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Predictive score for diagnosing acute colonic diverticulitis in the emergency department: a retrospective study

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Abstract

Background Acute diverticulitis is commonly misdiagnosed among patients with acute abdominal pain in the emergency department (ED). There are predictive scores that assist in the diagnosis of acute left-sided diverticulitis, but no scoring system is available for diagnosing acute diverticulitis without regard to the affected side. Therefore, developing a predictive score for diagnosing acute diverticulitis that is not limited to the left side will guide physicians in making a diagnosis and increase the appropriateness of computed tomography. This study aimed to establish a predictive score for diagnosing acute diverticulitis.

Method This single-centre retrospective study included adult patients (≥ 18 years) who presented to the ED with acute abdominal pain. Multivariate logistic regression analysis was used to identify essential factors for diagnosing acute diverticulitis, and the Akaike information criterion was calculated to identify significant predictive factors for diagnosing acute diverticulitis using a clinical scoring system.

Results Of 424 patients who fulfilled the inclusion criteria, 72 (17%) were diagnosed with acute diverticulitis. The significant factors associated with acute diverticulitis were age ≥ 60 years (adjusted odds ratio (adj.OR) 2.23, 95% confidence interval (CI): 1.20 – 4.14, $p = 0.01$), duration of abdominal pain ≥ 48 h (adj.OR 2.64, 95% CI: 1.28 – 5.45, $p = 0.017$), history of a diverticulum (adj.OR 7.77, 95% CI: 3.27 – 18.45, $p < 0.001$), absence of nausea and vomiting (adj.OR 3.42, 95% CI: 1.65 – 7.10, $p < 0.001$), absence of anorexia (adj.OR 3.33, 95% CI: 1.34 – 8.33, $p = 0.026$), absence of tachycardia (adj.OR 3.51, 95% CI: 1.39 – 8.87, $p = 0.003$), and abdominal guarding (adj.OR 2.99, 95% CI: 1.52 – 5.91, $p = 0.002$). These predictive factors were converted into predictive scores for diagnosing acute diverticulitis. For the score of ≥ 4, the sensitivity and specificity were 73.24% (95% CI: 0.61–0.83) and 80.40% (95% CI: 0.76–0.84), respectively, and the negative predictive value was 93.71% (95% CI: 0.90–0.96). No significant signs, symptoms, or laboratory findings were associated with complicated diverticulitis.

Conclusion Predictive factors for diagnosing acute diverticulitis included age ≥ 60 years, duration of abdominal pain ≥ 48 h, history of a diverticulum, abdominal guarding, and absence of nausea and vomiting, anorexia, and tachycardia. A predictive score ≥ 4 suggested the presence of acute diverticulitis.

Keywords Predictive score, Diagnosis, Acute diverticulitis, Acute abdominal pain

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Background

Abdominal pain is one of the most common reasons for emergency department (ED) visits, accounting for approximately 5–10% of all ED visits. Abdominal problems can present with uncommon or unusual presentations and, hence, can be challenging to diagnose by ED physicians [1]. Some patients with abdominal pain are often diagnosed with nonspecific acute abdominal pain. Acute diverticulitis is one of the most common diagnoses in this group (1–3%) and one of the most frequently missed diagnoses [2].

Inflammation and infection of the diverticulum cause acute colonic diverticulitis, affecting approximately 10−25% of individuals. It has a high incidence and mortality rate in European countries but is less common in Asian countries, although the mortality rate remains high [3]. In Thailand, data collected from hospitals nationwide from 2009 to 2010 showed that the mortality rate of acute diverticulitis was 3.8%. One factor identified as responsible for the increased mortality rate was delayed diagnosis [4].

Limited data exists on the diagnosis of acute diverticulitis, which mimics other abdominal diseases. Abdominal computed tomography (CT) is the gold standard for diagnosing and assessing the severity of acute diverticulitis. It also helps in the differential diagnosis of other conditions. However, CT also has disadvantages because patients are exposed to radiation and contrast agents, which increases the risk of contrast-induced nephropathy [5]. Furthermore, CT scans may not be available in some resource-limited hospitals, particularly in rural hospitals.

A predictive score has been developed for the diagnosis of acute left-sided diverticulitis [6–8]. However, different incidences have been reported in Western and Asian populations. In contrast to Western countries, right-sided diverticulitis is more common in Asian countries. The incidence of right-sided diverticulitis in Asians is 88.7%, while in Western populations, it is present in only 1.5% of patients [9, 10].

Therefore, establishing a predictive score for diagnosing acute diverticulitis without regard to the affected side will assist in making an early diagnosis, increase the accuracy of the diagnosis, and guide physicians regarding when CT is required.

Methods

Study design and setting

This single-centre retrospective study was conducted in patients ≥ 18 years who presented with acute abdominal pain at the ED of Songklanagarind Hospital, a tertiary referral and academic hospital in the Prince of Songkla University campus in southern Thailand.

The hospital's electronic medical records database was reviewed to obtain patient data from January 2013 to October 31, 2022. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee (REC 64-354-20-4).

Study population

The inclusion criteria were as follows: patients who were older than 18 years, presented with acute abdominal pain, and underwent a CT scan. The exclusion criteria were referred inpatients, pregnant patients, trauma patients, and patients with incomplete pertinent histories, physical examinations, and laboratory test data in their medical records.

Data collection

Data were collected from adult patients older than 18 years with abdominal pain as the chief complaint and with suspected acute diverticulitis or other surgical conditions. The information gathered included medical history, physical examination, laboratory investigations, and CT scans of the entire abdomen interpreted by a radiologist. Data collection began on December 1, 2021, and records were reviewed from January 2013 to May 2021. However, there were insufficient data after excluding some medical records following the exclusion criteria. Hence, data collection was extended to October 31, 2022.

The information collected from the medical record was divided into five parts, namely:

Part 1: Basic information, including age, gender, and triage level.

Part 2: Medical history containing information on abdominal pain, including its onset, duration, and pain score; associated symptoms such as nausea, vomiting, diarrhoea, constipation, anorexia, and rectal bleeding; comorbidities including diabetes mellitus, hypertension, chronic kidney disease, heart disease, stroke, human immunodeficiency virus, autoimmune disease, chronic liver disease; and a history of colonic diverticulum.

Part 3: Physical examination data, including vital signs, body weight, height, and abdominal examination findings such as bowel sounds, location of abdominal tenderness, rebound tenderness, and guarding.

Part 4: Laboratory investigations, including white blood cell (WBC), polymorphonuclear leukocyte (PMN) and band counts, and lactate levels.

Part 5: Final diagnosis of possible acute diverticulitis, laterality, Modified Hinchey classification: a severity grading of acute diverticulitis ranging from localised infection (stage I) to widespread infection with abscesses or peritonitis (stages II–IV), and other diagnoses.

Outcome measures

The objective of this study was to establish a predictive score for diagnosing acute diverticulitis (including both uncomplicated and complicated diverticulitis according

to the Modified Hinchey Classification) in patients with abdominal pain in the ED.

Statistical analysis

The sample size was calculated based on the study by Lameris et al., [7] which established the clinical rules for diagnosing acute diverticulitis. A diagnosis of acute diverticulitis was highly correlated with four symptoms, with subacute onset of pain having the lowest odds ratio. Therefore, it was used to obtain the largest number of patients (n) and to determine the relationship between each factor. With the Alpha (α) of 0.05 and power of 80%, a sample size of 424 patients was needed.

Continuous data are reported as medians with interquartile ranges and means with standard deviations. Categorical data are presented as counts and percentages. Categorical variables were compared using Pearson's chi-squared test, rank-sum test, Fisher's exact test, and t-tests.

The study population was classified into acute diverticulitis and non-acute diverticulitis groups. Based on the univariate logistic regression analysis, essential variables with $p<0.05$ were included in the multivariate logistic regression analysis. Factors were analysed to construct a model for predicting the probability of acute diverticulitis using the Akaike information criterion (AIC) in a backward stepwise algorithm. The clinical predictive score was analysed using the coefficients from the multivariate logistic regression analysis; the weight of each factor's score was determined according to its coefficient values. The Youden index was used to identify the optimal cut-off point for diagnosing acute diverticulitis and to plot a receiver operating characteristic (ROC) curve to determine the diagnostic ability.

Results

In total, 424 patients met the inclusion criteria. The patient flow chart for this study is presented in Fig. 1.

A total of 72 patients (17%) were diagnosed with acute diverticulitis; 34 and 38 had right- and left-sided diverticulitis, respectively. Among the 352 patients diagnosed with another disease, the most common diagnoses were enterocolitis (20.17%), acute appendicitis (19.18%), non-specific acute abdominal pain (11.07%), ovarian mass (7.67%), and bowel obstruction (6.48%).

The baseline patient characteristics are shown in Table 1. The median age of the patients with acute diverticulitis was 63.5 years. Patients aged ≥ 60 years had a significantly higher incidence of acute diverticulitis than patients with other diseases ($p=0.003$). Males were significantly more affected than females ($p=0.001$). Furthermore, most patients with acute diverticulitis had a history of a diverticulum ($p<0.001$).

No laboratory investigations revealed statistically significant differences between patients with acute diverticulitis and those with other types of abdominal pain. Table 2 presents the results of the study.

The results of the multivariate logistic regression analysis are shown in Table 3. The significant factors associated with acute diverticulitis were age over 60 years, duration of abdominal pain ≥ 48 h, history of diverticulum, absence of nausea and vomiting, absence of anorexia, absence of tachycardia, and abdominal guarding. The area under the curve was 0.847. ROC curves are shown in Supplementary Fig. 1.

The significant predictive factors were developed into predictive scores for the diagnosis of acute diverticulitis, as shown in Table 4. A score ≥ 4 indicated that the patient likely had acute diverticulitis. The sensitivity and specificity were 73.24% (95% CI: 0.61–0.83) and 80.40%

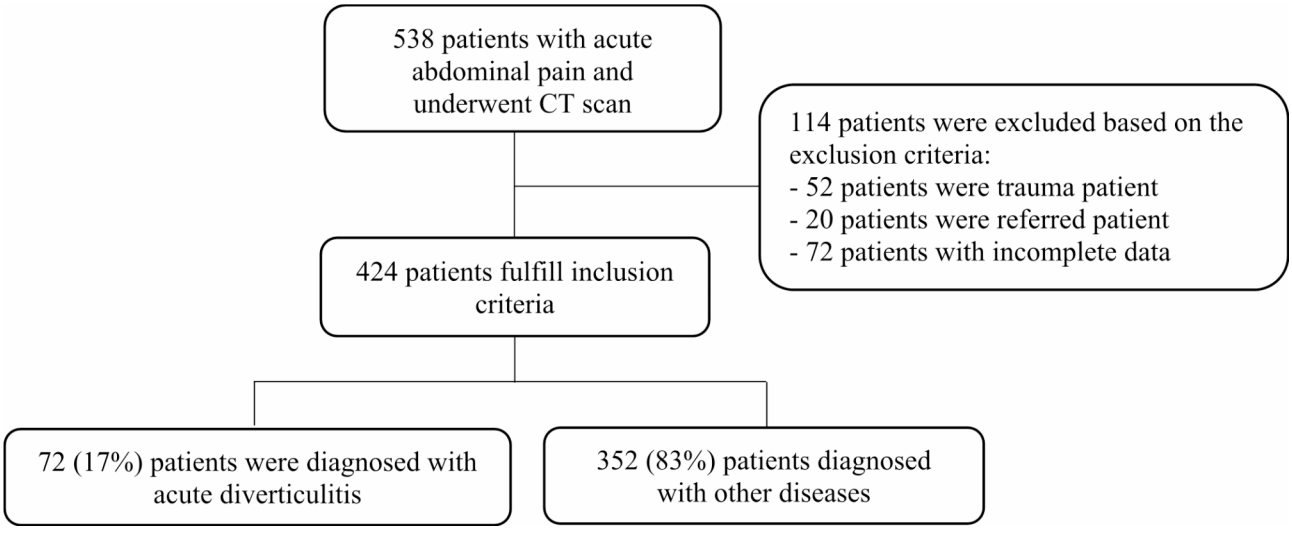

Fig. 1 Patient flowchart. CT, computed tomography

Table 1 Baseline characteristics of patients with acute abdominal pain in the ED

Characteristic	Number of patients		*p*-value
	Acute diverticulitis (*n* = 72)	Non acute diverticulitis (*n* = 352)	
Age, Median (IQR)	63.5 (53,72)	50 (28.8,68)	< 0.001
≥ 60 years	41 (56.9)	132 (37.5)	0.003
Male	40 (55.6)	122 (34.7)	0.001
Diabetes mellitus	9 (12.5)	33 (9.4)	0.554
Hypertension	22 (30.6)	82 (23.3)	0.248
CKD	4 (5.6)	12 (3.4)	0.493
Heart disease	0 (0)	18 (5.1)	0.269
Stroke/TIA	0 (0)	11 (3.1)	0.224
HIV	1 (1.4)	3 (0.9)	0.526
Autoimmune disease	3 (4.2)	5 (1.4)	0.139
Chronic liver disease	0 (0)	10 (2.8)	0.224
History of colonic diverticulum	21 (29.2)	15 (4.3)	< 0.001
History of acute diverticulitis	15 (20.8)	5 (1.4)	< 0.001

Abbreviations: CKD, chronic kidney disease; TIA, transient ischemic attack; HIV, human immunodeficiency virus; ED, emergency department; IQR, Interquartile range

Table 2 Results of laboratory investigations of patients with acute abdominal pain in the ED

Laboratory investigation	Number of patients		*p*-value
	Acute diverticulitis (*n* = 72)	Non acute diverticulitis (*n* = 352)	
WBC (cell/mm^3) (Mean [SD])	11,501 (3718.9)	12187.2 (7101.5)	0.426
WBC group (cell/mm^3)			0.279
< 10,000	21 (29.2)	130 (36.9	
10,000–15,000	36 (50)	141 (40.1)	
> 15,000	15 (20.8)	81 (23)	
PMN (%) (Mean [SD])	74.3 (9.9)	75.8 (12.4)	0.338
Band (%) (Mean [SD])	3.2 (7.6)	3.5 (7.9)	0.888
Lactate (mmol/L) (Mean [SD])	1.3 (0.4)	1.8 (2)	0.338

Abbreviations: ED, emergency department; WBC, white blood cell; PMN, polymorphonuclear neutrophils; LAC, lactate level; SD, Standard deviation

Table 3 Multivariate logistic regression results for factors associated with acute diverticulitis

	Crude OR (95% CI)	Adjusted OR (95% CI)	*P* (LR-test)
Age ≥ 60 years	2.28 (1.36,3.82)	2.23 (1.2,4.14)	0.01
Duration ≥ 48 h	2.31 (1.27,4.21)	2.64 (1.28,5.45)	0.017
History of diverticulum	9.44 (4.56,19.5)	7.77 (3.27,18.45)	< 0.001
Absence of nausea and vomiting	5.2 (2.7,10.02)	3.42 (1.65,7.1)	< 0.001
Absence of anorexia	4.49 (2.05,9.84)	3.33 (1.34,8.33)	0.026
Absence of tachycardia	3.95 (1.66,9.41)	3.51 (1.39,8.87)	0.003
Abdominal guarding	2.87 (1.64,5.01)	2.99 (1.52,5.91)	0.002

OR, Odds ratio; 95% CI, 95% Confidence interval; LR, likelihood ratio

Table 4 Predictive score for the diagnosis of acute diverticulitis

Predictive factors	Points
Age ≥ 60 years	1
Duration ≥ 48 h	1
History of diverticulum	2
Absence of nausea and vomiting	1
Absence of anorexia	1
Absence of tachycardia	1
Abdominal guarding	1

Note: A score of ≥ 4 points is predictive of acute diverticulitis

(95% CI: 0.76–0.84), respectively. The negative predictive value (NPV) was 93.71% (95% CI: 0.90–0.96). As shown in Fig. 2, the area under the curve was 0.823.

Regarding signs and symptoms, duration of abdominal pain ≥ 48 h was significantly more common in patients with acute diverticulitis ($p < 0.016$). Associated symptoms, including nausea, vomiting, and anorexia, were more common in other abdominal diseases ($p < 0.001$). The results are summarised in Table 5.

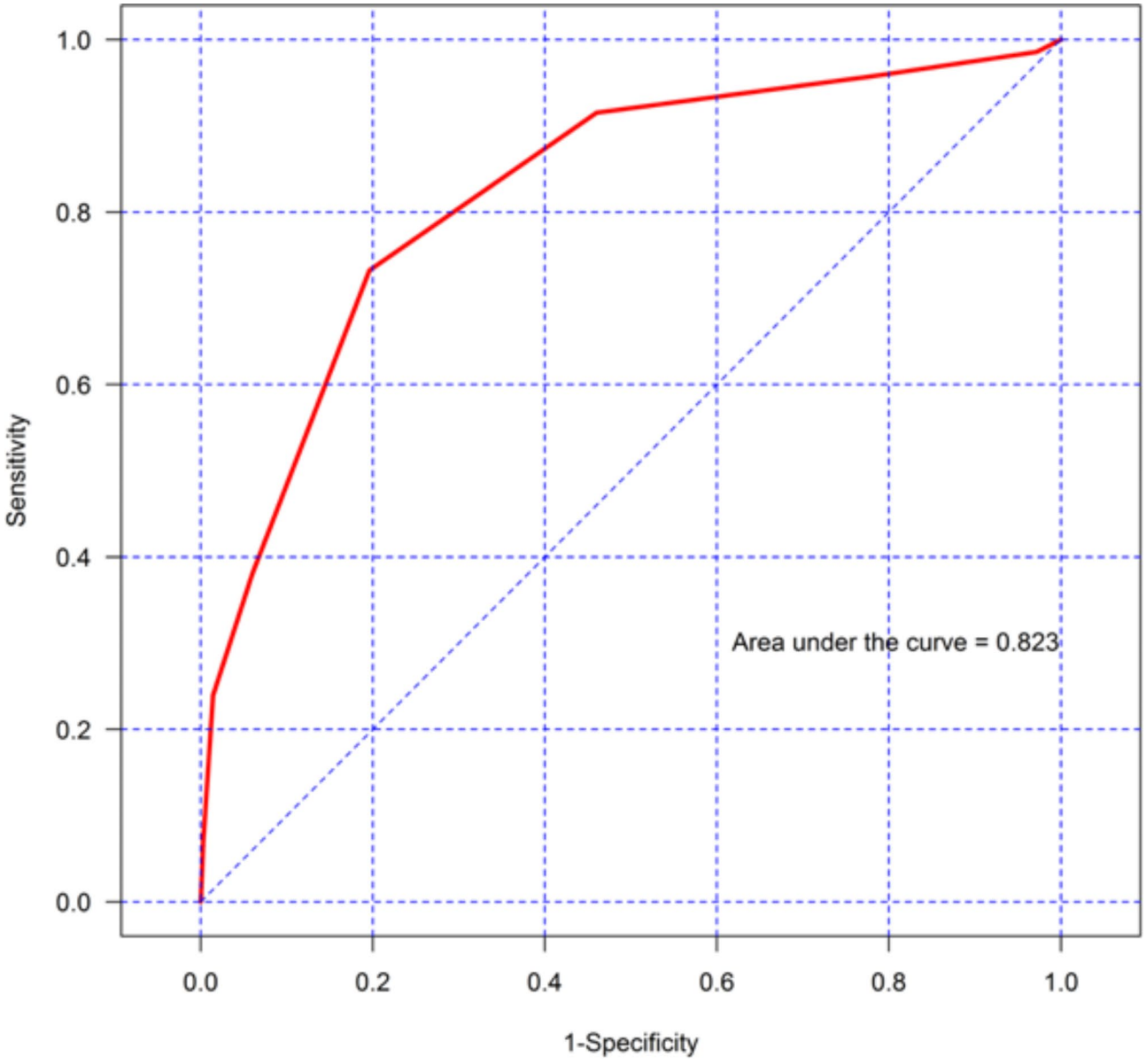

Fig. 2 Receiver operating characteristic (ROC) curve derived from the prediction score for diagnosing acute diverticulitis

Table 5 Signs and symptoms of patients with acute abdominal pain in the ED

Signs and symptoms	Number of patients		*p*-value
	Acute diverticulitis (*n* = 72)	Non acute diverticulitis (*n* = 352)	
Pain score (Median [IQR])	8 (6.8,9)	8 (6,9)	0.985
Duration of pain ≥ 48 h	38 (52.8)	130 (36.9)	0.016
Fever	24 (33.3)	92 (26.1)	0.27
Nausea or vomiting	12 (16.7)	181 (51.4)	< 0.001
Migratory pain	9 (12.5)	57 (16.2)	0.542
Diarrhoea	18 (25)	72 (20.5)	0.483
Constipation	7 (13.7)	63 (23.9)	0.158
Anorexia	9 (20.9)	113 (54.3)	< 0.001
Rectal bleeding	3 (4.2)	6 (1.7)	0.018

ED, emergency department; IQR, Interquartile range

Systolic blood pressure was significantly higher in patients with acute diverticulitis ($p=0.002$), whereas tachycardia, defined as a pulse rate > 100 bpm, was higher in those with other abdominal diseases ($p=0.012$). Statistically significant abdominal signs were left lower quadrant (LLQ) tenderness ($p<0.001$), right lower quadrant (RLQ) tenderness ($p=0.007$), and guarding ($p<0.001$). The results are summarised in Table 6.

The CT scans of patients with diverticulitis are shown in Supplementary Table 1. Among the 72 patients, 22 had uncomplicated diverticulitis, and 50 had complicated diverticulitis. However, no significant differences were observed between the groups. Secondary outcomes are presented in Supplementary Table 2.

Discussion

Our study showed that the predictive factors for diagnosing acute diverticulitis included age ≥ 60 years, duration of abdominal pain ≥ 48 h, history of diverticula, absence of nausea and vomiting, absence of anorexia, absence of tachycardia, and abdominal guarding. A predictive score ≥ 4 suggested a diagnosis of acute diverticulitis. Secondary outcomes included the absence of signs, symptoms, or laboratory findings associated with complicated diverticulitis.

In this study, acute diverticulitis was more common in males than females. This result is consistent with a study conducted in hospitals across Asia, which found that 65.5% of acute diverticulitis cases affected male patients [9]. Furthermore, we found that significantly more females had other diseases than diverticulitis. This could be because females also have gynaecological conditions. Patients with diverticula have a higher probability of acute diverticulitis according to the prevalence of this disease, which occurs in 10–25% of patients with diverticula.

Fever and body temperature were not significant factors in this study, as in a previous study conducted in 2006 [11], where body temperature did not differ in patients with acute diverticulitis and those with nonspecific acute abdominal pain. We also found that the absence of nausea and vomiting was a predictor of acute diverticulitis, similar to the report from Andeweg et al.'s study, which reported that nausea and vomiting were negative predictors of acute diverticulitis [6]. In previous studies, the location of pain and tenderness in the LLQ

Table 6 Physical examination findings of patients with acute abdominal pain in the ED

Signs and symptoms	Number of patients		*p*-value
	Acute diverticulitis (*n* = 72)	Non acute diverticulitis (*n* = 352)	
Body temperature (°C) (Median [IQR])	37.0 (36.6, 37.5)	36.9 (36.5–37.6)	0.466
≥ 38 (°C)	10 (13.9)	58 (16.5)	0.712
SBP (mmHg) (Median [IQR])	141 (127.0, 159.2)	133.5 (118.8, 148.2)	0.002
PR (bpm) (Median [IQR])	83.5 (75.5,92)	88 (78,102.2)	0.012
> 100 bpm	6 (8.3)	94 (26.7)	0.001
NEWS (Median [IQR])	2 (0,3)	2 (1,3)	0.072
BMI (kg/m^2) (Median [IQR])	23.6 (21.8,27.0)	22.8 (20.1,27.0)	0.066
≥ 30	8 (11.4)	33 (11.1)	1
Abdominal distention	12 (17.9)	74(21)	0.68
Bowel sound			0.089
Hyperactive	17 (23.6)	66 (18.8)	
Normoactive	42 (58.3)	241 (68.5)	
Hypoactive	9 (12.5)	40 (11.4)	
Absent	4 (5.6)	5 (1.4)	
Epigastrium tenderness	1 (1.4)	20 (5.7)	0.227
RUQ tenderness	2 (2.8)	21 (6)	0.396
LUQ tenderness	3 (4.2)	8 (2.3)	0.408
Periumbilical tenderness	3 (4.2)	30 (8.5)	0.31
LLQ tenderness	31 (43.1)	51 (14.5)	< 0.001
RLQ tenderness	20 (27.8)	161 (45.7)	0.007
Suprapubic tenderness	10 (13.9)	32 (9.1)	0.305
Generalised tenderness	3 (4.2)	29 (8.2)	0.344
Rebound tenderness	18 (26.1)	63 (17.9)	0.162
Guarding	26 (36.6)	59 (16.8)	< 0.001

Abbreviations: ED, emergency department; IQR, Interquartile range; SBP: systolic blood pressure, PR: pulse rate, BMI, body mass index; RUQ, right upper quadrant; LUQ, left upper quadrant; RLQ, right lower quadrant; LLQ, left lower quadrant. NEWS, National Early Warning Score

was a significant predictor of acute diverticulitis [11, 12]. Similarly, in this study, LLQ tenderness was significantly correlated with acute diverticulitis. However, RLQ tenderness was not significantly associated with acute diverticulitis. This could be because other diseases, especially acute appendicitis, present with pain and tenderness in the RLQ. However, multivariate logistic regression analysis showed that the location of tenderness was not significantly related to acute diverticulitis. This may be because the numbers of patients with left- and right-sided diverticulitis were nearly equal in this study. Laurell et al. reported that the abdominal guarding was significant in patients with acute diverticulitis [11]. As in this study, abdominal guarding was a predictor of acute diverticulitis. Furthermore, we found tachycardia to be a negative predictor of acute diverticulitis. This could be because patients with acute diverticulitis in this study tended to have less severe disease or fewer complications that typically triggered tachycardia.

We found that the mean WBC, neutrophil, and band counts did not significantly differ between acute diverticulitis and other diseases, similar to a report from a previous study by Laurell et al. in 2007 [11]. In contrast to the study by Iyer et al. in 2014 [12], leukocytosis was one of the most common findings in patients with acute diverticulitis. However, they also found that leukocytosis was less common in older patients. In this study, most patients with diverticulitis were elderly, which may explain the absence of leukocytosis compared to other diseases occurring in the younger group. Therefore, leukocytosis is not the laboratory test of choice for diagnosing acute diverticulitis. A 2010 study found that one of the clinical decision rules for diagnosing acute diverticulitis was the C-reactive protein (CRP) level [7]. However, at Songklanakarin Hospital, CRP is not used in routine laboratory investigations. Therefore, we could not determine the association between CRP levels and acute diverticulitis due to its absence in routine testing.

A previous study in 2011 developed a clinical scoring system for left-sided diverticulitis [6]. The score included age, one or more episodes of abdominal pain, LLQ pain, LLQ tenderness, pain on movement, absence of vomiting, and CRP level ≥ 50 mg/L. This score had a sensitivity and specificity of 75% and 84%, respectively. Another study conducted in 2010 identified a clinical decision rule for acute diverticulitis [7]. Three factors were used to predict the probability of acute left-sided diverticulitis, including LLQ pain, absence of vomiting, and CRP ≥ 50 mg/L. This clinical decision rule had sensitivity and specificity of 36% and 98%, respectively. However, the scores mentioned in the previous studies were only used to diagnose left-sided diverticulitis [6–8]. In Asia, there are more incidents of right-sided diverticulitis; therefore, these scores are not applicable [8]. This study calculated the score without considering the location of tenderness, making it particularly useful for evaluating acute diverticulitis in Asian patients. Furthermore, with its high specificity and negative predictive value, the score aids in making decisions to rule out the disease, especially in rural hospitals with limited resources.

Regarding the secondary outcomes, we found no significant factors associated with complicated diverticulitis. Contrastingly, Longstreth et al. [13] found that body temperature > 37.5 °C, leukocytosis (> 11,000 cell/mm^3), neutrophilia (PMN > 77%), and a predominance of bands (> 7%) were associated with severe disease. This may be because few patients had acute diverticulitis, and most patients with complicated diverticulitis were in the less severe group (modified Hinchey classes Ia and Ib).

This study had some limitations. Although we used a software package for sample size calculation, this size might not considered sufficient by other methods. Furthermore, patients who were discharged without a CT scan were excluded. This might have caused a selection bias, as only more severe cases were included, so the predictive score may only apply to cases with greater severity and complexity than what is commonly seen in general clinical practice. Moreover, factors that were significant in other studies, such as CRP levels, were not included in this study. This was due to the fact that CRP is not routinely tested in our hospital, and due to the retrospective nature of this study, we did not have this value for analysis. Finally, in this retrospective study, the utility of the predictive score is limited due to the lack of prospective or external validation. Future research should focus on prospectively validating the score to confirm its reliability and enhance its broader applicability.

Conclusions

This study showed that a decision rule consisting of age, symptoms duration, previous history of diverticulum, absence of nausea and vomiting, absence of anorexia, absence of tachycardia, and abdominal guarding had great specificity and acceptable sensitivity for diagnosing diverticulitis. A predictive score ≥ 4 indicates a diagnosis of acute diverticulitis, with a sensitivity of 73.24%, specificity of 80.40%, and an NPV of 93.71%. This tool is valuable for ruling out acute diverticulitis without regard to the affected side and can assist physicians in deciding whether to perform a CT scan, particularly in resource-limited settings such as rural hospitals. However, future prospective validation is necessary before it can be confidently implemented in clinical practice.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12873-024-01127-2.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
Siriwimon Tantarattanapong performed the literature search, study design, and critical revision. Choasita Glawsongkram performed the literature search, study design, data collection, data analysis, data interpretation, and manuscript writing. Wasuntaraporn Pethyabarn designed the study, analysed and interpreted the data, wrote the manuscript, and critically revised it.

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Data availability
All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate
Ethical approval was obtained from the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC 64-354-20-4). The requirement for patient consent was waived, as approved by the Ethics Committee of the Faculty of Medicine of Prince of Songkla University because the participants had minimal risk and received standard medical care.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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