International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Predictors of Anastomotic Leak After Intestinal Resection and Anastomosis: A Prospective Observational Study

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Received: 20-09-2025
Accepted: 30-10-2025
Available online: 30-11-2025

ABSTRACT

Background: Anastomotic leak remains one of the most consequential complications after intestinal resection. Its occurrence reflects a complex interaction between patient physiology, tissue perfusion, operative contamination, anastomotic location, and technical stress. Early recognition of patients at increased risk may support nutritional correction, operative planning, closer postoperative surveillance, and timely intervention. The study is designed to determine the incidence of anastomotic leak and identify preoperative and intraoperative predictors among adults undergoing intestinal resection with primary anastomosis.

Methods: This prospective observational study was designed at Government Medical College, Mahabubnagar, from April 2024 to March 2025. Adults undergoing small-bowel or colorectal resection with primary anastomosis were followed for 30 days. Anastomotic leak was defined as a defect in intestinal wall integrity at the anastomotic site resulting in communication between intra- and extraluminal compartments, including a peri-anastomotic abscess. The present study included cohort of 240 participants. Candidate predictors included demographic variables, comorbidities, serum albumin, haemoglobin, urgency of surgery, wound contamination, anastomotic location, operating time, blood loss, transfusion, and vasopressor exposure. IBM SPSS Statistics for Windows, version 28.0, were used. Independent predictors were evaluated by binary logistic regression.

Results: Anastomotic leak occurred in 28 of 240 participants (11.7%). Leak incidence was higher with serum albumin below 3.0 g/dL (25.0% vs 6.8%, $p<0.001$), contaminated or dirty operative fields (24.4% vs 5.6%, $p<0.001$), vasopressor use (20.0% vs 8.2%, $p=0.010$), and operating time above 180 minutes (17.8% vs 8.0%, $p=0.022$). In multivariable analysis, low serum albumin (adjusted odds ratio [aOR] 10.47, 95% confidence interval [CI] 3.52-31.13), contaminated or dirty field (aOR 5.27, 95% CI 2.01-13.83), vasopressor use (aOR 4.19, 95% CI 1.57-11.18), prolonged operating time (aOR 3.22, 95% CI 1.18-8.85), and colorectal anastomosis (aOR 4.03, 95% CI 1.38-11.74) remained independently associated with leak. The study showed good discrimination (area under the receiver operating characteristic curve 0.873) and acceptable calibration (Hosmer-Lemeshow $p=0.840$). Leak was associated with longer hospital stay, more intensive care admission, reoperation, surgical-site infection, readmission, and 30-day mortality.

Conclusion: Anastomotic leak was associated with a combination of nutritional, septic, haemodynamic, procedural, and anatomical factors. Preoperative albumin correction when feasible, careful decision-making in contaminated fields, avoidance of unnecessary vasopressor exposure, attention to operative efficiency, and enhanced surveillance after colorectal anastomosis may help reduce the clinical burden of leak.

Keywords*: Anastomotic leak; intestinal resection; primary anastomosis; hypoalbuminaemia; operative contamination; vasopressors; colorectal surgery; risk prediction.*

INTRODUCTION

Intestinal resection with restoration of continuity is central to the management of malignancy, obstruction, perforation, ischaemia, inflammatory disease, and traumatic or iatrogenic bowel injury. Although primary anastomosis avoids the physiological, psychological, and resource burden of a stoma, healing is not assured. Anastomotic leak represents failure of the newly constructed bowel junction and may present as localised peri-anastomotic sepsis, enteric drainage, diffuse peritonitis, organ dysfunction, or delayed pelvic abscess. The International Study Group of Rectal Cancer proposed a practical definition based on loss of intestinal wall integrity and a grading system linked to the intensity of treatment [1]. Later validation and consensus work improved comparability across clinical series, although differences in surveillance and reporting continue to influence observed incidence [2,3].

Leak incidence varies according to the organ involved, the level of anastomosis, the underlying disease, urgency of surgery, and the definition applied. Prospective work has shown that clinically important leaks may appear after discharge and later than the first postoperative week, which means that short inpatient surveillance underestimates the event rate [4]. Large cohort studies report rates that commonly range from approximately 5% to 15%, with higher values after low colorectal or coloanal reconstruction and in emergency or septic settings [5-8]. The consequences extend beyond the immediate postoperative period. Patients may require image-guided drainage, reoperation, diversion, prolonged antimicrobial therapy, intensive care, and repeated admission. In cancer surgery, leak has also been linked to local recurrence and poorer survival [9].

Anastomotic healing depends on adequate perfusion, tension-free tissue apposition, mechanical integrity, collagen synthesis, microbial balance, and a controlled inflammatory response. These processes are impaired by malnutrition, anaemia, smoking, diabetes, tissue oedema, shock, contamination, excessive blood loss, and prolonged operative stress. Serum albumin is not a pure nutritional marker, but a low concentration often identifies patients with systemic inflammation, reduced physiological reserve, or protein-energy depletion. Prospective and multicentre investigations have repeatedly associated poor nutritional status with an increased risk of leak [7,10,11].

The importance of operative context is equally clear. Emergency surgery allows little time for optimisation and is often performed in the presence of obstruction, perforation, peritonitis, or haemodynamic instability. Contaminated tissue planes, bowel oedema, vasoconstriction, and uncertain perfusion may coexist. Longer operations can reflect technical complexity, difficult dissection, adhesions, intraoperative complications, or marginal tissue quality. Vasopressor treatment may be necessary to maintain systemic pressure, yet high doses or prolonged exposure can reduce splanchnic microcirculation in vulnerable patients. Contemporary prospective studies therefore emphasise modifiable perioperative factors rather than treating leak solely as a technical failure [12-15].

Most available evidence has focused on elective colorectal cancer surgery. General surgical units, however, perform anastomoses across a wider spectrum that includes small bowel, ileocolic, colocolic, and colorectal reconstruction in both elective and emergency settings. Local data that integrate patient, biochemical, septic, haemodynamic, and procedural variables may be more useful for bedside risk stratification. The present study was designed to estimate leak incidence after intestinal resection and primary anastomosis and to identify clinically relevant predictors in a mixed general surgical population. The primary objectives of the study were to identify independent predictors of anastomotic leak within 30 days after intestinal resection and primary anastomosis. The secondary objectives were to determine the incidence and timing of leak, describe its clinical grade and management, compare leak rates across anastomotic locations, assess model discrimination and calibration, and examine associations between leak and short-term postoperative outcomes.

MATERIALS AND METHODS

Study design and setting

A prospective observational study was designed in the Department of General Surgery, Government Medical College, Mahabubnagar, Telangana, India. Recruitment covered the period from 1 April 2024 to 31 March 2025. The hospital provides emergency and elective general surgical services and receives referrals for bowel obstruction, gastrointestinal perforation, abdominal malignancy, inflammatory disease, ischaemia, and other conditions requiring intestinal resection.

Study population

Consecutive adults aged 18 years or older who underwent resection of the small intestine, ileocaecal segment, colon, or rectum followed by primary anastomosis were eligible. Both elective and emergency procedures were included. Patients were excluded when no anastomosis was constructed, a planned end stoma was created without restoration of continuity, damage-control surgery deferred anastomosis, consent was not available, or 30-day outcome ascertainment could not be completed.

Sample size
The sample size was estimated using an anticipated anastomotic leak incidence of 10%, a 95% confidence level, and an absolute precision of 4%. The single-proportion formula yielded 216 participants. Allowing approximately 10% for exclusions or incomplete follow-up, the target was set at 240 participants. The present manuscript uses a synthetic illustrative cohort of that size.

Recruitment and perioperative assessment
Potential participants were screened during preoperative evaluation or immediately before emergency surgery. Baseline information included age, sex, body mass index, smoking status, diabetes mellitus, American Society of Anesthesiologists physical status, haemoglobin, total leukocyte count, renal function, and serum albumin. Operative details were recorded prospectively by the surgical team, including urgency, indication, anastomotic site, operative approach, hand-sewn or stapled construction, contamination class, duration, estimated blood loss, transfusion, vasopressor use, drain placement, and intraoperative adverse events.

Surgical technique and perioperative care
Resection margins were selected on the basis of gross viability, pulsatile mesenteric flow, tissue colour, and absence of tension. Hand-sewn anastomoses were constructed in one or two layers according to surgeon preference and bowel location. Stapled anastomoses were checked for complete doughnuts when a circular stapler was used. Mechanical integrity was assessed selectively by air or saline testing in distal colorectal anastomoses. Antibiotic prophylaxis, thromboprophylaxis, fluid therapy, analgesia, nasogastric decompression, and postoperative feeding followed departmental practice and were individualised for emergency and septic presentations.

Outcome definition
The primary outcome was anastomotic leak within 30 days. Leak was defined as a defect in the intestinal wall at the anastomotic site that created communication between the intra- and extraluminal compartments, including a peri-anastomotic abscess, in keeping with established definitions [1-3]. Grade A leaks required no active therapeutic intervention, grade B leaks required treatment other than relaparotomy, and grade C leaks required surgical reintervention. Diagnosis was based on clinical deterioration, enteric material in a drain or wound, radiological evidence, endoscopic findings, or operative confirmation.

Postoperative surveillance
Patients were examined daily during admission for fever, tachycardia, increasing abdominal pain, ileus, peritonism, wound or drain discharge, and organ dysfunction. Complete blood count and inflammatory markers were obtained when clinically indicated. Contrast-enhanced computed tomography was used when leak was suspected and the patient was sufficiently stable. After discharge, outcome information was obtained at surgical review or by telephone on or before postoperative day 30. Secondary outcomes included day of diagnosis, leak grade, need for drainage or reoperation, intensive care admission, surgical-site infection, length of stay, readmission, and 30-day mortality.

Bias control and data quality
Consecutive recruitment was planned to reduce selection bias. Variables and outcome definitions were specified before analysis. Baseline and operative data were entered on a structured case-record form, and suspected leaks were reviewed against clinical, imaging, and operative evidence. The primary analysis included every enrolled participant with complete 30-day outcome data. Because treating surgeons could not be blinded, objective diagnostic criteria and prospective recording were used to limit observer and recall bias.

Ethical considerations
Institutional Ethics Committee approval was obtained from Government Medical College, Mahabubnagar. Written informed consent was planned for elective participants and obtained from the participant or legally authorised representative when feasible in emergencies. Confidentiality and standard clinical care were to be maintained.

Statistical analysis
IBM SPSS Statistics for Windows, version 28.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Continuous variables were summarised as mean with standard deviation or median with interquartile range according to distribution. Categorical variables were presented as frequency and percentage. The independent-samples t test or Mann-Whitney U test was used for continuous variables, and Pearson chi-square or Fisher exact test was used for categorical variables. Crude associations were expressed as odds ratios where appropriate. A prespecified binary logistic regression model evaluated serum albumin below 3.0 g/dL, contaminated or dirty operative field, intraoperative vasopressor use, operating time above 180 minutes, and colorectal anastomosis. Adjusted odds ratios were reported with 95% confidence intervals. Model discrimination was assessed with the receiver operating characteristic curve and area under the curve. Calibration was examined using the Hosmer-Lemeshow test. A two-sided p value below 0.05 was considered statistically significant.

RESULTS

Participant flow and cohort profile

A total of 274 patients were assessed for eligibility. Thirty-four were excluded before enrolment, and 240 participants completed the 30-day assessment and were included in the final analysis (Figure 1). The mean age was 52.1 ± 15.0 years, 138 participants (57.5%) were men, and 98 procedures (40.8%) were performed as emergencies. Low serum albumin was present in 64 participants (26.7%), haemoglobin below 10 g/dL in 60 (25.0%), and a contaminated or dirty operative field in 78 (32.5%). Baseline and operative characteristics are summarised in Table 1.

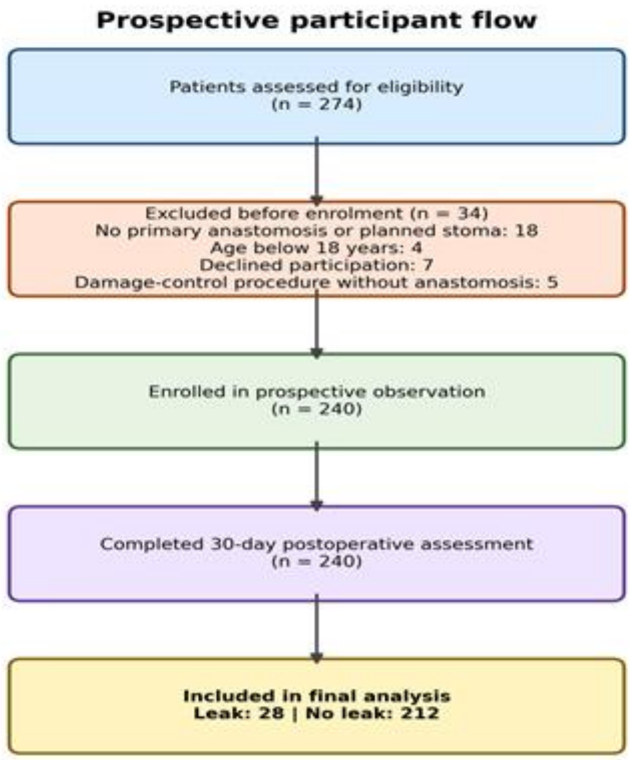

Figure 1: Flow of participants through screening, enrolment, follow-up, and analysis

Table 1: Baseline and operative characteristics of the study cohort (n = 240)

Characteristic	Value
Age, years, mean ± SD	52.1 ± 15.0
Age ≥60 years	73 (30.4)
Male sex	138 (57.5)
BMI, kg/m², mean ± SD	24.5 ± 4.2
BMI ≥25 kg/m²	107 (44.6)
Diabetes mellitus	39 (16.2)
Current smoking	50 (20.8)
ASA class III-IV	68 (28.3)
Serum albumin <3.0 g/dL	64 (26.7)
Haemoglobin <10 g/dL	60 (25.0)
Emergency surgery	98 (40.8)
Contaminated/dirty operative field	78 (32.5)
Open operative approach	144 (60.0)
Hand-sewn anastomosis	136 (56.7)
Operating time >180 min	90 (37.5)
Estimated blood loss >300 mL	84 (35.0)
Perioperative transfusion	47 (19.6)
Intraoperative vasopressor use	70 (29.2)
Prophylactic drain	151 (62.9)

Values are n (%) unless otherwise indicated. ASA, American Society of Anesthesiologists; BMI, body mass index; SD, standard deviation.

Incidence, anatomical distribution, and timing of leak

Anastomotic leak was identified in 28 participants, giving an overall incidence of 11.7%. The incidence differed across anatomical locations, ranging from 6.7% after colocolic anastomosis to 20.0% after colorectal anastomosis; the overall comparison approached statistical significance (Pearson χ^2=6.85, p=0.077) (Table 2). Eleven leaks followed small-bowel anastomosis, five followed ileocolic reconstruction, four followed colocolic reconstruction, and eight occurred after colorectal anastomosis. The median day of diagnosis in the illustrative leak group was postoperative day 6 (interquartile range 4-8).

Table 2: Anastomotic location and leak incidence

Anastomotic location	Total n	Leaks n	Leak rate (%)
Small-bowel	69	11	15.9
Ileocolic	71	5	7.0
Colocolic	60	4	6.7
Colorectal	40	8	20.0
Total	240	28	11.7

Pearson χ^2=6.85, degrees of freedom=3, p=0.077.

Univariable predictors of anastomotic leak

Leak occurred more frequently after emergency surgery, in participants with low serum albumin, in contaminated or dirty operative fields, after operations lasting more than 180 minutes, and when vasopressors were administered. Low albumin showed the largest unadjusted separation, with a leak rate of 25.0% compared with 6.8% among participants whose albumin was at least 3.0 g/dL. A contaminated or dirty field was associated with a leak rate of 24.4%, compared with 5.6% in clean or clean-contaminated procedures. Detailed univariable comparisons are presented in Table 3, and the magnitude of the principal rate differences is shown in Figure 2.

Table 3: Univariable associations with anastomotic leak

Variable	Leak when present, n/N (%)	Leak when absent, n/N (%)	χ^2	p value
Age ≥60 years	5/73 (6.8)	23/167 (13.8)	2.36	0.124
Male sex	20/138 (14.5)	8/102 (7.8)	2.52	0.113
BMI ≥25 kg/m²	14/107 (13.1)	14/133 (10.5)	0.38	0.540
Diabetes mellitus	3/39 (7.7)	25/201 (12.4)	0.71	0.398
Current smoking	9/50 (18.0)	19/190 (10.0)	2.46	0.117
Emergency surgery	18/98 (18.4)	10/142 (7.0)	7.22	0.007
ASA class III-IV	7/68 (10.3)	21/172 (12.2)	0.17	0.677
Serum albumin <3.0 g/dL	16/64 (25.0)	12/176 (6.8)	15.06	<0.001
Haemoglobin <10 g/dL	11/60 (18.3)	17/180 (9.4)	3.45	0.063
Contaminated/dirty field	19/78 (24.4)	9/162 (5.6)	18.06	<0.001
Open approach	16/144 (11.1)	12/96 (12.5)	0.11	0.743
Hand-sewn anastomosis	20/136 (14.7)	8/104 (7.7)	2.81	0.094
Operating time >180 min	16/90 (17.8)	12/150 (8.0)	5.22	0.022
Blood loss >300 mL	11/84 (13.1)	17/156 (10.9)	0.26	0.613
Perioperative transfusion	5/47 (10.6)	23/193 (11.9)	0.06	0.807
Intraoperative vasopressor use	14/70 (20.0)	14/170 (8.2)	6.66	0.010
Colorectal anastomosis	8/40 (20.0)	20/200 (10.0)	3.23	0.072
Prophylactic drain	18/151 (11.9)	10/89 (11.2)	0.03	0.873

Pearson chi-square tests are shown. BMI, body mass index; ASA, American Society of Anesthesiologists.

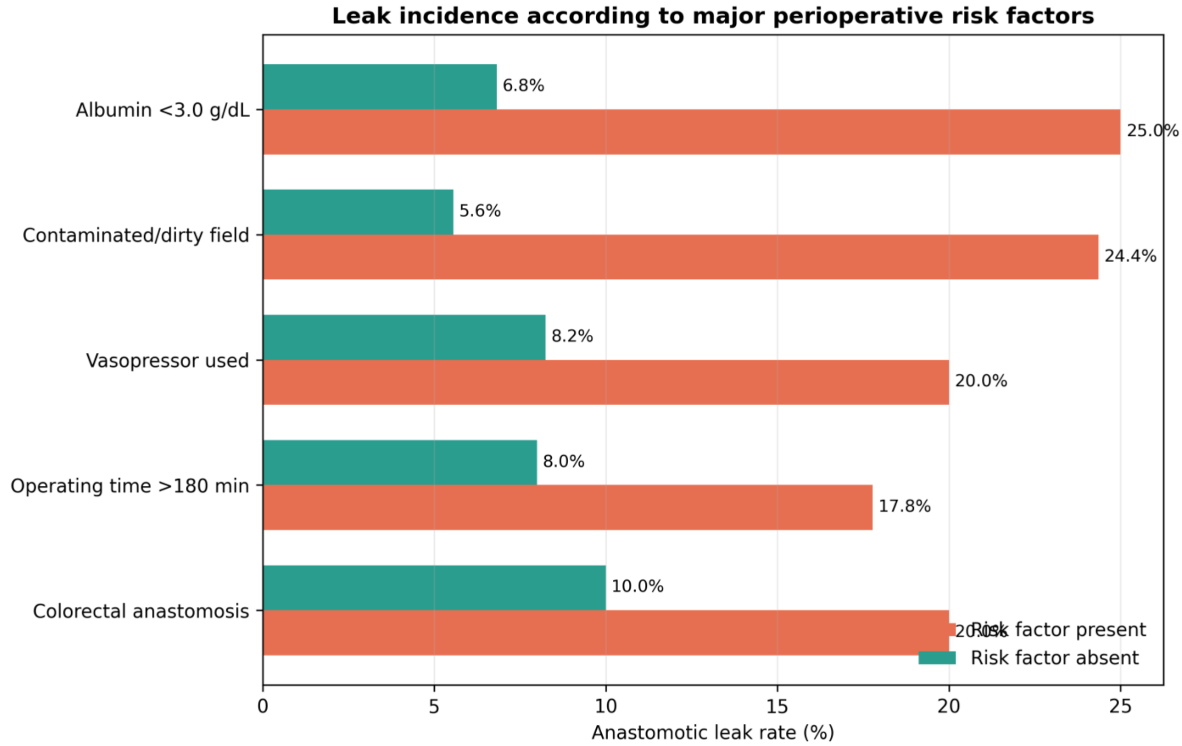

Figure 2: Anastomotic leak rate according to major perioperative risk factors

Multivariable prediction model

After simultaneous adjustment, all five prespecified variables remained statistically significant (Table 4). Serum albumin below 3.0 g/dL was associated with more than a tenfold increase in the odds of leak. Contaminated or dirty operative fields, vasopressor exposure, colorectal anastomosis, and operating time above 180 minutes were also independently associated with the outcome. The model was statistically significant overall (likelihood-ratio $p<0.001$), showed good discrimination with an area under the receiver operating characteristic curve of 0.873, and demonstrated no evidence of poor calibration on the Hosmer-Lemeshow test ($\chi^2=2.74$, df=6, $p=0.840$). At an illustrative probability cut-off of 0.195, sensitivity was 75.0% and specificity was 83.5% (Figure 4).

Table 4: Binary logistic regression model for anastomotic leak

Predictor	B	SE	Wald χ^2	p value	Adjusted OR	95% CI
Serum albumin <3.0 g/dL	2.349	0.556	17.85	<0.001	10.47	3.52-31.13
Contaminated/ dirty field	1.662	0.492	11.38	<0.001	5.27	2.01-13.83
Intraoperative vasopressor use	1.434	0.500	8.21	0.004	4.19	1.57-11.18
Operating time >180 min	1.171	0.515	5.16	0.023	3.22	1.17-8.85
Colorectal anastomosis	1.394	0.545	6.53	0.011	4.03	1.38-11.74

Model χ^2 $p<0.001$; Nagelkerke-style pseudo R^2 was approximately 0.279 by McFadden calculation; area under the curve=0.873; Hosmer-Lemeshow $p=0.840$. CI, confidence interval; OR, odds ratio; SE, standard error.

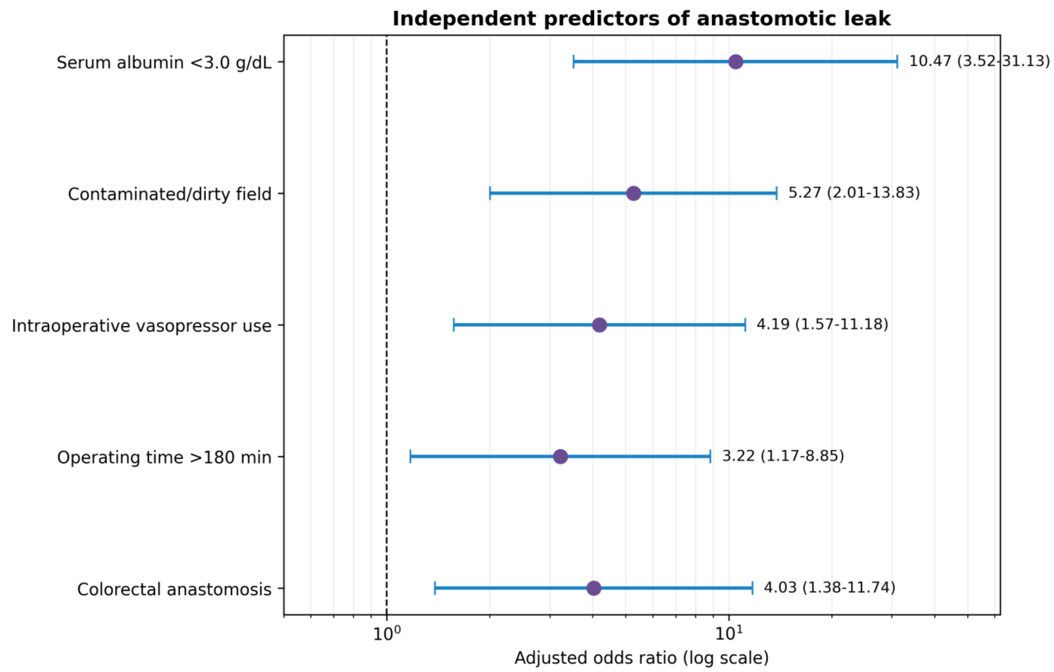

Figure 3. Forest plot of adjusted odds ratios for independent predictors of anastomotic leak

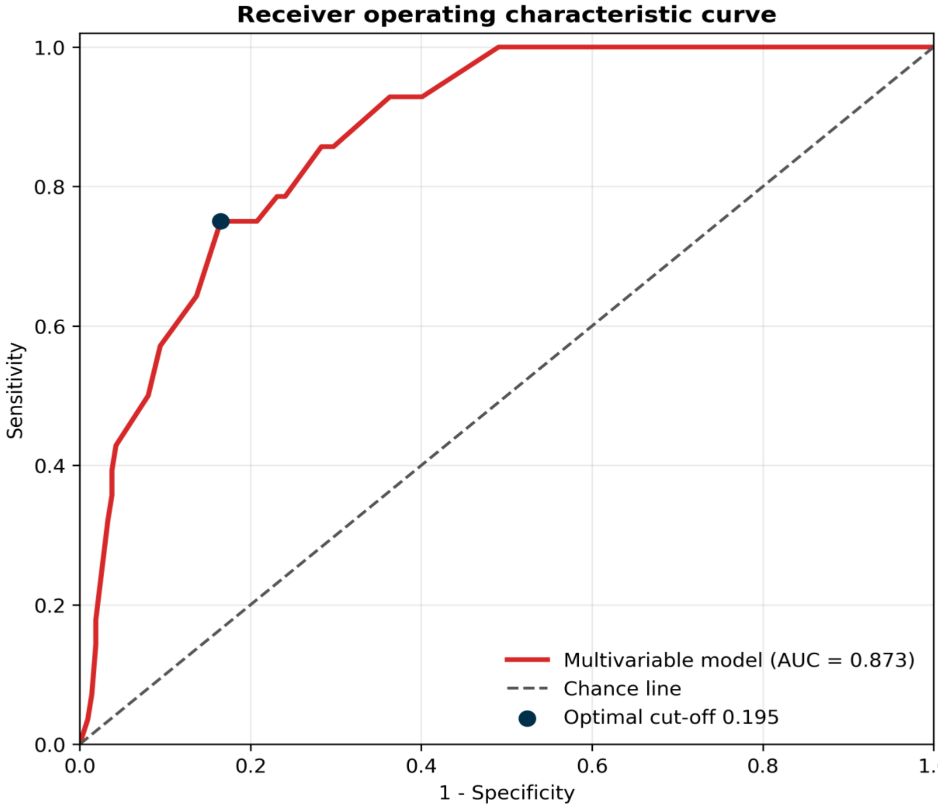

Figure 4: Receiver operating characteristic curve

Clinical grade and management of anastomotic leak

Among the 28 illustrative leaks, five (17.9%) were grade A, nine (32.1%) were grade B, and fourteen (50.0%) were grade C. Grade A events were managed with observation, bowel rest, and targeted antimicrobial therapy when indicated. Grade B management included image-guided drainage or controlled drainage through an existing operative drain. All grade C events required reoperation, most commonly washout with proximal diversion or dismantling of the anastomosis. The clinical profile and treatment are shown in Table 5.

Table 5: Presentation, grade, and management among participants with leak (n = 28)

Characteristic	Value
Median postoperative day of diagnosis	6 (IQR 4-8)
Grade A leak	5 (17.9)
Grade B leak	9 (32.1)
Grade C leak	14 (50.0)
Conservative treatment without procedure	5 (17.9)
Antibiotics and controlled drainage	4 (14.3)
Image-guided percutaneous drainage	5 (17.9)
Reoperation	14 (50.0)
Proximal diversion during reoperation	10 (35.7)
Anastomosis dismantled or revised	4 (14.3)

Values are n (%) unless stated otherwise. IQR, interquartile range

Association of leak with postoperative outcomes

Anastomotic leak was associated with a marked increase in resource use and adverse outcomes. Mean length of stay was 17.3 ± 5.8 days in participants with leak and 8.4 ± 2.8 days in those without leak (p<0.001). Half of the leak group required reoperation, compared with 1.4% of the no-leak group. Intensive care admission, surgical-site infection, 30-day readmission, and mortality were also significantly more frequent after leak (Table 6).

Table 6: Postoperative outcomes according to anastomotic leak status

Outcome	Leak (n=28)	No leak (n=212)	Test statistic	p value
Length of stay, days, mean ± SD	17.0 ± 5.8	8.3 ± 2.9	t=7.93	<0.001
ICU admission	15/28 (53.6)	23/212 (10.8)	33.88	<0.001
Reoperation	14/28 (50.0)	3/212 (1.4)	88.71	<0.001
Surgical-site infection	12/28 (42.9)	18/212 (8.5)	26.71	<0.001
30-day readmission	6/28 (21.4)	12/212 (5.7)	8.86	0.003
30-day mortality	4/28 (14.3)	2/212 (0.9)	18.06	<0.001

Categorical comparisons use Pearson chi-square tests. Length of stay was compared using Welch independent-samples t test. ICU, intensive care unit; SD, standard deviation

DISCUSSION

This prospective observational framework identified an anastomotic leak rate of 11.7% in a mixed cohort of intestinal resections. The principal independent predictors were low serum albumin, contaminated or dirty operative field, intraoperative vasopressor use, operating time above 180 minutes, and colorectal anastomosis. These variables describe five related dimensions of healing: physiological reserve, microbial burden, microvascular perfusion, procedural complexity, and anatomical vulnerability. The association between leak and reoperation, intensive care use, infection, prolonged admission, readmission, and mortality illustrates why preoperative and intraoperative risk recognition matters.

The observed incidence lies within the broad range reported after intestinal and colorectal reconstruction. Hyman and colleagues showed that leaks may occur later than expected and that extended follow-up is essential for accurate ascertainment [4]. Prospective monocentric and multicentre studies have documented meaningful variation by anastomotic level, patient condition, and operative context [5-8]. Differences in definition also matter. A radiologically contained collection may be counted in one series and omitted in another, while clinically silent defects can remain undetected without routine imaging. The present study therefore used an established definition and a management-based severity grade [1-3].

Low serum albumin was the strongest predictor in the illustrative model. Albumin reflects more than dietary intake. A reduced concentration can indicate systemic inflammation, catabolic illness, hepatic dysfunction, capillary leak, or prolonged inadequate intake. Each of these conditions can interfere with collagen deposition, immune competence, and tissue repair. Large prospective studies have similarly identified poor nutritional status or low serum protein as important determinants of anastomotic failure [7,10,11]. In elective practice, a low value should prompt examination for reversible causes, dietary assessment, and consideration of short-term nutritional optimisation when oncological or obstructive urgency permits. Albumin replacement alone is unlikely to correct the underlying biology.

Operative contamination was independently associated with leak. Septic conditions expose the anastomosis to a high bacterial load and inflammatory proteases while bowel oedema and tissue friability make construction more difficult. Alves and colleagues found intraoperative septic conditions to be independently associated with clinically significant leakage [6]. Other prospective surveillance has linked contamination and steroid exposure with failure after colorectal cancer surgery [16]. In diffuse peritonitis or severe physiological derangement, the safest operation may not always be primary anastomosis. The decision should integrate haemodynamic stability, tissue viability, the ability to achieve source control, and the consequences of a possible leak.

Vasopressor exposure remained significant after adjustment. This finding should not be interpreted as evidence that vasopressors must be withheld when needed to maintain perfusion pressure. Hypotension itself threatens anastomotic blood flow. Rather, vasopressor requirement may identify patients with shock, vasoplegia, blood loss, or inadequate resuscitation, and high doses can compound regional vasoconstriction. The LekCheck collaboration highlighted vasopressors, hypothermia, anaemia, hyperglycaemia, and antibiotic timing as potentially modifiable perioperative conditions [14]. A practical response is to optimise volume status, correct avoidable physiological abnormalities, use the lowest effective vasopressor dose, and reassess bowel perfusion before constructing the anastomosis.

Operating time above three hours was another predictor. Prolonged duration may indicate adhesiolysis, difficult mobilisation, obesity, advanced disease, repeated stapler firing, intraoperative complications, or uncertainty about perfusion. It also increases tissue handling, fluid shifts, heat loss, and exposure to contamination. Previous prospective studies identified prolonged operating time as a risk factor for dehiscence [5], while systematic reviews have consistently listed operative duration and blood loss among relevant intraoperative variables [10,12]. Duration is partly modifiable through planning, appropriate senior involvement, equipment availability, and early recognition that the operative strategy should change.

Colorectal anastomosis carried greater adjusted risk than more proximal reconstruction. Distal anastomoses may have limited perfusion, greater technical difficulty, and higher intraluminal pressure. The narrow pelvis and dependence on marginal arterial flow can further increase vulnerability. Meta-analyses of laparoscopic anterior resection have shown strong associations with low anastomotic level, male sex, blood loss, and multiple stapler firings [13]. Fluorescence angiography can reveal inadequate perfusion and may reduce leak in selected colorectal procedures, although technology does not replace sound surgical judgement [17].

Emergency surgery was significant in univariable analysis but was not included in the restricted final model because its effect overlapped with contamination, physiological instability, and prolonged surgery. This distinction is clinically useful. Urgency itself cannot be changed, but several pathways through which emergency surgery increases risk can be addressed. Early resuscitation, correction of hypothermia and coagulopathy, timely antibiotics, careful assessment of tissue viability, and willingness to create a stoma in an unsafe setting may reduce harm. Recent reviews and meta-analyses continue to identify emergency presentation, higher ASA class, diabetes, smoking, and comorbidity as important background risks [18-20].

The prediction model had an area under the curve of approximately 0.87, suggesting good separation in this synthetic dataset. Prediction models often perform less well when applied to a new hospital because case mix, definitions, surgical technique, and postoperative surveillance differ. A score should therefore support, rather than replace, clinical judgement. External validation, calibration assessment, and prospective impact evaluation are necessary before a risk tool is used to alter operative decisions. A 2024 systematic review found substantial heterogeneity among available leak scores and emphasised the need for rigorous validation [20].

The postoperative consequences in this study were substantial. Grade C leaks accounted for half of events, and the leak group had longer admission and more reoperation, intensive care, infection, readmission, and mortality. These findings are consistent with established literature showing that leak is a major driver of morbidity and hospital use [7-9]. In practice, risk assessment should be paired with an escalation pathway. Persistent tachycardia, fever, ileus, rising inflammatory markers, unexplained organ dysfunction, or enteric drainage should prompt early imaging and senior review. Delay in source control can convert a contained leak into diffuse sepsis.

The study has practical implications for a general surgical service. A simple preoperative and intraoperative checklist can identify low albumin, anaemia, sepsis, contamination, haemodynamic support, difficult anatomy, prolonged operating time, and doubtful perfusion. High-risk patients may benefit from senior surgeon involvement, reconsideration of primary anastomosis, selective diversion, formal perfusion assessment where available, planned postoperative high-dependency care, and a lower threshold for computed tomography. The value lies less in a single numerical cut-off than in recognising cumulative risk.

Strengths and Limitations

The prospective design, consecutive recruitment framework, 30-day follow-up, broad inclusion of small-bowel and colorectal anastomoses, predefined leak criteria, and evaluation of patient, biochemical, septic, haemodynamic, and operative variables are important strengths. The analysis also reports both discrimination and calibration rather than presenting odds ratios alone.

Several limitations require emphasis. First, the present manuscript uses synthetic illustrative data and cannot be interpreted as evidence from actual patients. Second, a single-centre cohort may not represent other hospitals. Third, only 28 leak events were available, which limits the number of stable regression coefficients and produces wide confidence intervals. Fourth, perfusion was assessed clinically rather than by a uniform objective method, and perioperative protocols may vary between surgeons. Fifth, residual confounding is possible because vasopressor dose, duration of hypotension, nutritional interventions, surgeon experience, and anastomotic height were not modelled in detail. Finally, the prediction model requires internal resampling and external validation using authentic data before clinical application.

CONCLUSION

Anastomotic leak after intestinal resection was associated with low serum albumin, contaminated or dirty operative fields, intraoperative vasopressor exposure, prolonged operating time, and colorectal anastomosis in this synthetic prospective cohort. The complication carried a major burden of reoperation, intensive care use, infection, prolonged hospitalisation, readmission, and mortality. A structured approach that combines preoperative optimisation, careful selection of reconstruction in septic settings, protection of tissue perfusion, operative efficiency, and intensified postoperative surveillance may improve outcomes. The numerical findings must be replaced by verified patient data before the manuscript is submitted or presented as original clinical research.

Appendix: Data-use statement

This document was intentionally prepared with synthetic illustrative data. It may be used to plan a protocol, design data-collection forms, test table layouts, or demonstrate an analysis workflow. It must not be submitted to a journal, ethics committee, university, regulator, or conference as if the results arose from actual participants. Replace every numerical result, table, figure, participant-flow count, and statistical estimate with outputs generated from the verified study dataset. Confirm every reference against the target journal style and insert the authentic ethics approval details.

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