute appendicitis is comparable to the West.

The risks factors associated with prolonged LOS following appendectomy were analysed in our study. These included increased age, male gender, prolonged duration of symptoms prior to hospitalisation, patients symptomatic with fever, patients with generalised tenderness, and prolonged operative time. Increasing age appeared to be an independent risk factor for complication after appendectomy. This is supported by the study using the NSQIP database where age was found to be associated with the increased risk of post-operative sepsis.[13] Laparoscopic approach was associated with shorter LOS. A laparoscopic appendectomy appeared to confer protective effect against severe complications. This is consistent with studies demonstrating clear advantages in terms of less pain, lower incidence of SSI, decreased LOS, earlier return to work, and overall costs.[12]

The effect of race on LOS has been observed in the literature for other surgical procedures. In elective colorectal surgeries, it was observed that Black patients had longer post-operative stays even in the absence of post-operative complications.[14] Similarly, Schneider et al.[15] demonstrated that race was an independent risk factor for prolonged LOS following pancreaticoduodenectomy even after adjusting for other differences prior to surgery. In our study, multivariate Cox regression analysis showed that patients of Burmese and Thai descent were independently associated with a prolonged LOS. In addition, the mean MPI scores for Burmese and Thais were lower than other racial groups such as the Chinese and Malays. These findings contribute to the possibility of intrinsic racial differences in the post-surgery recovery. However, the numbers are small and therefore prone to type I error.

The limitation of our study was its retrospective nature and the lack of socioeconomic data in our analysis of our patient demographics. Nonetheless, our large-scale study with multi-racial south Asian population may provide sufficient power and robustness to determine the independent risk factors even when considering multiple variables.

Table III: Univariate and multivariate Cox regression analyses of variables on the length of hospital stay of patients with appendicitis

	Univariate analysis			Multivariate analysis		
Variables	**HR**	**p-value**	**95% CI**	**HR**	**p-value**	**95% CI**
Race						
Chinese	1			1		
Malay	0.95	0.633	0.77–1.18	0.98	0.847	0.79–1.22
Indian	0.75	<0.0001	0.65–0.87	1.16	0.091	0.98–1.39
Bangladeshi	0.76	0.002	0.65–0.91	1.16	0.108	0.97–1.41
Burmese	1.08	0.673	0.77–1.49	1.56	0.010	1.11–2.22
Thai	1.19	0.302	0.85–1.67	1.52	0.019	1.08–2.17
Others	1.10	0.365	0.89–1.35	1.43	0.002	1.14–1.79
Age	1.02	<0.0001	1.01–1.02	1.01	<0.0001	1.01–1.02
Male	1.32	<0.0001	1.15–1.52	1.20	0.033	1.01–1.41
ASA status						
1 and 2	1			1		
3 and 4	2.70	<0.0001	1.79–4.17	1.37	0.219	0.83–2.27
Comorbidities						
IHD	2.04	0.036	1.05–3.85	0.65	0.235	0.31–1.33
DM	2.27	<0.0001	1.67–3.13	1.22	0.332	0.82–1.79
HTN	2.17	<0.0001	1.69–2.78	1.09	0.599	0.79–1.52
CKD	6.67	0.008	1.64–25.0	2.44	0.245	0.54–11.1
Duration of symptoms	1.18	<0.0001	1.12–1.22	1.14	<0.0001	1.09–1.18
Abdominal pain						
Migratory	1			1		
Localised	1.04	0.528	0.91–1.20	0.98	0.805	0.85–1.14
Generalised	1.56	<0.0001	1.25–1.96	1.20	0.124	0.95–1.54
Periumbilical	1.22	0.088	0.97–1.54	1.08	0.578	0.84–1.37
Atypical	1.49	<0.0001	1.20–1.85	1.11	0.379	0.88–1.41
Other symptoms						
Fever	1.30	<0.0001	1.15–1.45	1.25	0.010	1.10–1.43
Nausea	0.94	0.392	0.83–1.08			
Vomiting	0.91	0.114	0.81–1.02			
Anorexia	0.98	0.776	0.84–1.14			
Diarrhoea	1.35	0.001	1.14–1.64	1.05	0.641	0.86–1.27
Dysuria	0.95	0.788	0.69–1.32			
Abdominal tenderness						
Right-sided	1			1		
Generalised	1.69	0.001	1.25–2.32	1.52	0.014	1.09–2.08
Suprapubic	1.67	0.001	1.23–2.27	1.37	0.125	0.53–2.08
None	1.61	0.017	1.09–2.38	1.12	0.514	0.79–1.59
Atypical	1.47	0.005	1.12–1.92	1.47	0.011	1.09–1.96
Other signs						
Rebound	0.89	0.041	0.79–1.00	1.04	0.948	0.88–1.13
Guarding	1.01	0.851	0.90–1.14			
Mass	1.92	0.015	1.14–3.33	0.88	0.654	0.51–1.52
Investigations, mean ± SD						
NWR	1.00	0.355	1.00–1.01			
CRP	1.00	<0.0001	1.00–1.01			
Approach						
Laparoscopic	0.71	<0.0001	0.60–0.84	0.66	<0.0001	0.56–0.79
Converted	2.17	<0.0001	1.61–2.86			
Duration of surgery	1.01	<0.0001	1.01–1.01	1.01	<0.0001	1.01–1.01

HR, hazard ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; IHD, ischaemic heart disease; DM, diabetes mellitus; HTN, hypertension; CKD, chronic kidney disease; SD, standard deviation; NWR, neutrophil–white blood cell ratio; CRP, C-reactive protein

CONCLUSION

In our institution, the surgical management of acute appendicitis is driven by pre-operative imaging and laparoscopic approach, with low conversion rate, morbidity, and readmission rate. Risks factors associated with severe complications and prolonged LOS may potentially provide targets for risk reduction strategies in quality-improvement program to reduce complications, LOS or readmission. The impact of shortening every person's LOS by one day will have large impact and free up hospital beds for other more complex procedures.

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