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Leucocyte Count Does Not Improve the Diagnostic Performance of a Diagnostic Score (DS) in Distinguishing Acute Appendicitis (AA) from Nonspecific Abdominal Pain (NSAP)

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Abstract. *Background/Aim: Although, acute appendicitis (AA) and nonspecific abdominal pain (NSAP) are the most common diagnoses among secondary care patients with acute abdominal pain, the diagnostic performance of leucocyte count (LC) in DS (Diagnostic Score) model is rarely considered. Patients and Methods: As an extension of the World Organisation of Gastro-Enterology Research Committee (OMGE) acute abdominal pain study, 1,333 patients presenting with acute abdominal pain were included in the study. The clinical history and diagnostic symptoms (n=22), signs (n=14) and tests (n=3) in each patient were recorded in detail, and the collected data were related with the final diagnoses of the patients. Results: In the ROC comparison test, there was no statistically significant difference in the performance of DS_{LC-} (DS without LC) and DS_{LC+} (DS with LC). The highest sensitivities of the DS_{LC-} and DS_{LC+} tests for detecting AA were 86% (95%CI=81-90%) and 87% (95%CI=82-91%), respectively. The highest specificities of the DS_{LC-} and DS_{LC+} tests for detecting AA were 98% (95%CI=97-99%) and 98% (95%CI=96-99%), respectively. Conclusion: DS could assist the clinician in differentiating AA from NSAP and other causes of acute abdominal pain. Importantly, LC does not improve the diagnostic performance of a DS in AA.*

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Key Words: Acute appendicitis, non-specific abdominal pain, diagnostic score, leucocyte count, ROC, HSROC.

We have studied acute abdominal pain in connection with the survey on acute abdominal pain by the Research Committee of the World Organization of Gastroenterology (OMGE) (1) and investigated the diagnostic performance of history-taking and clinical examination in acute appendicitis (AA) (2), nonspecific abdominal pain (NSAP) (3), acute small bowel obstruction (4) and acute renal colic (5). Given that AA and NSAP are the most common diagnoses among secondary care patients with acute abdominal pain, the diagnostic performance of history-taking, clinical examination and possible diagnostic score (DS) is extremely important. However, the differential diagnosis of AA and NSAP is not always easy due to many similarities in the clinical presentation at the onset and many cases may be misdiagnosed in the initial diagnostic setting. Although, there is some DS models available (2, 6-10) in the diagnosis of acute abdominal pain (AAP) there is continuing debate on the shortcomings of the DS models and we thus aimed to examine the performance of our DS model i) without leucocyte count (DS_{LC-}) and ii) with leucocyte count (DS_{LC+}).

Patients and Methods

Criteria for inclusion in this study and the diagnostic criteria were those set out by the OMGE Committee (1). There were 636 males (47.7%) and 697 females (52.3%) with a mean age (±SD) of 38.0±22.1 years (Table I).

The clinical findings in each patient were recorded in detail (Tables II and III), using a predefined structured data collection sheet. The disease history was recorded and categorised as shown in Tables II and III. The examination of the clinical symptoms, signs and tests were conducted using a standard technique and the results were graded positive or negative (Tables II and III). The diagnosis of acute abdominal pain (AAP) was done by considering all symptoms, signs and results of the laboratory tests together and the diagnostic criteria of AA defined elsewhere (1-3).

The likelihood ratio of a positive test result (LR+) shows how many times greater the probability of a positive test result is among

Table I. *The distribution of diagnoses in patients with acute abdominal pain according to initial decision.*

Disease category	No. of patients	%
Non-specific		
Abdominal pain (1)*	552	41.4
Acute appendicitis (2)	402	30.2
Acute cholecystitis (3)	135	10.1
Small bowel obstruction (4)	57	4.3
Dyspepsia (5)	27	2.0
Renal colic (6)	59	4.4
Diverticular disease (7)	13	1.0
Mesenteric lymphadenitis (8)	9	0.7
Acute pancreatitis (9)	29	2.2
Perf. peptic ulcer (10)	6	0.5
Urinary tract infection (11)	10	0.8
Acute gynae. disease (12)	12	0.9
Miscellaneous (13)	22	1.7
Total	1333	100.0

*OMGE Rank order number in parenthesis.

patients with acute appendicitis (AA) than in subjects without acute appendicitis. LR+ should always be higher than 1.0 and LR+ of a good test (diagnostic method) is 10 or higher. The likelihood ratio of a negative test result (LR–) is the probability of a negative test result among patients with AA divided by the corresponding probability among the subjects without acute AA. LR– should be less than 1 and the LR– ratio of a good test is less than 0.1.

Statistical analysis. In the computation of the diagnostic score (DS), a logistic stepwise multivariate regression analysis of the SPSS Statistics 26.0.0.1 (IBM, NY, USA) was used. All the variables presented in Tables II and III were included in the analysis as binary data *e.g.* AA (1) and NSAP (0). The multivariate analysis was used to disclose the variables with an independent predictive value. Using the coefficients of the regression model, a DS was built and its predictive value for AA was studied. The coefficient of the multivariate analysis shows the relative risk (RR=e_, n=β) of a patient with a given symptom or sign to have an AA.

The rest of the analyses were performed with STATA/SE version 16.1 (StataCorp, College Station, TX, USA). Statistical tests presented were two-sided, and *p*-value <0.05 was considered statistically significant. Using 2×2 tables, we calculated sensitivity (Se) and specificity (Sp) with 95% confidence intervals (95%CI) for each symptom, sign or test, and created separate forest plots for showing each set of data, separately for each diagnostic variable. We calculated the summary estimates of Se and Sp, positive (LR+) and negative likelihood ratio (LR–) and diagnostic odds ratio (DOR), using a random effect bivariate model and fitted the summary hierarchical receiving operating characteristic (HSROC) curves including all diagnostic variables in the DS_{LC-} and DS_{LC+} models, using the AA endpoint.

Using the STATA's predict tool, we also made posterior predictions [Empirical Bayes (EB) estimates] of the Se and Sp in each variable in DS_{LC-} and DS_{LC+}. Analogous to its use in meta-analysis, EB estimates here give the best estimates of the true Se and Sp for each diagnostic variable, the variable-specific point estimates usually shrinking toward the summary point of the HSROC. We explored the statistical heterogeneity between diagnostic variables (Tables II and III) and DS models (Tables II and III) through visual examination of the forest plots and the HSROC curves. To study the potential bias, we used the Cook's distance to check for the particularly influential variables, together with a scatter plot of the standardised (level 2) residuals to check for the variables that are distinct outliers.

Results

Diagnostic performance of the symptoms. The pooled overall Se and Sp of the diagnostic symptoms for detecting AA were 75% (95%CI=60-87%) and 35% (95%CI=23-49%), respectively (Figures 1 and 2). In 13 diagnostic symptoms the Se was higher than 75%, and the Sp was higher than 35% in 10 diagnostic symptoms. The five best diagnostic symptoms (vertigo, jaundice, micturition, drugs for abdominal pain and use of alcohol) showed 97-100% Se in the diagnosis of AA (Figure 1). The four best diagnostic symptoms showed 69-91% Sp, the initial pain being the most specific (91%) followed by the intensity of the abdominal pain, sex and location of the pain at diagnosis (Figure 2).

Diagnostic performance of the signs and tests. The pooled overall Se and Sp of the clinical signs and tests for detecting AA were 87% (95%CI=81-92%) and 38% (95%CI=19-59%), respectively (Figures 3 and 4). For 10 clinical signs and tests, the Se exceeded 87%, and the Sp was higher than 38% for 10 diagnostic signs. The best four clinical signs and tests (mass, urine, distension and Murphy's sign positive) showed 96-100% Se for AA (Figure 3). The best four clinical signs and tests showed 71-98% Sp, rigidity (98%) being the most specific, followed by rectal digital tenderness, leucocyte count (LC) and rebound (Figure 4).

Diagnostic performance of the DS without leucocytes (DS_{LC-}). The most significant predictors were used to construct six different DS_{LC-} formulas for AA diagnosis (Table IV). The pooled overall Se and Sp of these six DS_{LC-} models for AA diagnosis were 77% (95%CI=70-84%) and 95% (95%CI=93-97%) (Figures 5 and 6). At the best diagnostic performance level for AA, the DS_{LC-} (formula DS I, Figures 5 and 6) showed Se of 82% (95%CI=77-86%) and Sp of 95% (95%CI=93-97%). The formula without LC, showing the highest diagnostic performance for AA in HSROC analysis is as follows: DS_{LC-}=–1.72×guarding (positive endpoint=1, negative endpoint=0)–0.56×type of pain (positive endpoint=1, negative endpoint=0) –0.9×pain at diagnosis (positive endpoint=1, negative endpoint=0) –1.36×tenderness (positive endpoint=1, negative endpoint=0) –3.32×rigidity (positive endpoint=1, negative endpoint=0) –1.1×vomiting (positive endpoint=1, negative endpoint=0) –1.44×previous abdominal

Table II. *The clinical history of the patients with acute appendicitis versus non-specific abdominal pain.*

Clinical history variable	Positive endpoint	Negative endpoint	TP	FN	FP	TN
1. Gender	Male	Female	149	268	121	346
2. Location of initial pain (OMGE)	Upper left or right quadrants of abdomen	Other quadrants of abdomen	6	264	57	557
3. Location of pain at diagnosis (OMGE)	Right lower quadrant of abdomen	Other quadrants of abdomen	207	63	188	426
4. Duration of pain: Duration of pain at diagnosis	≤12 h	>12 h	80	190	217	397
5. Intensity of abdominal pain	Subjectively moderate/ intolerable pain	Weak pain	179	349	91	265
6. Progression of pain from onset to diagnosis	Subjectively same or worse pain	Weaker pain than at the onset	190	72	375	239
7. Type of pain	Subjectively steady pain	Colicky or intermittent pain	190	80	313	301
8. Aggravating factors	Movement, coughing, respiration, food or other	No aggravating factors	244	26	410	204
9. Relieving factors	No relieving factors	Vomiting, lying still, food, antacids or no relieving factors	52	218	233	381
10. Previous similar pain	No	Yes	229	35	397	210
11. Vertigo	No	Yes	270	0	588	23
12. Nausea	Yes	No	153	117	326	288
13. Vomiting	Yes	No	129	141	211	403
14. Appetite	No appetite	Normal appetite	219	51	407	207
15. Previous indigestion	No	Yes	240	30	504	108
16. Jaundice	No	Yes	269	1	613	3
17. Bowels	Normal	Constipation, diarrhea, blood, mucus, white or normal stools	226	44	472	142
18. Micturition	Normal	Abnormal	263	7	581	33
19. Drugs for abdominal pain	No	Yes	268	2	589	25
20. Previous abdominal surgery	No	Yes	247	23	477	137
21. Previous abdominal diseases	No	Yes	249	21	516	98
22. Use of alcohol	No	Yes	268	2	581	33

Table III. *The clinical signs and tests of patients with acute appendicitis versus non-specific abdominal pain.*

Clinical signs and investigations	Positive endpoint	Negative endpoint	TP	FN	FP	TN
1. Mood	Normal	Distressed or anxious	233	37	537	77
2. Colour	Normal	Jaundiced, flushed, pale or cyanosed	245	25	556	58
3. Abdominal movement	Normal	Poor/nil	245	25	594	20
4. Scar	No	Yes	246	24	469	145
5. Distension	No	Yes	264	6	596	18
6. Tenderness (OMGE)	Right lower quadrant of abdomen	Other quadrants of abdomen	248	22	223	391
7. Mass	No	Yes	269	1	612	2
8. Rebound	Yes	No	247	23	180	434
9. Guarding	Yes	No	243	27	201	413
10. Rigidity	Yes	No	171	99	11	602
11. Murphy's positive	No	Yes	259	11	601	13
12. Bowel sounds	Normal	Abnormal	236	34	571	43
13. Renal tenderness	No	Yes	200	70	496	118
14. Rectal digital tenderness	Abnormal	Normal	142	128	147	467
15. Body temperature (Temp)	>37.1˚C	≤37.1˚C	175	90	210	352
16. Leucocyte count (LC)	>10,000/mm^3	≤10,000/mm^3	190	57	132	361
17. Urine	Normal	Haematuria or bacteriuria	241	1	543	6

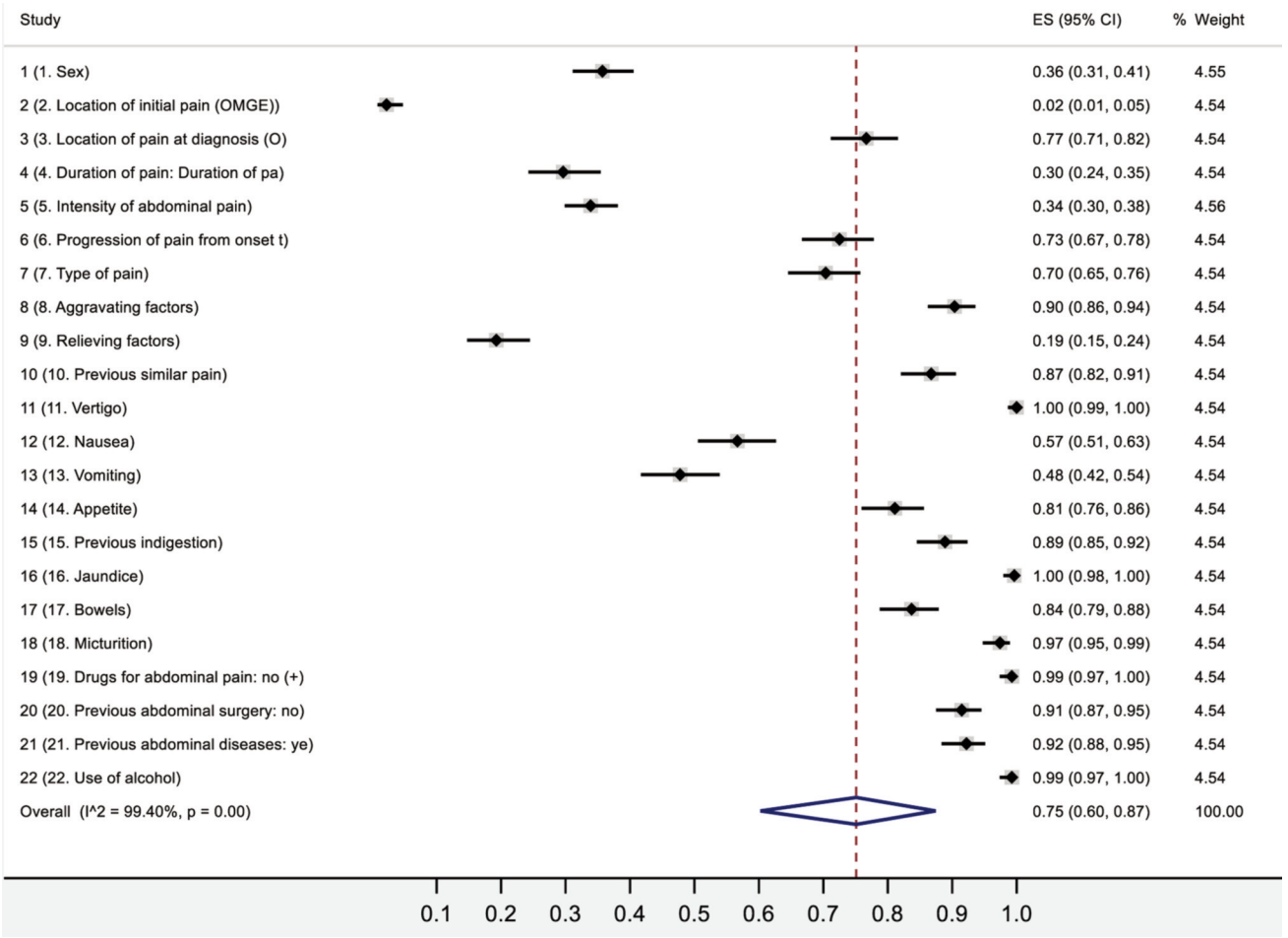

Figure 1. *Pooled sensitivities of the clinical symptoms in acute appendicitis (random-effects model). ES: Estimated sensitivity; CI: confidence interval.*

Table IV. *Diagnostic score without leucocyte count (DS_{LC-}) shown as six different combinations of symptoms, signs and test.*

Diagnostic score (DS)	Positive endpoint	Negative endpoint	TP	FN	FP	TN
1. Logistic model without leucocyte count DS I	Appendicitis	Non-specific abdominal pain	221	49	31	582
2. Logistic model without leucocyte count DS II	Appendicitis	Non-specific abdominal pain	227	43	40	573
3. Logistic model without leucocyte count DS III	Appendicitis	Non-specific abdominal pain	198	72	20	593
4. Logistic model without leucocyte count DS IV	Appendicitis	Non-specific abdominal pain	198	72	20	593
5. Logistic model without leucocyte count DS V	Appendicitis	Non-specific abdominal pain	231	39	59	554
6. Logistic model without leucocyte count DS VI	Appendicitis	Non-specific abdominal pain	170	100	10	603

Diagnostic score values from DS I to DS VI formulas refer to different combination of symptoms, signs and tests.

surgery (positive endpoint=1, negative endpoint=0)+6.91. The mean (SD) of DS_{LC-} values for AA (n=270) were –2.06 (2.2) and DS_{LC-} mean (SD) values for NSAP (n=613) were 3.38 (1.91). This DS_{LC-} formula shows Se of 82% (95%CI=77-86%) and Sp of 95% (95%CI=93-97%), which is the best diagnostic performance level for DS without LC (Figures 5 and 6).

Diagnostic performance of the DS with leucocytes (DS_{LC+}). The most powerful predictors were used to build up six different DS_{LC+} formulas for AA diagnosis (Table V). The pooled overall Se and Sp of these six DS_{LC+} models for AA diagnosis were 79% (95%CI=72-85%) and 95% (95%CI=93-97%) (Figures 7 and 8). At the best diagnostic performance

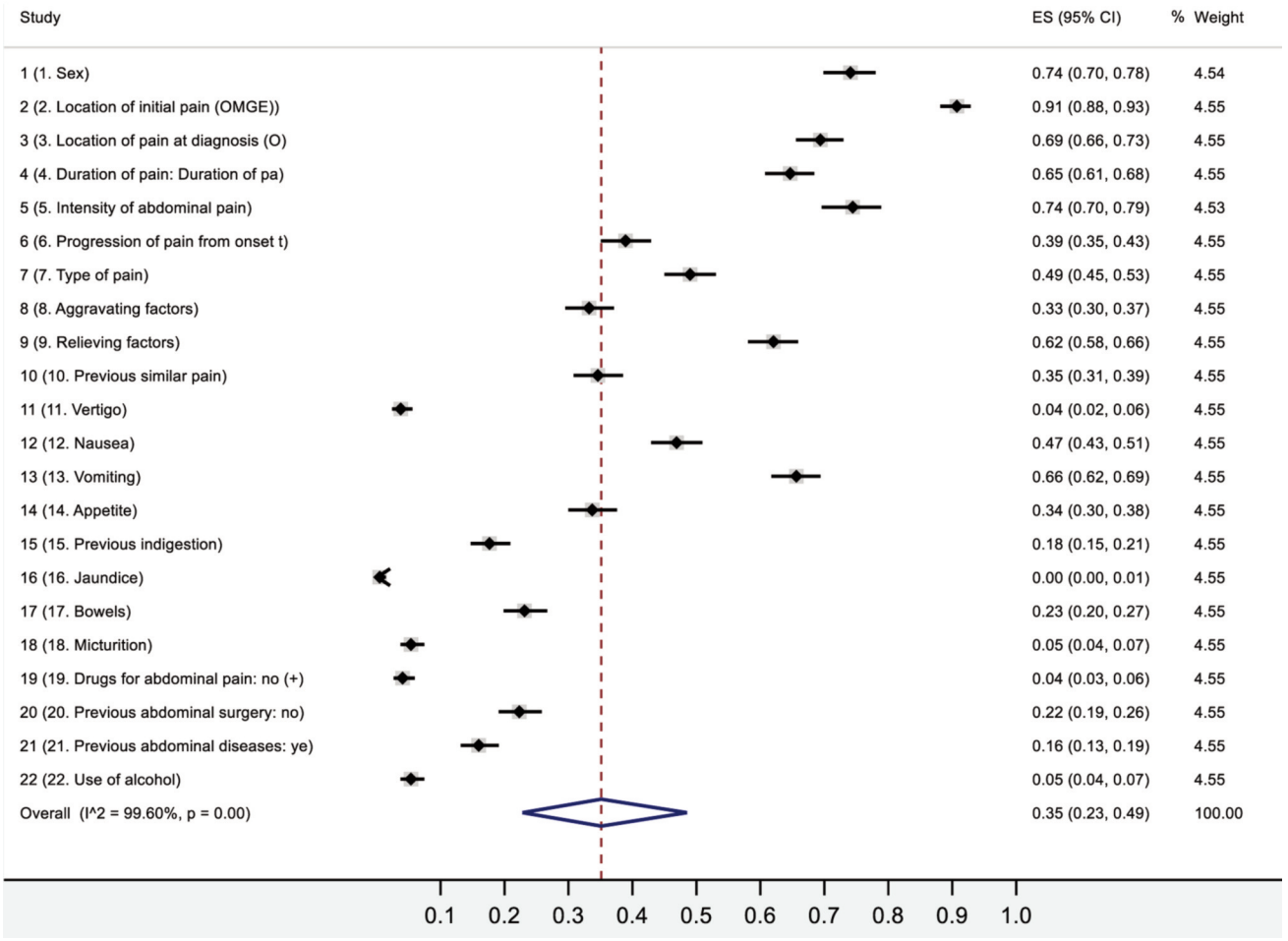

Figure 2. *Pooled specificities of the clinical symptoms in acute appendicitis (random-effects model). ES: Estimated sensitivity; CI: confidence interval.*

Table V. *Diagnostic score with leucocyte count (DS_{LC+}) shown as six different combinations of symptoms, signs and test.*

Diagnostic score (DS)	Positive endpoint	Negative endpoint	TP	FN	FP	TN
1. Logistic model with leucocyte count DS VII	Appendicitis	Non-specific abdominal pain	202	45	23	469
2. Logistic model with leucocyte count DS VIII	Appendicitis	Non-specific abdominal pain	205	42	30	462
3. Logistic model with leucocyte count DS IX	Appendicitis	Non-specific abdominal pain	191	56	20	472
4. Logistic model with leucocyte count DS X	Appendicitis	Non-specific abdominal pain	200	47	26	466
5. Logistic model with leucocyte count DS XI	Appendicitis	Non-specific abdominal pain	214	33	50	442
6. Logistic model with leucocyte count DS XII	Appendicitis	Non-specific abdominal pain	155	92	10	482

Diagnostic score values from DS VII to DS XII formulas refer to different combination of symptoms, signs and tests.

level for AA, the DS_{LC+} (formula DS VII, Figures 7 and 8) showed Se of 82% (95%CI=76-86%) and Sp of 95% (95%CI=93-97%), which is the best diagnostic performance level for DS with LC (Figures 7 and 8).

The Se of the best DS_{LC-} and DS_{LC+} formulas for detecting AA were equal: 82% (95%CI=77-86%) and 82% (95%CI=76-86%), respectively. The Sp of the best DS_{LC-} and DS_{LC+} formulas for detecting AA were identical: 95% (95%CI=93-97%) and 95% (95%CI=93-97%). The formula with LC (DS_{LC+}) showing the highest diagnostic performance for AA in HSROC analysis (Figure 7) is the following: DS_{LC+}=−0.95×location of pain at diagnosis (positive endpoint=1,

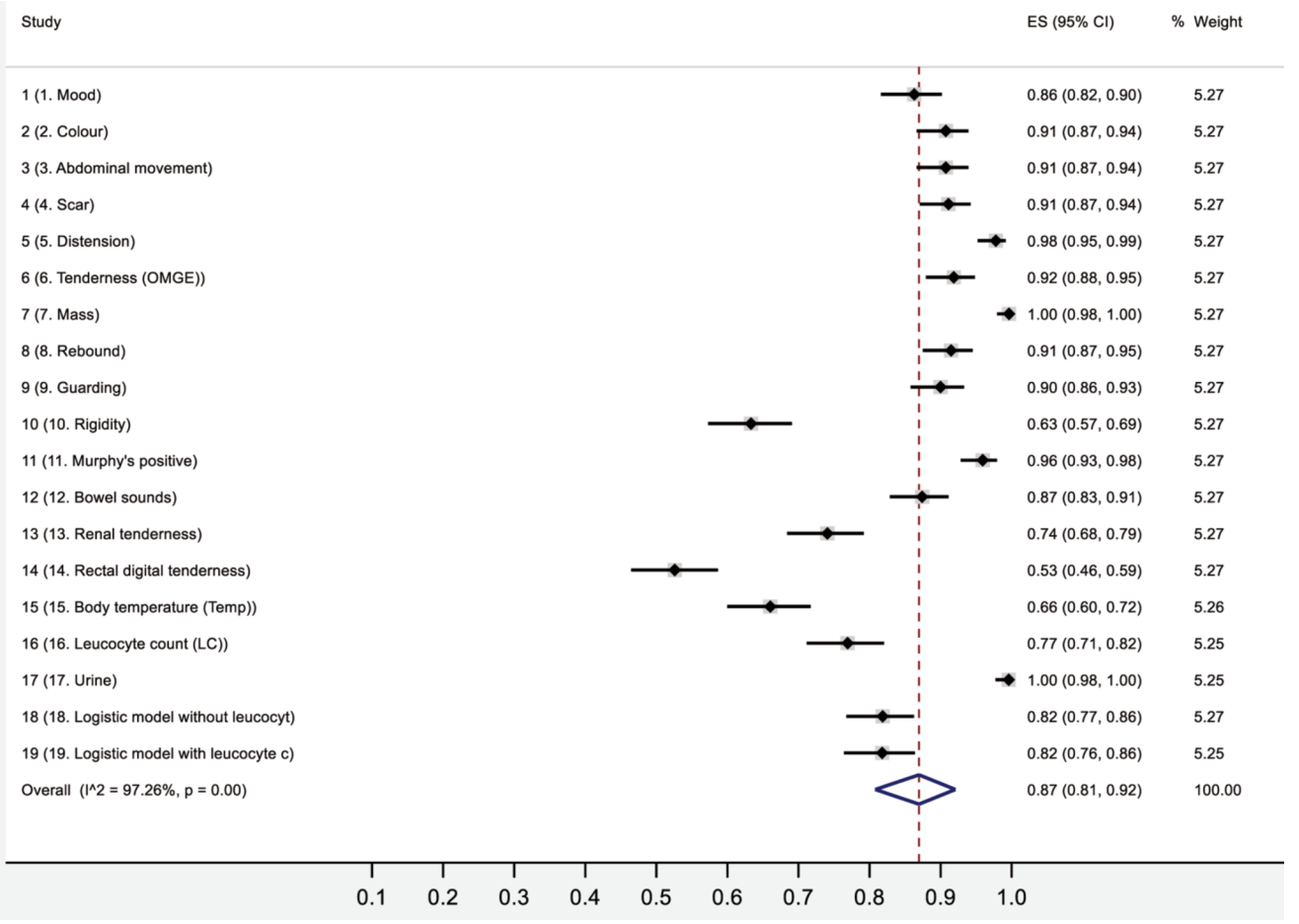

Figure 3. *Pooled sensitivities of the clinical signs and tests in acute appendicitis (random-effects model). ES: Estimated sensitivity; CI: confidence interval.*

negative endpoint=0), –1.77×previous abdominal surgery (positive endpoint=1, negative endpoint=0), –1.16×rebound (positive endpoint=1, negative endpoint=0), –1.61×guarding (positive endpoint=1, negative endpoint=0), –3.32×rigidity (positive endpoint=1, negative endpoint=0), –0.97×tenderness (positive endpoint=1, negative endpoint=0) and –2.2×LC (positive endpoint=1, negative endpoint=0)+7.035. The mean (SD) of DS_{LC+} values for AA (n=247) were –2.50 (2.27) and DS_{LC+} mean (SD) values for NSAP (n=492) were 3.38 (2.12) (Figures 7 and 8).

HSROC analyses and empirical Bayes (EB) estimates. STATA (metandiplot algorithm) was used to draw the HSROC curves and empirical Bayes (EB) estimates to visualise the comparison of the pooled overall diagnostic performance of the diagnostic symptoms with the clinical signs and tests in AA diagnosis (Figures 9, 10, 11, and 12). HSROC curves and HSROC-EB estimates were also used to compare the pooled overall diagnostic performance of the different DS formulas in detecting AA (Figures 13, 14, 15, and 16). In the HSROC analysis, there was no statistically significant difference between the $DS_{LC–}$ and DS_{LC+} formulas, with AUC=0.860 (95%CI=0.85-0.86) and AUC=0.870 (95%CI=0.86-0.88), respectively (p=0.799, ROC comparison test).

Discussion

In this analysis, we focused on the diagnostic performance of the patients' symptoms/signs and DS in a clinical setting of patients with acute abdominal pain. The present study compared all predictive factors for AA diagnosis including 22 clinical symptoms and history variables with 14 diagnostic tests or signs. Sensitivity was defined as the proportion of AA positive patients among those who were diagnosed with the outcome of interest. Specificity referred to the number of participants with negative AA test results divided by the number of participants without AA.

Although there is a general impression that DS_{LC+} performs better than $DS_{LC–}$, limited data on the performance

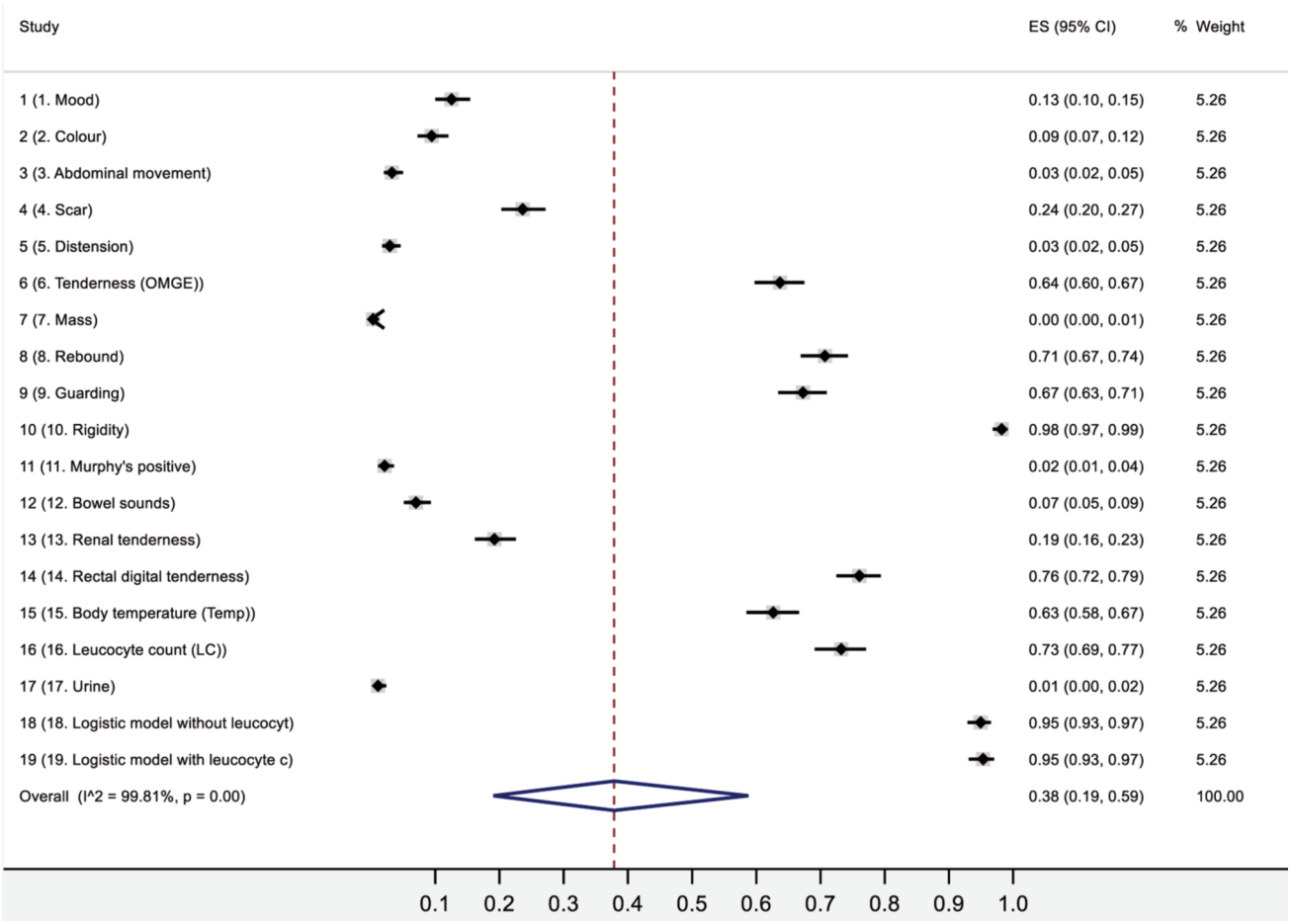

Figure 4. *Pooled sensitivities of the clinical signs and tests in acute appendicitis (random-effects model). ES: Estimated sensitivity; CI: confidence interval.*

of DS makes it difficult to decide which DS test to choose in the clinical diagnosis of AA to keep both negative appendectomy rate low (FP rate) and perforated appendix rate (FN rate) at a minimum. To improve the diagnostic performance in AA, such inflammatory biomarkers as LC and C-reactive protein (CRP) have been included in the DS models as in Alvarado score (6). We feel that LC is more sensitive in early AA than CRP, which is related to the severity of the AA and is a possible biomarker of AA perforation.

Alvarado's DS is based on retrospective data of 305 patients with AAP and included 8 predictive factors for AA, each given a value of 1 point or 2 points based on the diagnostic weight for AA. One point was given for shifting of pain to the right lower quadrant (RLQ), anorexia, nausea or vomiting, rebound, body temperature >37.3˚C and LC left shift. Two points were given for tenderness at RLQ and LC>10,000/μl. Alvarado's recommendations for management of AA patients are based on the sum of the points of these eight variables. Alvarado score between 7 and 8 suggests that "AA probable" and the score between 9 and 10 denotes "AA very probable". In a meta-analysis, Ohle *et al*. (11) estimated that Alvarado score has 82% Se and 81% Sp at the score 7 cut-off level.

We have studied AAP in connection with the survey of OMGE (1) and investigated the diagnostic performance of history-taking, clinical signs and tests and computer-based decision in confirming AA (2). In Finland, a total of 1,333 patients presenting with AAP were included in the OMGE study (1) and 25 clinical history variables, 13 clinical signs and 3 tests were evaluated in multivariate analyses to find the optimal combinations of independent predictors of AA. The most important predictors of AA were tenderness, rigidity, rebound, LC, location of pain and duration of pain. In practice, the use of DS is relatively simple as shown by the following; "A patient is admitted to the emergency room with abdominal pain of ≤48 h duration (2 points×2,13); at onset the pain was localized in the upper abdomen, but has shifted to RLQ (2 points×3.51); clinical examination showed RLQ tenderness (2 points×11.4) and rigidity (2

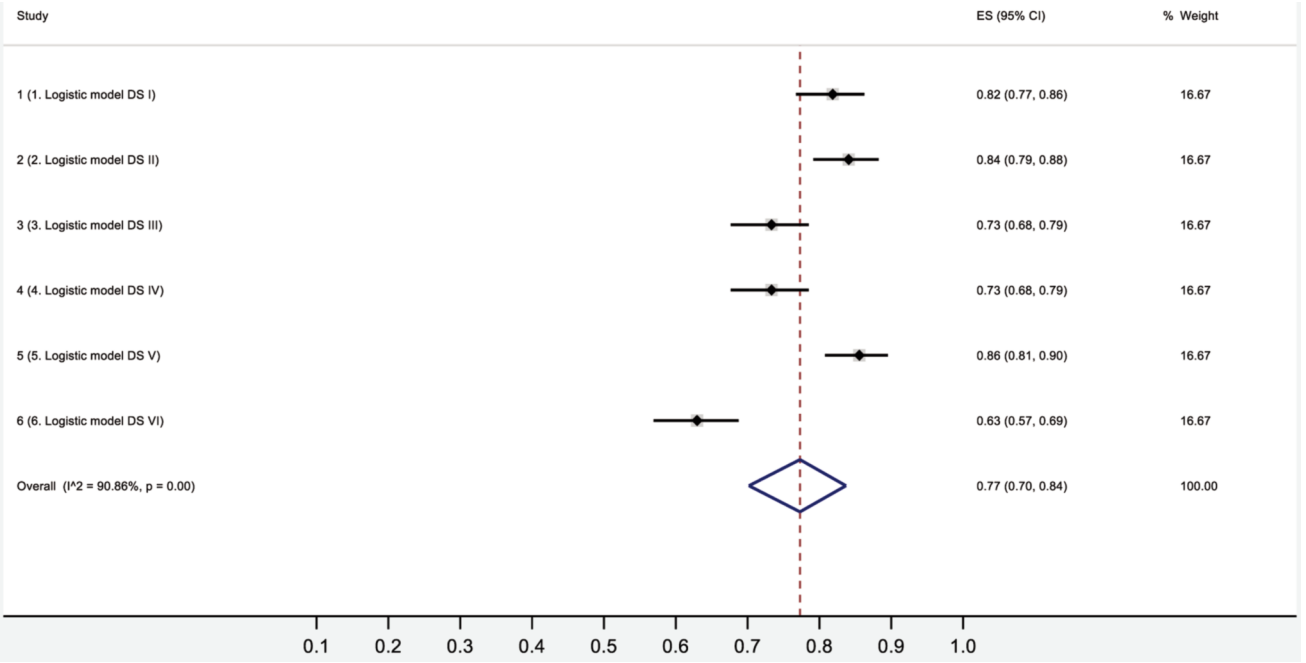

Figure 5. *Sensitivities of diagnostic scores without leucocyte count (DSLC–) shown as six different combination of symptoms, signs and test.*

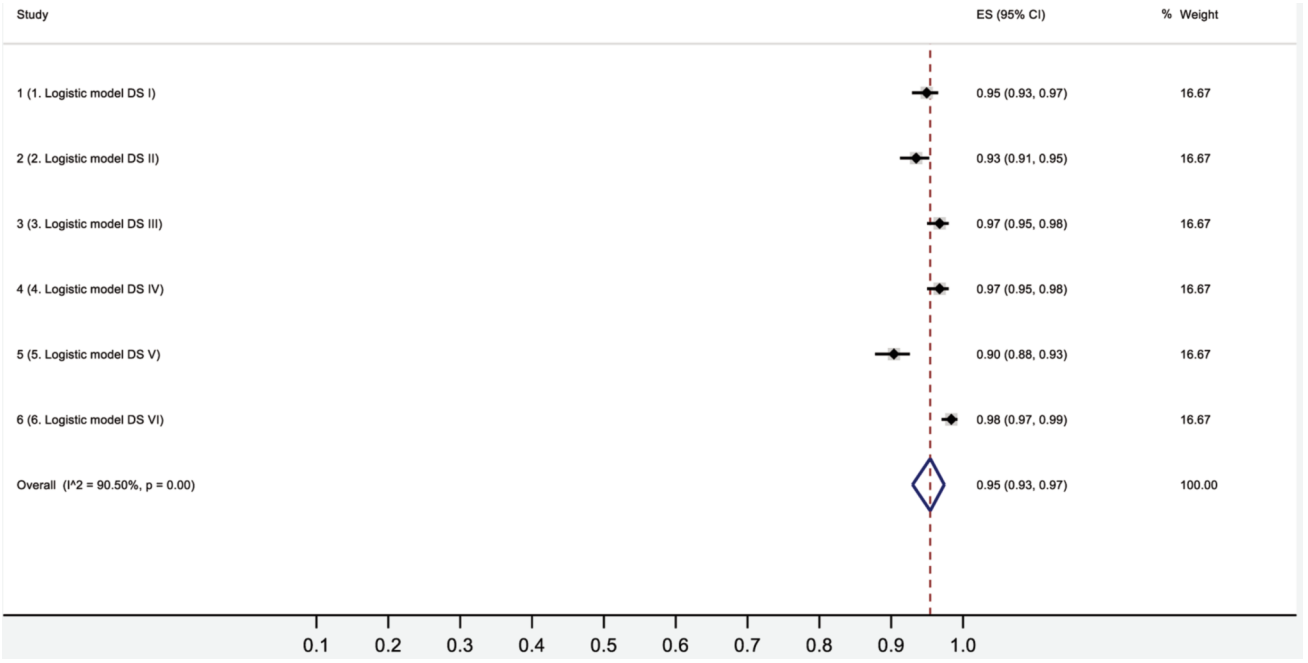

Figure 6. *Specificities of diagnostic scores without leucocyte count ($DS_{LC–}$) shown as six different combination of symptoms, signs and test.*

points×6.62), and the rebound tests were positive (2 points×5.58); LC test showed positive value (≥10,000/μl, 5.87). In this example, the total score is 67 points and diagnosis is AA. Our original cut-off level for AA was 55 points (2). Sitter *et al.* (8) tested our DS in a prospective trial including 2,359 patients with AAP. After careful analysis they suggested a higher cut-off value of 57 points, which gives 91% AUC for the AA endpoint.

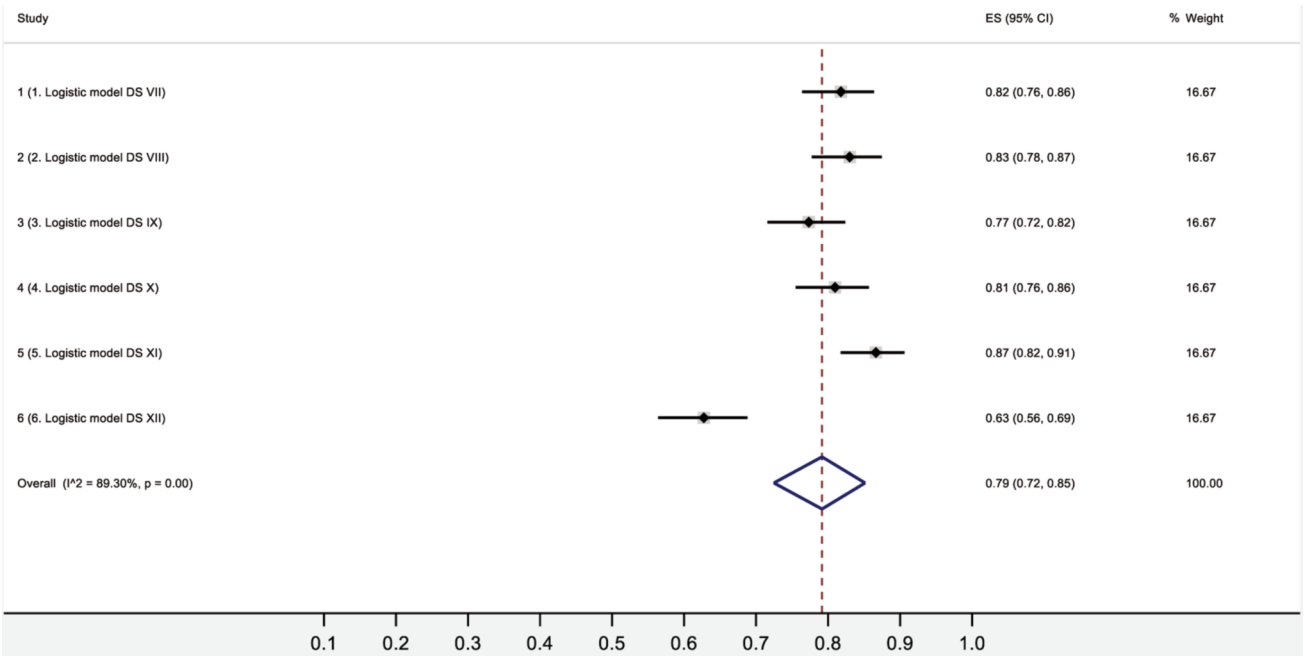

Figure 7. *Sensitivities of diagnostic scores with leucocyte count (DS_{LC+}) shown as six different combinations of symptoms, signs and test.*

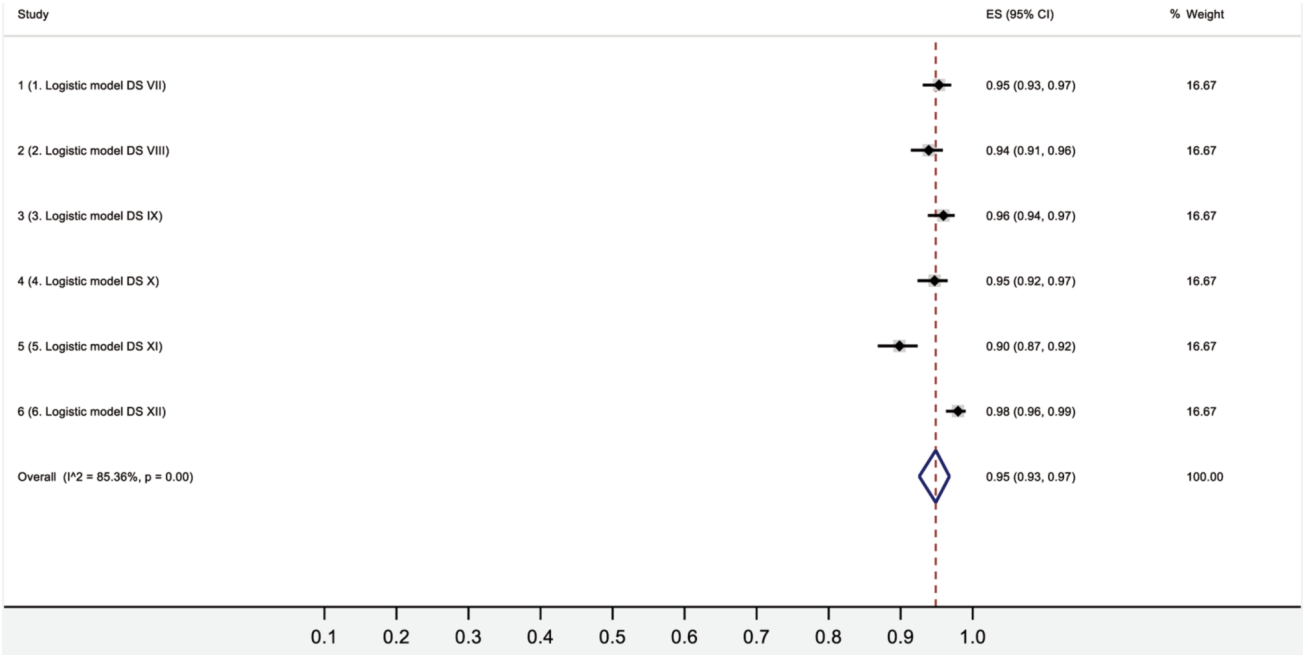

Figure 8. *Specificities of diagnostic scores with leucocyte count (DS_{LC+}) shown as six different combinations of symptoms, signs and tests.*

Ohmann *et al*. (7) formulated a DS including 8 factors; Age <50 years, shifting of pain to RLQ, type of pain (steady), micturition (normal), tenderness, rebound, rigidity, LC≥10,000/μl. However, when tested in a clinical setting, the Ohmann score did not significantly improve the clinical performance of AA diagnosis (7).

Tzanakis *et al*. (10) introduced DS for AA diagnosis using a combination of clinical tests for tenderness and rebound in

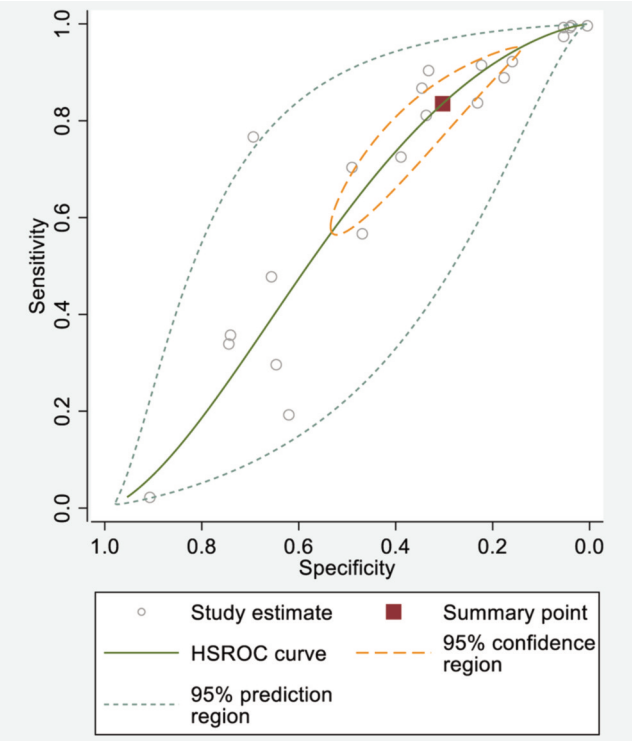

Figure 9. *Hierarchical summary receiver operating characteristic (HSROC) curve of the clinical symptoms.*

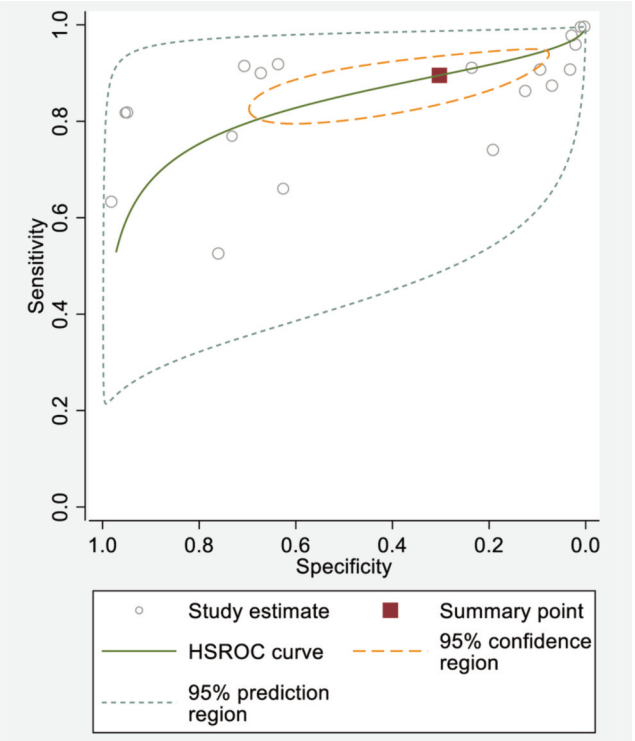

Figure 11. *Hierarchical summary receiver operating characteristic (HSROC) curve of the clinical signs and tests.*

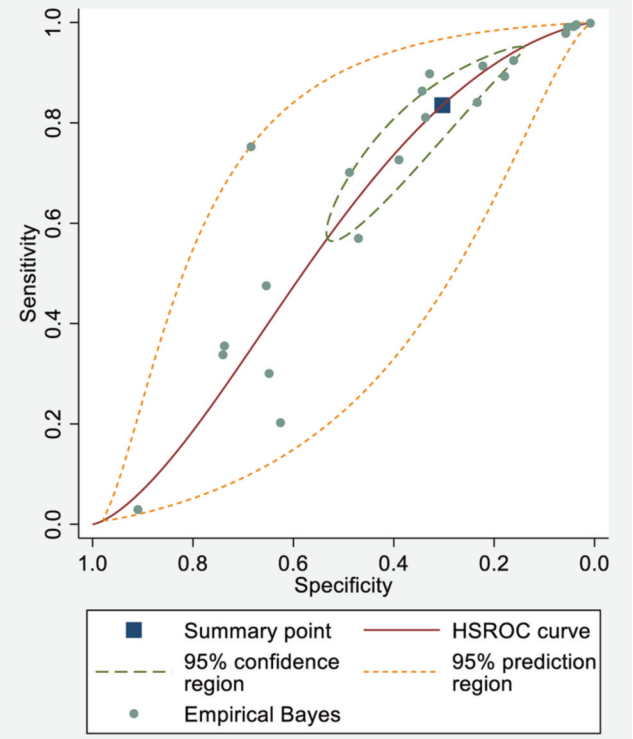

Figure 10. *Hierarchical summary receiver operating characteristic (HSROC) and Empirical Bayes curves of the clinical symptoms.*

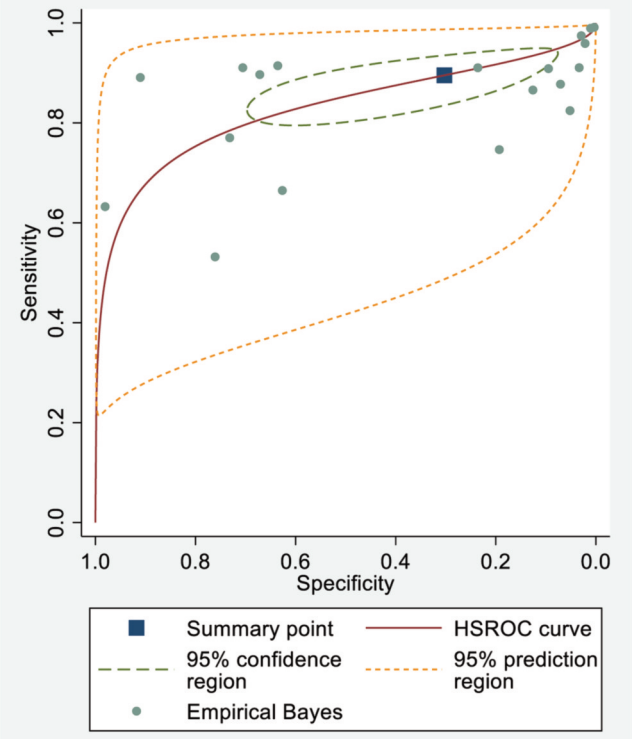

Figure 12. *Hierarchical summary receiver operating characteristic (HSROC) and Empirical Bayes curves of the clinical signs and tests.*

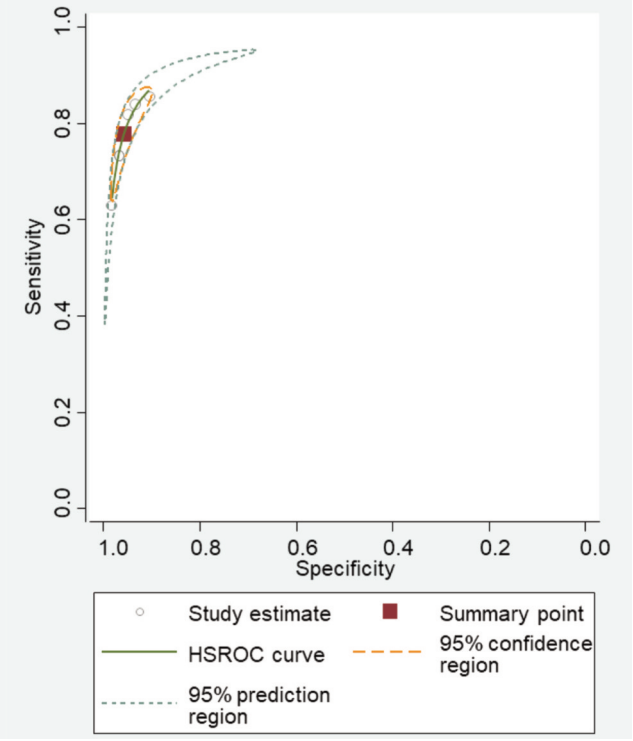

Figure 13. *Hierarchical summary receiver operating characteristic (HSROC) curve of the six DS_{LC-} tests.*

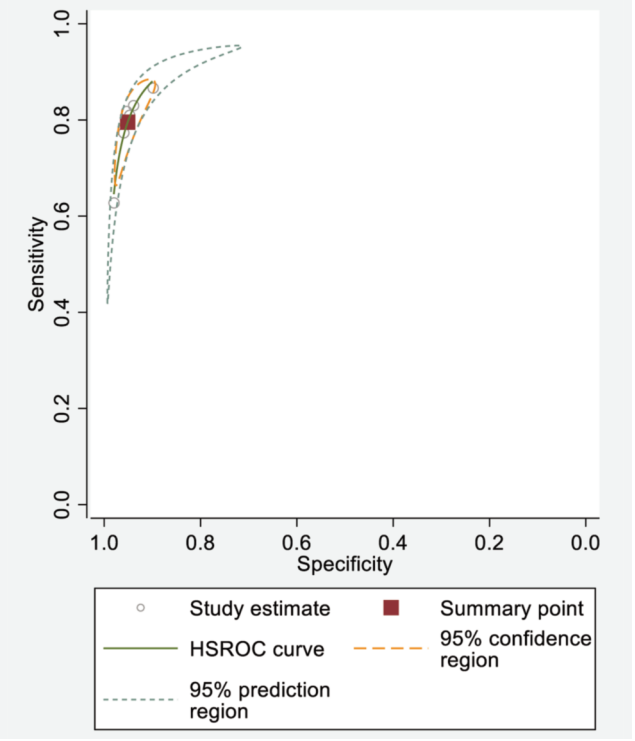

Figure 15. *Hierarchical summary receiver operating characteristic (HSROC) curve of the six DS_{LC+} tests.*

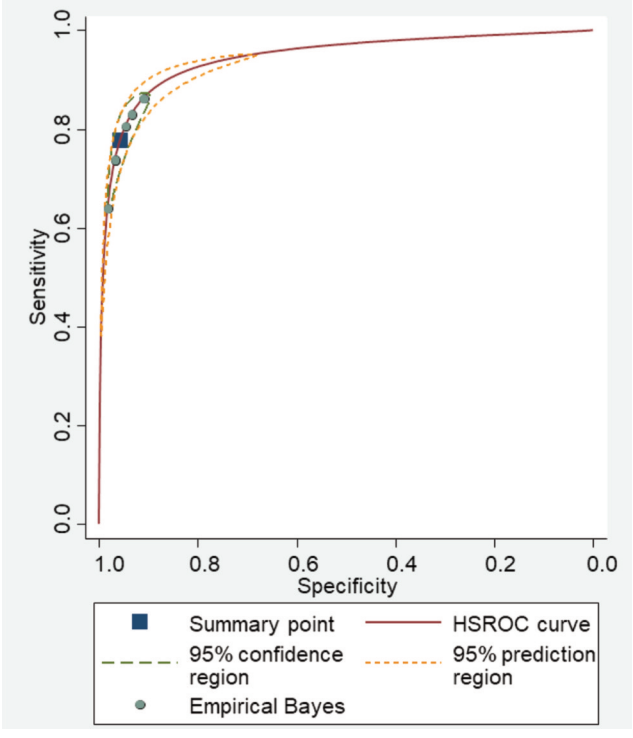

Figure 14. *HSROC-Empirical Bayes Figure 5. Hierarchical summary receiver operating characteristic (HSROC) and Empirical Bayes curves of the six DS_{LC-} tests.*

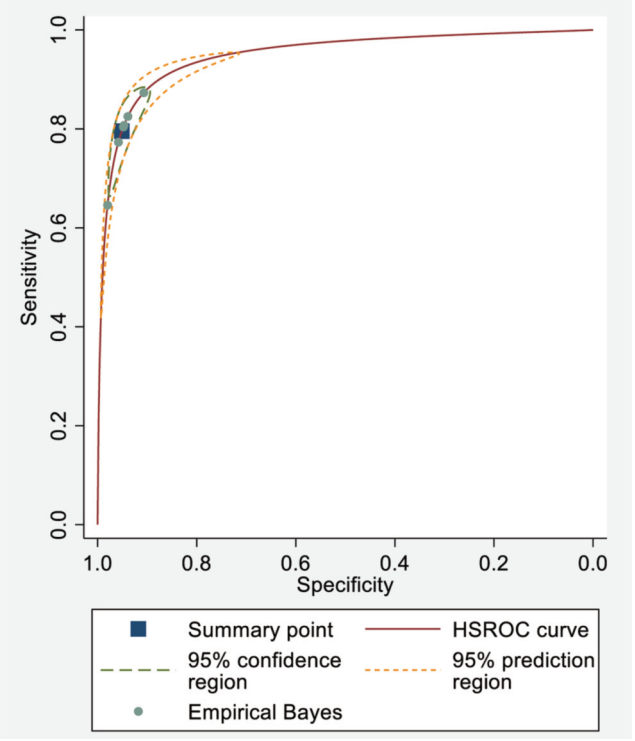

Figure 16. *Hierarchical summary receiver operating characteristic (HSROC) and Empirical Bayes curves of the six DS_{LC+} tests.*

combination with abdominal ultrasound examination (US) and LC (cut-off >12,000/μl). When tested in a clinical setting, their DS reached 90% AUC for the AA endpoint. Although US is less expensive than other imaging methods, its diagnostic performance still remains questionable, especially in borderline US findings and in problems to visualize retrocaecal appendix (12). In a prospective multicenter trial of 2,280 patients with AAP, Franke *et al*. (12) reported no correlation between the diagnostic performance of US and a clinician, and the negative appendectomy or perforation rate, thus showing no clear benefit of US in AA diagnosis. In another study, Lee *et al*. (13) found US to even delay appendectomy in a cohort of 766 patients.

In our study, the LC test showed Se of 82% (95%CI=76-86%) and Sp of 95% (95%CI=93-97%), suggesting that the routine determination of the total number of leucocytes and their relative ratio could help in AA diagnosis. However, the delay of appendectomy should be kept in mind, especially when the LC is not fully necessary to support the AA diagnosis. To find the optimal combination of symptoms, signs and tests in the DS formula, we compared the DS_{LC-} and DS_{LC+} models at six different combinations of predictors. No significant difference in performance between DS_{LC-} and DS_{LC+} formulas were detected. In the AA endpoint, DS_{LC-} and DS_{LC+} formulas showed almost equal AUC values in HSROC analysis (0.86 *versus* 0.87, p=0.799).

The new diagnostic strategies of AA, beside the DS formulas and US may include interleukin 6 (IL-6), which is an early marker of inflammation. IL-6 blood levels were shown to increase even 3-fold from the IL-6 reference levels in 90% of the patients with perforated appendicitis (14, 15). Anielski *et al*. (15) found significantly higher IL-6 serum levels in patients with gangrenous perforated AA, suggesting that IL-6 test could be useful in assessing the risk of complications during the course of AA. Although, the IL-6 results are promising, the current enzyme-linked immunosorbent assay (ELISA) precludes its use as a point-of-care (POC) test in AA so far (16, 17).

In conclusion, the DS test could assist the clinician in differentiating AA from NSAP and other causes of acute abdominal pain. Importantly, LC does not improve the diagnostic performance of a DS in AA.

Conflicts of Interest

The Authors report no conflicts of interest or financial ties in relation to this study. The Authors alone are responsible for the content and writing of this article.

Authors' Contributions

All Authors have met all of the following four criteria: 1. Substantial contributions to the conception or design of the work or the acquisition, analysis, or interpretation of data for the work, 2. Drafting the work or revising it critically for important intellectual content, 3. Final approval of the version to be published, 4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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