Supplementary Material

Title: R-PREDICT-STOMA: Performance of clinical stoma scores for the incidence of anastomotic leakage after robotic rectal resection

Journal: Techniques in Coloproctology

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Table S1 Final search strategies for the systematic review

Database	Date	Search strategy	Records identified
PubMed	May 19, 2026	(("Rectal Neoplasms/surgery"[Mesh] OR "rectal resection"[tiab] OR "low anterior resection"[tiab] OR "total mesorectal excision"[tiab] OR TME[tiab]) AND ("Anastomotic Leak"[Mesh] OR "anastomotic leak*"[tiab] OR "anastomotic leakage"[tiab]) AND ("Risk Factors"[Mesh] OR "risk factor*"[tiab] OR "predictive factor*"[tiab] OR predictor*[tiab] OR "associated factor*"[tiab]))	759
Cochrane CENTRAL	May 19, 2026	("low anterior resection" OR "rectal resection" OR "total mesorectal excision") AND ("anastomotic leak*" OR "anastomotic leakage") AND ("risk factor*" OR predictor* OR "predictive factor*")	48
Embase	May 19, 2026	('rectal resection'/exp OR 'rectal resection' OR 'low anterior resection'/exp OR 'low anterior resection' OR 'total mesorectal excision'/exp OR 'total mesorectal excision') AND ('anastomotic leak*' OR 'anastomotic leakage'/exp OR 'anastomotic leakage') AND ('risk factor'/exp OR 'risk factor*' OR 'predictive factor*' OR predictor*)	1284
Web of science	May 19, 2026	(("rectal resection" OR "low anterior resection" OR "total mesorectal excision") AND ("anastomotic leak*" OR "anastomotic leakage") AND ("risk factor*" OR "predictive factor*" OR predictor*))	1274

Table S2 Modified NOS-Scale

Categories	Definition	Points
SELECTION		**(max 4★)**
S1 Representativeness of the exposed cohort		
a) Representative	All eligible patients of the target population within a clearly defined period, or an evidently representative series (e.g. consecutive recruitment, registry, or multicentre cohort), with no sign of selection-driven recruitment.	★
b) Partly representative	Single-centre cohort with a clearly defined recruitment period and complete capture of eligible patients, but without an explicit statement of consecutive recruitment.	★
c) Selective cohort	A subset of a broader treated population selected on pre-operative patient-, tumour-, or surgery-related features likely to correlate with the exposure or outcome (e.g. only laparoscopic patients when open surgery was also performed; only high-risk patients; only neoadjuvant patients drawn from a wider cohort). Exclusion that targets the exposure/outcome measurement itself (e.g. missing CT when CT is the exposure) also scores 0. Exclusion of APR / Hartmann / local excision is never a reason for 0 (no anastomosis = no AL risk = Type-a exclusion).	
d) No description	No recruitment info and no database/registry info — cohort origin unclear.	
S2 Selection of non-exposed cohort		
a) Same population	NAL patients from the same rectal-cancer cohort as AL patients (retrospective without explicit source but clinically plausible also qualifies).	★
b) Different population	External/historical comparison group.	
c) No description	No information on the comparison group's origin.	
S3 Ascertainment of exposure		
a) Secure source	Medical records, prospective database, registry, or electronic health record.	★
b) Structured interview	Exposure ascertained by interview.	
c) Self-report	Exposure ascertained by patient self-report.	
d) No description	Source of exposure data not described.	
S4 Outcome not present at start		
a) Yes	AL arose postoperatively — by definition met for postoperative-complication studies.	★
COMPARABILITY		**(max 2★)**
C1 Adjustment for basic confounders		
a) Multivariable	Multivariable analysis or propensity-score matching adjusting for ≥1 basic confounder: age, sex, BMI, ASA / relevant comorbidity (e.g. CCI), or diabetes. Only variables actually entered in the final model / matching set are counted.	★
b) Univariable	Univariate analysis only.	
c) No basic Confounder	No relevant basic confounder adjusted for.	
C2 Adjustment for tumour-/surgery confounders*		
a) Multivariable	Additionally adjusts for ≥1 tumour-/surgery confounder: tumour height / anastomotic height, neoadjuvant CRT, or tumour stage.	★
b) Univariable	Univariate analysis only.	
c) None / Star 1 not awarded	No such confounder adjusted for, or the first star was not awarded.	
OUTCOME		**(max 3★)**
O1 Assessment of outcome		
a) Independent / secure	Independent or secure documentation for every leak: medical record, operative report, radiological confirmation, reoperation, or ISREC classification.	★
b) Clinical only	Only diagnosed clinically.	
c) No description	No information provided on the duration of outcome assessment.	
O2 Follow-up long enough for the outcome to occur		

Categories	Definition	Points
a) Adequate	Explicit ≥30-day follow-up, or 30-day morbidity/mortality reported (implies ≥30 days), or a protocol-driven examination at a fixed time point ≥30 days postoperatively scheduled for all (or practically all) patients — e.g. routine contrast enema/endoscopy before stoma closure, or control rectoscopy at 6 weeks — since leaks remained detectable up to that point.	★
b) Inadequate	In-hospital stay only.	
c) No description	No information provided on the duration of follow-up.	
O3 Adequacy / completeness of follow-up		
a) Complete	Registry / national database, or explicit <20% loss to follow-up, or a retrospective/prospective cohort with consecutive/complete recruitment and no sign of relevant loss.	★
b) Incomplete	Single-centre with no loss-to-follow-up figure and not consecutive.	
c) No description	No information provided on the completeness of follow-up.	
TOTAL		
H	High quality	**7-9**
M	Moderate	**5-6**
L	Low quality	**≤4**

*If a listed variable is itself the studied exposure (e.g. BMI, smoking), its non-adjustment is NOT a flaw; judge by adjustment of the OTHER relevant confounders.

Table S3 Characteristics of the studies included in the systematic review

Characteristic	Overall
Number of included studies	101
Total number of patients	197 685
Median study sample size [IQR][a]	496 [230–1063]
Countries represented	25
Publication period	1998–2026
Study design	
Retrospective cohort studies	88
Prospective cohort studies	10
Other study designs	3
Study setting	
Single-center studies	79
Multi-center studies	16
Population-based registry studies	6
Maximum study population	72 055

[a] Median and IQR calculated after exclusion of one outlier study (n = 72 055 patients); this study is reported separately as the maximum study population.

IQR, interquartile range.

Table S4 Anastomotic leakage rates across the included studies

Characteristic	Overall
Number of included studies	101
Median anastomotic leakage rate	9.3%
Interquartile range	6.4–11.9%
Minimum	2.3%
Maximum	21.5%

Table S5 Laboratory Parameters

Variable	Valid cases	**Total Cohort n = 233** Median [IQR] or number (%)	**AL n = 50** Median [IQR] or number (%)	**NAL n = 183** Median [IQR] or number (%)	p-value[a]	d_{Cohen}	Test Statistic	Z
Pre-Operative								
Leukocytes (10^3/uL)	233	6.6 [2.7]	6.9 [3.7]	6.5 [2.7]	.15		5183	1.44
Hemoglobin [g/dL]	233	13.2 [2.6]	13.0 [3.4]	13.3 [2.5]	.126		3928	-1.532
Thrombocytes [10^3/uL]	233	246 [108]	274 [125]	243 [91]	.305		5008	1.025
Quick [%]	232	97.5 [17]	98 [11.5]	97 [18.3]	.714		4396	-.367
Creatinine [mg/dL]	233	.9 [.3]	1.0 [.3]	.9 [.4]	.157		5167.5	1.415
CRP (mg/dL)	233	.3 [.6]	.5 [1.4]	.3 [.5]	**<.001**	.446	5954	3.321
CEA (ng/mL)	219	2.7 [4.4]	3.2 [6.1]	2.6 [4.1]	.339		4475	.957
CA 19-9 (U/mL)	215	11.2 [17.6]	16.8 [29.7]	10.5 [13.4]	**.002**	.431	5180	3.086
Post-Operative								
CEA [ng/mL]	155	1.9 [2]	1.8 [1.9]	1.9 [2.0]	.87		1975.5	-.164
CA 19-9 (U/mL)	131	9.7 [13.3]	10.6 [16.4]	9.7 [13.6]	.302		1626	1.033

[a] Statistics were performed by Mann-Whitney-U-Test, as appropriate.

CA 19-9, carbohydrate antigen 19-9; CEA, carcinoembryonic antigen; CRP, C-reactive protein; AL, anastomotic leakage; NAL, no anastomotic leakage; IQR, interquartile range; SD, standard deviation; U, Mann-Whitney U test statistic; Z, standardized test statistic.

Table S6 Histopathological Characteristic and Radiotherapy

Variable	Valid cases	Total Cohort n = 233 Median [IQR] or number (%)*	AL n = 50 Median [IQR] or number (%)*	NAL n = 183 Median [IQR] or number (%)*	p-value[a]	d_{Cohen}	Phi	Test Statistic	df/Z
Entity	233								
Carcinoma		233 (100)	50 (100)	183 (100)					
UICC	233	2 [2]	2 [1]	2 [2]	.079			5289	1.759
UICC 0		7 (3)	2 (4)	5 (2.7)					
UICC I		68 (29.2)	9 (18)	59 (32.2)					
UICC II		75 (32.2)	17 (34)	58 (31.7)					
UICC III		60 (25.8)	15 (30)	45 (24.6)					
UICC IV		23 (9.9)	7 (14)	16 (8.7)					
T4	233	20 (8.6)	4 (8)	16 (8.7)	.868			.028	1
R1[b]	233	4 (1.7)	1 (2)	3 (1.6)	1.000				
Tumor size[c] [cm]	216	3.5 [2.4]	4.0 [3.6]	3.5 [2.2]	.264			4329.5	1.117
CRM	233								
Positive		2 (0.9)	1 (2)	1 (0.5)	.384			–	–
Mercury classification[d]	233				.732			4630.5	.343
Grade 1		221 (94.8)	47 (94)	174 (95.1)					
Grade 2		8 (3.4)	1 (2)	7 (3.8)					
Grade 3		4 (1.7)	2 (4)	2 (1.1)					
DRM (cm)	219	3 [3]	2.8 [3.5]	3.2 [3]	.497			3658	-.679
Radiotherapy [neoadjuvant]	233	62 (26.6)	17 (34)	45 (24.6)	.182			1.781	1

[a] Statistics were performed by Fisher's exact test, Chi² test, Man-Whitney U-Test or Kruskal-Wallis-test, as appropriate.
[b] R1, microscopic residual disease.
[c] Reported as maximal diameter.
[d] According to Mercury score classification.

CRM, circumferential resection margin; DRM, distal resection margin; UICC, Union for International Cancer Control. AL, anastomotic leakage; NAL, no anastomotic leakage; IQR, interquartile range; SD, standard deviation; df, degrees of freedom; U, Mann-Whitney U test statistic; Z, standardized test statistic.

Table S7 Intraoperative Characteristics related to anastomosis and restoration of continuity

Variable	Valid cases	Total Cohort n = 233 Median [IQR] or number (%)	AL n = 50 Median [IQR] or number (%)	NAL n = 183 Median [IQR] or number (%)	p-value[a]	Phi	Test Statistic	df/Z
Linear-Stapler [number of magazines]	202	2 [1]	2 [2]	2 [1]	.195		3813.5	1.296
1		68 (33.7)	15 (34.9)	53 (33.3)				
2		109 (54.0)	16 (37.2)	93 (58.5)				
3		22 (10.9)	11 (25.6)	11 (6.9)				
4		2 (1.0)	1 (2.3)	1 (0.6)				
5		1 (0.5)	0 (0)	1 (0.6)				
Linear-Stapler [≥ 2 numbers of magazines]	202	134 (66.3)	28 (65.1)	106 (66.7)	.849		.036	1
Circular stapler diameter [mm]	216				.049		4433.5	1.965
29		122 (56.5)	21 (47.7)	101 (58.7)				
31		53 (24.5)	8 (18.2)	45 (26.2)				
33		41 (19.0)	15 (34.1)	26 (15.1)				
Blood transfusion intraoperative	233	2 (0.9)	1 (2)	1 (0.5)	.384		–	–
Blood loss [mL]	233	20 [50]	25 [100]	20 [50]	.285		4995.5	1.07

[a] Statistics were performed by Fisher's exact test, Chi² test, Man-Whitney U-Test or Kruskal-Wallis-test, as appropriate

AL, anastomotic leakage; NAL, no anastomotic leakage; IQR, interquartile range; SD, standard deviation; df, degrees of freedom; U, Mann-Whitney U test statistic; Z, standardized test statistic.

Table S8 Contingency table of the Stoma Score 1 and anastomotic leakage

Variable	AL n = 50	NAL n = 183	Total
Stoma Score ≥ 1.5 (Test positive)	33 (TP)	90 (FP)	123
Stoma Score < 1.5 (Test negative)	17 (FN)	93 (TN)	110
Total	50	183	233

The cutoff value of ≥ 1.5 was derived from receiver operating characteristic (ROC) curve analysis using the Youden index.

TP, True positive; FP, False positive; FN, False negative; TN, True negative; AL, anastomotic leakage; NAL, no anastomotic leakage; IQR, interquartile range; SD, standard deviation.

Table S9 Contingency table of the Stoma Score 4 and anastomotic leakage

Variable	AL n = 50	NAL n = 183	Total
Stoma Score ≥ 1.5 (Test positive)	39 (TP)	109 (FP)	148
Stoma Score < 1.5 (Test negative)	11 (FN)	74 (TN)	85
Total	50	183	233

The cutoff value of ≥ 1.5 was derived from receiver operating characteristic (ROC) curve analysis using the Youden index.

TP, True positive; FP, False positive; FN, False negative; TN, True negative; AL, anastomotic leakage; NAL, no anastomotic leakage; IQR, interquartile range; SD, standard deviation.

Table S10 Univariable Logistic Regression of StS4 for Anastomotic Leakage

Stoma Score	B	SE	Wald	p-value[a]	OR	CI for OR lower bound	CI for OR upper bound
Stoma Score 4	.226	.103	4.799	**.028**	1.253	1.024	1.534

[a] Statistics were performed by binary logistic regression analysis

Model statistics: $\chi^2 = 4.78$, $p = .029$; Nagelkerke $R^2 = .031$; Hosmer–Lemeshow $\chi^2 = 1.612$, $p > .05$.
Linearity of the logit was confirmed using the Box-Tidwell procedure ($p = .37$).

OR, Odds ratio; CI, Confidence interval; AL, anastomotic leakage; NAL, no anastomotic leakage.

Figure S1 Geographic distribution of included studies.

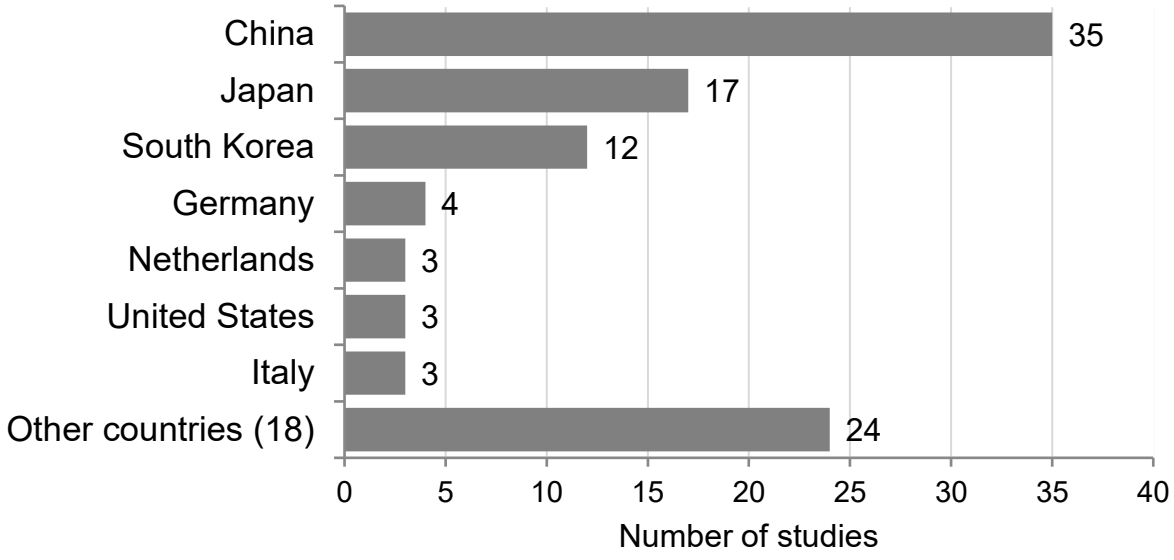


Figure S1 The included studies originated from 25 countries, 70 (69.3%) were conducted in Asian countries, including China (n = 35), Japan (n = 17), South Korea (n = 12), Iran (n = 2), Taiwan (n = 2), India (n = 1), and Saudi Arabia (n = 1).

Figure S2 Frequency of reported risk factors for anastomotic leakage among studies providing high-level evidence in the systematic review.

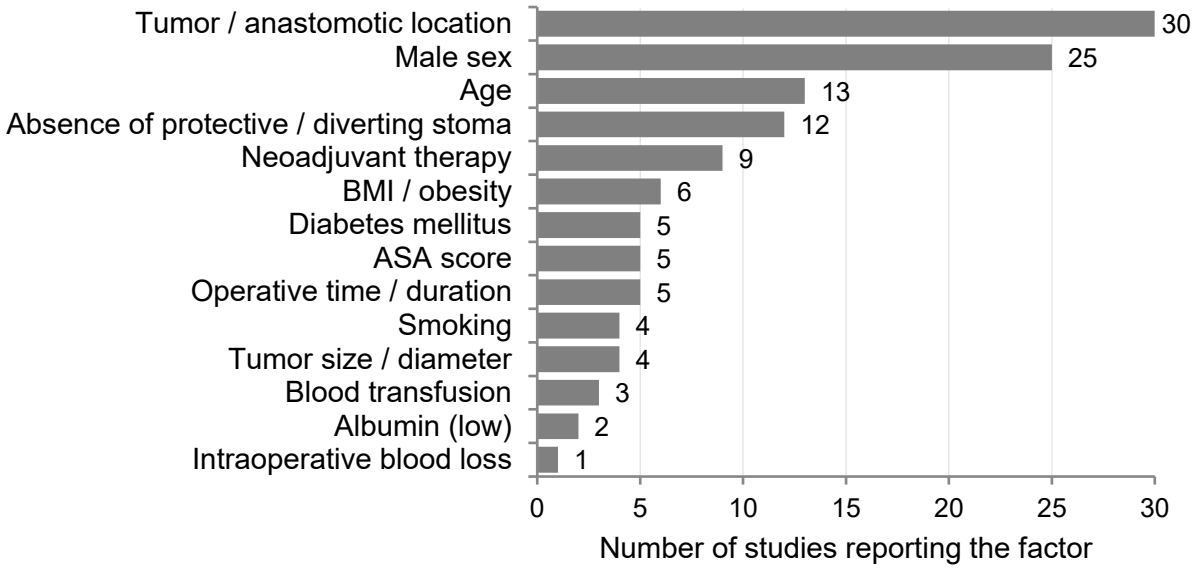


Figure S2 Frequency of reported risk factors for anastomotic leakage among high-evidence studies included in the systematic review. Bars represent the number of included studies reporting each factor. Tumor/anastomotic location included reported tumor or anastomotic height/distance from the anal verge, which were harmonized for the purpose of this analysis. Neoadjuvant therapy included radiotherapy, chemoradiotherapy, and short-course radiotherapy regimens, which were combined into a single category. ASA, American Society of Anesthesiologists; BMI, body mass index.

Figure S3 Severity grading of anastomotic leakage.

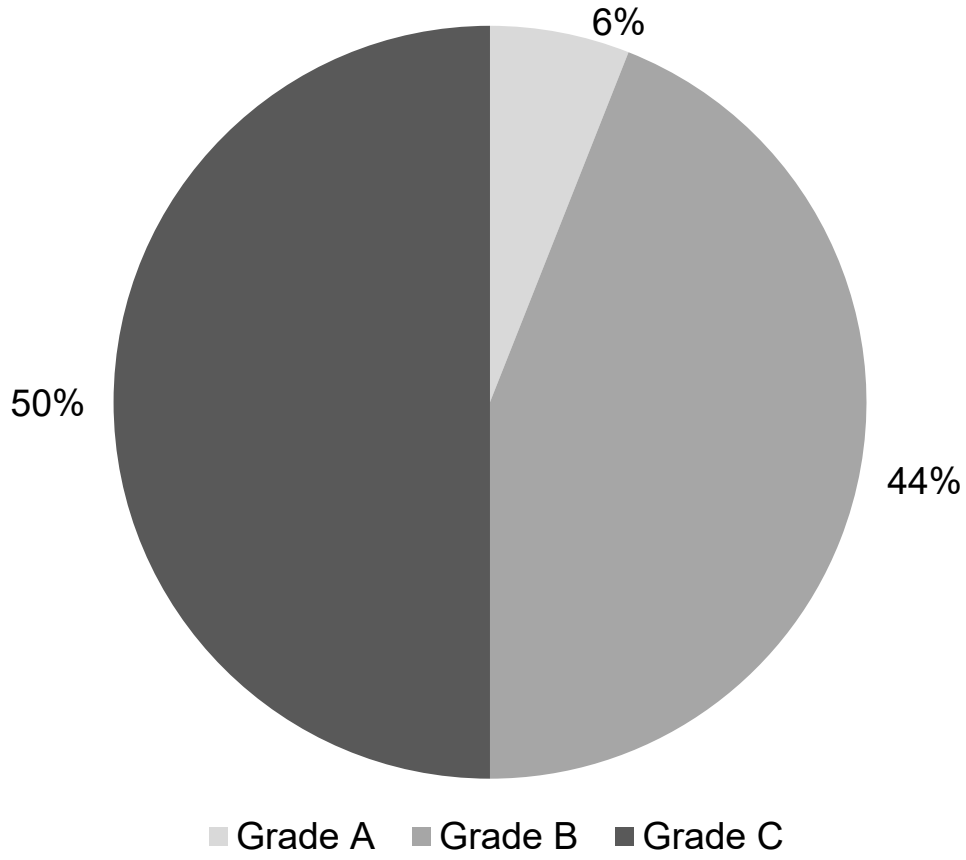


Figure S3 Severity grading of anastomotic leakage according to the International Study Group of Rectal Cancer (ISREC) classification among the 50 patients with anastomotic leakage in the cohort of 233 patients. Grade A, n = 3; Grade B, n = 22; Grade C, n = 25.