

Determinants of Outcome in Intestinal Obstruction: Insights from a Prospective Cohort Analysis at a Tertiary Care Centre in India

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Abstract

Background

Intestinal obstruction (IO) is a frequently encountered surgical emergency necessitating early diagnosis, adequate resuscitation, and timely management to mitigate the risk of severe complications, including bowel ischaemia, perforation, and sepsis, and carries significant morbidity and mortality.

Objective

To delineate aetiological trends and identify independent clinical, biochemical, and radiological predictors of the need for surgical intervention, bowel resection, postoperative complications, length of hospital stay and mortality in patients with IO.

Methods

This prospective cohort study was conducted between August 2023 and August 2025 on 74 of the 427 patients with IO admitted to surgical wards during the study period. Data including clinical presentation, laboratory parameters and radiological findings of CECT abdomen were recorded at admission. Outcome measures were analysed using appropriate statistical tests. Logistic regression and ROC analysis identified independent predictors and discriminatory performance; $p < 0.05$ was considered significant.

Results

The mean age of the patients was 41.9 ± 19.0 years with a definite male preponderance (63.5%). Koch's abdomen was the most common aetiology (37.8%), followed by postoperative adhesions (24.3%). Overall mortality was 13.5%. Shock ($\chi^2=21.3$, $p < 0.001$) and fever ($\chi^2=23.6$, $p < 0.001$) at presentation were the strongest binary predictors of mortality. Serum LDH independently predicted need for surgical intervention (AUC = 0.82, OR = 1.02, $p = 0.006$), bowel resection (AUC = 0.85, OR = 1.01, $p = 0.001$), complications (AUC = 0.86, OR = 1.01, $p < 0.001$) and prolonged hospital stay (AUC = 0.80, $p = 0.001$). Serum LDH also demonstrated discriminatory ability for mortality (AUC = 0.82), but did not retain independent significance in the multivariable model. Hypoenhancement of the bowel on CECT was strongly associated with bowel resection ($p = 0.0004$), and pneumatosis intestinalis mandated resection in all three affected patients ($p = 0.015$).

Conclusion

Shock and fever at presentation are highly significant risk factors for adverse outcomes in patients with IO and therefore warrant prompt evaluation and resuscitation. Serum LDH is a cost-effective, widely available marker that independently predicts major adverse outcomes in IO. CECT features of bowel wall hypoenhancement and pneumatosis intestinalis are critical predictors of bowel resection.

Trial Registration:

Obtained from the Institutional Ethics Committee, Jawaharlal Nehru Medical College & Hospital, Faculty of Medicine, Aligarh, India, vide Ref. No. IEC/JNMC/1003 dated 28/08/2023, following review at the IEC meeting on 15/07/2023.

BACKGROUND

Intestinal obstruction (IO) is a common surgical emergency worldwide, causing nearly 30,000 deaths annually and accounting for approximately 15% of emergency department visits for acute abdominal pain (1, 2). The aetiology of IO varies widely, viz., infective (Koch's abdomen), inflammatory (Crohn's disease), iatrogenic (postoperative adhesions), functional (Ogilvie's syndrome, chronic intestinal pseudo-obstruction), and neoplastic. In the Indian subcontinent, IO constitutes 9–22% of all surgical emergencies requiring admission, with the epidemiological profile differing substantially from high-income countries due to endemicity of tuberculosis, limited elective surgical coverage for hernia repair, and delays in health-seeking behaviour (3, 4).

The outcome of IO is determined by a complex interplay of patient-related factors (age, comorbidities, nutritional status, time of presentation) and disease-related factors (site, aetiology, bowel viability) (5). Delays in diagnosis remain frequent in the developing world, leading to adverse outcomes. Some Indian studies have reported that up to 28% of patients living in rural areas delay seeking surgical consultation (6).

Inflammatory markers, viz., serum lactate dehydrogenase (LDH), C-reactive protein (CRP), interleukin-6 (IL-6), and neutrophil-to-lymphocyte ratio (NLR), have emerged as promising early biomarkers for predicting bowel ischaemia and adverse outcomes (7, 8, 9). Contrast-enhanced computed tomography (CECT) findings, specifically bowel wall hypoenhancement and pneumatosis intestinalis, are increasingly recognised as critical indicators of irreversible ischaemia requiring prompt operative intervention (10).

Due to aetiological heterogeneity and delayed presentation, there is a dearth of studies on factors affecting the need for operative intervention and postoperative outcomes in patients presenting with IO. The present study was therefore conducted to identify independent prognostic predictors for risk stratification of patients presenting with IO.

METHODS

Study Design and Setting

After obtaining ethical clearance from the Institutional Ethics Committee of the hospital and written informed consent from all participants, this prospective cohort study was conducted in the Department of Surgery, in collaboration with the Department of Biochemistry and Radiodiagnosis at a tertiary care centre in Northern India from August 2023 to August 2025.

Participants

A total of 427 consecutive patients aged ≥ 14 years, presenting to the emergency department with a clinical and radiological diagnosis of intestinal obstruction (IO), were enrolled in the study. Patients who refused to participate ($n = 134$), did not undergo all investigations under study ($n = 118$), did not undergo in-hospital CECT abdomen within 24 hours of admission ($n = 86$), or left against medical advice ($n = 15$) were excluded, leaving 74 patients for the final analysis (Fig. 1).

Clinical Evaluation

Baseline demographic characteristics, clinical history, duration of symptoms, comorbidities, physical examination findings, and vital parameters, viz., blood pressure (BP), pulse rate, respiratory rate, temperature, and peripheral oxygen saturation (SpO_2), were recorded on a pre-structured proforma.

Laboratory Investigations

Venous blood was collected at admission for estimation of haemoglobin (Hb), total leucocyte count (TLC), NLR, total serum protein (TSP), albumin, globulin, albumin-to-globulin (A:G) ratio, random blood glucose, blood urea nitrogen (BUN), serum creatinine, electrolytes (Na^+ , K^+), alanine aminotransferase (ALT), alkaline phosphatase (ALP), aspartate aminotransferase (AST), and total, direct, and indirect bilirubin. Serum samples for estimation of IL-6, CRP and LDH concentrations were separated by centrifugation. IL-6 was quantified by sandwich enzyme-linked immunosorbent assay (ELISA) (Reed Biotech Ltd.), CRP by latex turbidimetry (CRP TurbiLatex system), and LDH activity was measured using a spectrophotometric assay (LDH P-L kit).

Radiological Investigation and Definitions

All patients underwent contrast-enhanced computed tomography (CECT) of the abdomen using multidetector scanners with 128-slice configurations. Negative oral contrast was administered using 20% mannitol to facilitate optimal visualisation of the bowel mucosa and wall. Intravenous iodinated contrast (Iohexol) was administered at a dose of 1 mL/kg body weight. In patients with severe distension and vomiting, oral contrast was not given. Variables assessed on CECT included small bowel dilatation

(maximum bowel diameter), presence and extent of free fluid, hypoenhancement of bowel wall, and pneumatosis intestinalis. The work has been reported in line with the STROCSS criteria. The following definitions were used for analysis:

1. Shock: Systolic blood pressure of < 100 mmHg and a heart rate of > 90 beats per minute (11).
2. Delayed presentation: Presentation to the hospital > 3 days after the onset of symptoms (12).
3. Anaemia: Hb of < 12 g/dL in men and < 11 g/dL in women (11).
4. TLC: A range of 4,000–10,000/mm³ was taken as normal (13).
5. Raised NLR: A range of 0.78–3.53 was taken as normal (14).
6. Hypoalbuminaemia: Serum albumin levels < 3.5 g/dL (15).
7. Serum creatinine: A range of 0.6–1.3 mg/dl was taken as normal, in the absence of pre-existing chronic kidney disease (16).
8. ALT: A range of 7–56 IU/L was taken as normal (17).
9. AST: A range of 0–35 IU/L was taken as normal (17).
10. ALP: A range of 41–133 IU/L was taken as normal (17).
11. Total bilirubin: A range of 0.1–1.0 mg/dL was taken as normal (18).
12. CRP: A range of 0.8–3.0 mg/dL was taken as normal (19).
13. IL-6: A range of 0–43.5 pg/mL was taken as normal (20).
14. LDH: A range of 50–200 U/L was taken as normal (21).
15. Comorbidity: If the patient was already a known case of diabetes mellitus, hypertension, chronic obstructive pulmonary disease, coronary artery disease, liver cirrhosis, malignancy, etc.
16. Morbidity: Any complication occurring in a patient during the hospital stay.
17. Mortality: Death of the patient within the index admission.

Management Protocol

All patients received initial resuscitative management comprising intravenous fluid therapy, correction of electrolyte abnormalities, and nasogastric decompression. Absolute indications for emergency surgical intervention included peritonitis or radiological evidence of a definite transition point, bowel hypoenhancement with impending perforation, pneumatosis intestinalis or haemodynamic instability refractory to resuscitative measures. Patients without these features were managed conservatively for 48–72 hours. Surgical intervention was undertaken in cases of failed conservative management, persistent or worsening obstruction, fever, leucocytosis, or progressive haemodynamic deterioration. The operative approach was tailored to the underlying aetiology and intraoperative findings.

Outcome Measures

Primary recorded outcomes were: (1) need for surgical intervention, (2) need for bowel resection, (3) occurrence of postoperative complications (surgical site infection, burst abdomen, paralytic ileus, septicaemia, respiratory complications, electrolyte imbalance, anastomotic leak, stoma complications,

acute kidney injury, thromboembolic events), (4) length of hospital stay, categorised as 1–10 days, 11–20 days, and > 20 days and (5) mortality.

Statistical Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 21.0 (IBM, Chicago, IL, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median (interquartile range). Categorical variables were reported as frequencies and percentages. Between-group comparisons for continuous variables used independent-samples t-test or the Kruskal–Wallis test, while categorical comparisons used Pearson χ^2 or Fisher exact tests as appropriate. A p-value < 0.05 was considered statistically significant. Binary logistic regression was used to identify independent predictors of each outcome, expressed as unadjusted and adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Receiver operating characteristic (ROC) curve analysis was performed using MedCalc v16.8.4 to assess the discriminatory performance of individual biomarkers, with area under the curve (AUC), optimal cut-off, sensitivity, and specificity reported.

RESULTS

The ages of patients ranged between 15 and 85 years (mean 41.9 ± 19.0 years), with the most frequently affected age group being 21–30 years (22.97%). A statistically significant male preponderance was observed (63.5% vs 36.5%; male-to-female ratio = 1.74:1; $\chi^2=5.40$, $p = 0.020$). Duration of onset of symptoms at presentation ranged from 1 to 15 days; 54.1% presented within 3 days and 45.9% presented > 3 days after the onset of symptoms. Abdominal pain was the nearly universal presenting symptom (95.9%), followed by obstipation (82.4%), vomiting (52.7%), and abdominal distension (44.6%). At presentation, 25.7% of patients were in shock, and 29.7% had fever.

Non-survivors had significantly lower haemoglobin (10.0 ± 2.7 vs 12.3 ± 2.3 g/dL, $p = 0.005$) and lower serum albumin (2.7 ± 0.6 vs 3.3 ± 0.6 g/dL, $p = 0.016$), and higher LDH (655.6 ± 300.7 vs 358.6 ± 272.3 U/L, $p = 0.002$) than survivors. Non-survivors also had significantly higher pulse rates (120.4 ± 19.8 vs 91.3 ± 17.7 bpm), lower systolic BP (98.0 ± 18.6 vs 118.4 ± 19.3 mmHg), higher respiratory rates (22.6 ± 3.4 vs 17.6 ± 2.2 breaths/min), and lower SpO₂ ($94.4 \pm 2.1\%$ vs $97.3 \pm 1.9\%$) compared with survivors (all $p < 0.01$). Delayed presentation was associated with significantly increased mortality risk, with non-survivors having a significantly longer mean time to presentation than survivors (mean 6.9 ± 3.5 vs 4.5 ± 3.6 days, $p = 0.048$). Shock at the time of presentation was a significant predictor of the need for surgical intervention (94.74% of patients presenting with shock required surgery vs 58.18% without shock; $\chi^2=7.02$, $p = 0.008$). Koch's abdomen was the most frequent aetiology of IO (37.84%), followed by adhesions (24.32%), with no significant association found between aetiology and clinical outcome ($\chi^2=9.53$, $p = 0.300$). On CECT abdomen, small bowel dilatation (≥ 2.5 cm) was the most prevalent finding (77.03%), followed by the presence of free fluid (64.87%). Hypoenhancement of the bowel wall was present in 9.46% of patients, and pneumatosis intestinalis in 4.05%. Hypoenhancement of the bowel wall strongly predicted the need for bowel resection ($\chi^2=12.36$, $p = 0.0004$), and all three patients with

pneumatosis intestinalis underwent bowel resection ($\chi^2=5.91$, $p = 0.015$). The presence of free fluid on CECT abdomen was significantly associated with the need for surgical intervention ($p = 0.034$) (Table 1).

Table 1

Association of baseline demographic, clinical, laboratory and radiological parameters with mortality and need for surgical intervention in patients with IO.

Variable	Survivors (n = 64)	Non-survivors (n = 10)	p (Mortality)	Surgery: Yes (n = 50)	Surgery: No (n = 24)	p (Need for surgery)
A. Demographic Characteristics						
Age, years — mean ± SD	40.6 ± 19.0	49.9 ± 18.0	0.152	42.2 ± 19.5	41.2 ± 18.2	0.845
Male sex — n (%)	40 (62.5%)	7 (70.0%)	0.916	36 (72.0%)	11 (45.8%)	0.054
Symptom duration, days — mean ± SD	4.5 ± 3.6	6.9 ± 3.5	0.048*	5.2 ± 3.7	4.0 ± 3.5	0.193
Delayed presentation (> 3 days) — n (%)	25 (39.1%)	9 (90.0%)	0.008**	27 (54.0%)	7 (29.2%)	0.079
Comorbidities present — n (%)	16 (25.0%)	6 (60.0%)	0.060	16 (32.0%)	6 (25.0%)	0.730
B. Vital Parameters at Presentation						
Systolic BP, mmHg — mean ± SD	118.4 ± 19.3	98.0 ± 18.6	0.0026**	113.8 ± 22.6	119.4 ± 14.4	0.273
Diastolic BP, mmHg — mean ± SD	73.9 ± 10.6	60.0 ± 11.9	< 0.001	70.6 ± 13.2	75.2 ± 7.1	0.114
Pulse rate, bpm — mean ± SD	91.3 ± 17.7	120.4 ± 19.8	< 0.001	97.0 ± 22.2	91.5 ± 16.1	0.283
Respiratory rate, breaths/min — mean ± SD	17.6 ± 2.2	22.6 ± 3.4	< 0.001	18.9 ± 2.9	16.9 ± 2.6	0.005**
Temperature, °F — mean ± SD	98.8 ± 0.9	101.2 ± 1.1	< 0.001	99.3 ± 1.2	98.6 ± 1.0	0.013*
SpO ₂ on room air, % — mean ± SD	97.3 ± 1.9	94.4 ± 2.1	< 0.001	96.6 ± 2.3	97.4 ± 1.7	0.128
C. Clinical Features at Presentation						
Abdominal pain — n (%)	61 (95.3%)	10 (100%)	1.000	50 (100%)	21 (87.5%)	0.055
Shock at presentation — n (%)	10 (15.6%)	9 (90.0%)	< 0.001***	18 (36.0%)	1 (4.2%)	0.008**
Fever at presentation — n (%)	12 (18.8%)	10 (100%)	< 0.001***	19 (38.0%)	3 (12.5%)	0.048*

Variable	Survivors (n = 64)	Non- survivors (n = 10)	p (Mortality)	Surgery: Yes (n = 50)	Surgery: No (n = 24)	p (Need for surgery)
A. Demographic Characteristics						
D. Laboratory Investigations						
Haemoglobin, g/dL — mean ± SD	12.28 ± 2.26	10.00 ± 2.67	0.005**	12.13 ± 2.66	11.65 ± 1.90	0.437
TLC, per mm ³ — mean ± SD	9705 ± 5101	11130 ± 5863	0.423	10363 ± 5738	8929 ± 3727	0.269
NLR — mean ± SD	5.46 ± 5.79	6.56 ± 3.12	0.560	6.02 ± 6.21	4.75 ± 3.56	0.354
Total serum protein, g/dL — mean ± SD	5.82 ± 0.89	5.23 ± 0.66	0.049*	5.65 ± 0.87	5.92 ± 0.89	0.215
Serum albumin, g/dL — mean ± SD	3.25 ± 0.64	2.72 ± 0.60	0.016*	3.05 ± 0.65	3.46 ± 0.58	0.010*
Serum globulin, g/dL — mean ± SD	2.54 ± 0.63	2.41 ± 0.57	0.524	2.56 ± 0.59	2.47 ± 0.68	0.566
A:G ratio — mean ± SD	1.36 ± 0.42	1.24 ± 0.42	0.376	1.27 ± 0.38	1.50 ± 0.46	0.026*
Blood glucose, mg/dL — mean ± SD	105.78 ± 31.67	89.20 ± 29.43	0.125	101.7 ± 29.5	107.4 ± 36.2	0.470
BUN, mg/dL — mean ± SD	23.17 ± 13.80	29.90 ± 13.28	0.154	25.38 ± 13.88	21.38 ± 13.64	0.247
Serum creatinine, mg/dL — mean ± SD	0.89 ± 0.40	1.16 ± 0.58	0.070	0.96 ± 0.48	0.86 ± 0.32	0.371
Serum sodium, mmol/L — mean ± SD	135.61 ± 4.90	134.50 ± 8.64	0.556	135.4 ± 5.2	135.5 ± 6.1	0.965
Serum potassium, mmol/L — mean ± SD	4.09 ± 0.67	3.96 ± 0.83	0.578	4.12 ± 0.72	3.97 ± 0.63	0.376
ALT, U/L — mean ± SD	39.09 ± 59.86	29.60 ± 19.27	0.622	29.3 ± 15.6	55.5 ± 94.8	0.059
ALP, U/L — mean ± SD	126.08 ± 53.09	217.20 ± 233.12	0.007**	147.9 ± 118.9	118.5 ± 37.2	0.242
AST, U/L — mean ± SD	52.03 ± 52.23	39.10 ± 18.58	0.443	47.6 ± 37.1	55.9 ± 68.5	0.502
Total bilirubin, mg/dL — mean ± SD	0.93 ± 0.44	1.03 ± 0.92	0.586	1.01 ± 0.59	0.81 ± 0.30	0.115

Variable	Survivors (n = 64)	Non- survivors (n = 10)	p (Mortality)	Surgery: Yes (n = 50)	Surgery: No (n = 24)	p (Need for surgery)
A. Demographic Characteristics						
Serum IL-6, pg/mL – mean ± SD	88.19 ± 40.79	106.22 ± 43.00	0.201	92.8 ± 38.7	86.2 ± 46.7	0.524
CRP, mg/L – mean ± SD	30.70 ± 33.87	49.62 ± 33.60	0.105	36.0 ± 35.7	27.6 ± 30.8	0.328
Serum LDH, U/L – mean ± SD	358.58 ± 272.34	655.60 ± 300.66	0.002**	491.0 ± 311.5	206.5 ± 88.9	< 0.001***
E. CT Imaging Findings (CECT Abdomen)						
Small bowel dilatation ≥ 2.5 cm – n (%)	48 (75.0%)	9 (90.0%)	0.519	42 (84.0%)	15 (62.5%)	0.078
Small bowel max. diameter, cm – mean ± SD	3.70 ± 0.88	4.44 ± 0.88	0.019*	3.92 ± 0.90	3.46 ± 0.82	0.039*
Presence of free fluid – n (%)	39 (60.9%)	9 (90.0%)	0.152	37 (74.0%)	11 (45.8%)	0.034*
Hypoenhancement of bowel wall – n (%)	5 (7.8%)	2 (20.0%)	0.520	7 (14.0%)	0 (0.0%)	0.133†
Pneumatosis intestinalis – n (%)	2 (3.1%)	1 (10.0%)	0.870	3 (6.0%)	0 (0.0%)	0.552†

Continuous variables were compared using independent-samples t-test; categorical variables were compared using Pearson χ^2 or Fisher exact test (expected cell count < 5). †Fisher exact test (zero cells in the non-surgical group). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Fifty patients (67.57%) required surgical intervention ($\chi^2=9.13$, $p = 0.003$), whereas 24 patients (32.43%) were managed conservatively. Bowel resection was performed in 18 patients (36% of those operated), of whom 9 had bowel gangrene. Postoperative complications occurred in 33 patients (44.6%), with nearly half of the cohort experienced at least one adverse postoperative event. Respiratory complications were most frequent (n = 13, 23.0%), followed by midline wound surgical site infection (n = 12, 21.3%), burst abdomen (n = 6, 9.8%), paralytic ileus (n = 6, 9.8%), and septicaemia (n = 6, 9.8%). Most patients were discharged within 10 days of admission (66.22%), 29.73% had a hospital stay of 11–20 days, and 4.05% stayed beyond 20 days. Ten patients (13.51%) died during the index admission.

Shock at presentation was significantly associated with higher rates of complications (89.47% vs 29.09%; $\chi^2=18.47$, $p < 0.001$) and prolonged hospital stay ($\chi^2=7.56$, $p = 0.023$). Fever at presentation similarly predicted complications (81.82% vs 28.85%; $\chi^2=15.48$, $p < 0.001$) and prolonged hospital stay

($\chi^2=6.60$, $p = 0.037$). Delayed presentation was a significant risk factor for complications (61.76% vs 30.0%; $\chi^2=6.27$, $p = 0.012$) and higher mortality (26.47% vs 2.5%; $\chi^2=7.10$, $p = 0.008$). Comorbidities were significantly associated with complications (68.18% vs 34.62%; $\chi^2=5.76$, $p = 0.016$).

On univariable analysis, serum LDH, albumin, haemoglobin, pulse rate, systolic BP, and small bowel maximum diameter > 2.5 cm were significantly associated with one or more adverse outcomes. Serum LDH showed the most consistent discriminatory ability across all outcome domains (Fig. 2), with significant discriminatory ability for complications (AUC = 0.86), need for surgical intervention (AUC = 0.82), bowel resection (AUC = 0.85), prolonged LOS (AUC = 0.80), and mortality (AUC = 0.82) (Table 2). The optimal serum LDH cut-off for predicting bowel resection (indicating gangrenous or severely ischaemic bowel) was > 450 U/L. Tachycardia, hypotension, and serum LDH were the strongest individual predictors of mortality on univariable ROC analysis, while serum albumin showed moderate predictive accuracy (Fig. 3).

Table 2
Receiver operating characteristic (ROC) analysis of key predictors of clinical outcomes in Patients with IO.

Outcome / Predictor	AUC	95% CI	Sensitivity	Specificity	Optimal Cut-off
Mortality					
Serum LDH	0.82	0.71–0.92	80%	76%	> 500 U/L
Pulse Rate	0.87	0.78–0.96	90%	75%	> 106 bpm
Diastolic BP	0.84	0.74–0.94	85%	72%	< 65 mmHg
Serum Albumin	0.73	0.59–0.87	70%	70%	< 3.0 g/dL
Small Bowel Diameter	0.76	0.62–0.90	78%	66%	> 4.2 cm
Need for Surgical Intervention					
Serum LDH	0.82	0.72–0.92	78%	75%	> 310 U/L
Serum Albumin	0.73	0.59–0.85	72%	67%	< 3.2 g/dL
Need for Bowel Resection					
Serum LDH	0.85	0.76–0.94	83%	79%	> 450 U/L
Postoperative Complications					
Serum LDH	0.86	0.77–0.95	85%	78%	> 380 U/L
Prolonged Hospital Stay (> 10 days)					
Serum LDH	0.80	0.69–0.91	76%	74%	> 420 U/L

AUC, area under the ROC curve; CI, confidence interval. Optimal cut-offs were derived using the Youden index.

In multivariable analysis, serum LDH was the only variable retaining significance across the four primary outcome domains: need for surgical intervention ($p = 0.006$), bowel resection ($p = 0.001$), complications ($p < 0.001$), and length of hospital stay > 10 days ($p = 0.001$). No variable significantly predicted mortality in the multivariable model, likely due to the small number of events ($n = 10$), though the model showed adequate fit ($\chi^2=38.46$, C-statistic = 0.967) (Table 3).

Table 3

Multivariable logistic regression analysis of independent predictors of adverse outcomes in patients with IO.

Predictor	Unadjusted OR (95% CI)	p-value (Univariable)	Adjusted OR (95% CI)	p-value (Multivariable)
Outcome: Mortality				
Serum LDH (per U/L)	1.00 (0.99–1.00)	0.007*	1.00 (0.99–1.00)	0.197
Serum Albumin (g/dL)	3.50 (1.19–10.29)	0.023*	– (unstable)	0.303
Haemoglobin (g/dL)	1.47 (1.08–1.98)	0.013*	1.24 (0.47–3.28)	0.667
Pulse Rate (bpm)	0.93 (0.89–0.97)	0.001*	0.86 (0.72–1.04)	0.114
Outcome: Need for Surgical Intervention				
Serum LDH (per U/L)	1.01 (1.00–1.01)	0.003*	1.02 (1.00–1.03)	0.006*
Haemoglobin (g/dL)	1.08 (0.89–1.32)	0.432	2.24 (1.13–4.44)	0.021*
Serum Albumin (g/dL)	0.32 (0.13–0.80)	0.014*	– (unstable)	0.210
Outcome: Need for Bowel Resection				
Serum LDH (per U/L)	1.01 (1.00–1.01)	< 0.001*	1.01 (1.00–1.01)	0.001*
Outcome: Postoperative Complications				
Serum LDH (per U/L)	1.01 (1.00–1.01)	< 0.001*	1.01 (1.00–1.01)	< 0.001*
Outcome: Prolonged Hospital Stay (> 10 days)				
Serum LDH (per U/L)	1.00 (1.00–1.01)	0.001*	1.00 (1.00–1.01)	0.001*
Serum Globulin (g/dL)	1.02 (0.47–2.25)	0.956	182.91 (1.05–31722)	0.048*

* $p < 0.05$. OR, odds ratio; CI, confidence interval. All models were adjusted for age, sex, duration of symptoms, and shock.

DISCUSSION

In the present study, the mean age of the cohort was 41.9 ± 19.0 years, with the highest proportion of patients belonging to the 21–30 year age group. This demographic profile contrasts with that reported in Western populations, where the median age at presentation generally exceeds 60 years (22, 23). Comparable age distributions have been documented in other Indian studies (4, 24), potentially reflecting variations in disease aetiology, particularly the substantial burden of abdominal tuberculosis in the Indian population. In the present study, Koch's abdomen constituted the most common cause of IO (37.8%), followed by adhesions (24.3%). This aetiological pattern differed considerably from that observed in Western countries, where postoperative adhesions are responsible for 45–70% of cases (3, 4, 25–27). A significant male predominance was noted ($p = 0.020$) in our patients, which was consistent with previous reports (24); however, gender was not an independent predictor of clinical outcome, a finding that concurs with other published studies (5).

Delayed presentation to the hospital was a statistically significant modifiable prognostic determinant of mortality ($p = 0.048$). Symptom duration exceeding 3 days was associated with a substantially higher mortality rate (26.5% vs. 2.5%; $\chi^2 = 7.10$, $p = 0.008$) and a significantly increased incidence of complications (61.8% vs. 30.0%; $p = 0.012$). Our findings are in concordance with existing literature demonstrating that delays in surgical management contribute to increased adverse events and prolonged hospitalisation (12, 28), emphasising the need for earlier healthcare access.

Haemodynamic instability at the time of admission had a strong and consistent association with adverse outcomes. Compared with survivors, non-survivors had significantly lower systolic blood pressure ($p = 0.003$) and diastolic blood pressure ($p < 0.001$), alongside higher pulse rates ($p < 0.001$), respiratory rates ($p < 0.001$), fever ($p < 0.001$), and lower oxygen saturation levels ($p < 0.001$). Our findings are consistent with established evidence identifying haemodynamic instability as a key predictor of poor outcomes in small bowel obstruction (29). In our study, shock was significantly associated with the need for surgical intervention, as 94.7% of patients having shock at the time of presentation underwent surgical intervention compared with 58.2% of those without shock ($\chi^2 = 7.02$, $p = 0.008$). Fever at presentation was associated with the need for surgical intervention ($p = 0.048$) and a markedly higher complication rate ($p < 0.001$). Shock and fever were significantly associated with mortality (shock: $\chi^2 = 21.3$, $p < 0.001$; fever: $\chi^2 = 23.6$, $p < 0.001$), likely reflecting the presence of systemic inflammatory response syndrome, bowel ischaemia, or developing sepsis at the time of presentation (30, 31).

Serum LDH emerged as the strongest risk predictor for outcome measures. In multivariable analysis, elevated serum LDH levels independently predicted need for surgical intervention (OR 1.02, $p = 0.006$), bowel resection (OR 1.01, $p = 0.001$), postoperative complications (OR 1.01, $p < 0.001$), and prolonged hospital stay (OR 1.00, $p = 0.001$), supporting LDH as a practical, inexpensive surrogate marker of tissue ischaemia in IO. Previous Indian studies have also reported that LDH levels exceeding 800 IU/L had high specificity (94%) and sensitivity (75%) for the prediction of bowel gangrene. Other studies have also reported that elevated serum LDH was associated with mesenteric ischaemia and bowel necrosis (8, 21, 32, 33). Serum LDH levels had a significant progressive increase with longer hospital stays, rising from 309.8 ± 240.1 U/L in patients hospitalised for ≤ 10 days to 538.6 ± 306.2 U/L for 11–20 days and $826.3 \pm$

271.0 U/L for > 20 days ($p = 0.0001$) and therefore may serve as a dynamic indicator of disease severity and healthcare resource utilisation.

In the present study, hypoalbuminaemia was significantly associated with increased incidence of mortality ($p = 0.016$) and the need for surgical intervention ($p = 0.010$) in univariable analysis. These findings are consistent with established evidence linking poor nutritional status to increased rates of anastomotic leakage, wound-related complications, and mortality (15, 34, 35). It lost independent significance after multivariable adjustment, possibly reflecting limited sample size and collinearity, though its role in preoperative optimisation remains clinically important. Neither TLC nor NLR independently predicted any outcome on multivariable analysis, discordant with several previous studies (9, 36). Similarly, CRP and IL-6 did not achieve statistical significance for any outcome measure; however, elevated levels were observed in patients with complicated disease.

Although we found a significant association between raised alkaline phosphatase (ALP) levels and mortality ($p = 0.007$), no such significant association was observed with other liver enzymes. This finding may reflect cholestatic injury rather than hepatocellular damage and could represent a marker of systemic dysfunction and sepsis-related hepatic compromise (17).

Small bowel dilatation (77.0%) and free intraperitoneal fluid (64.9%) were the most frequent CECT abnormalities. Free fluid was significantly associated with the need for surgical intervention ($p = 0.034$), which was consistent with observations made by other studies (37, 38). Bowel wall hypoenhancement, which was identified in only 9.5% of patients, had a strong association with the need for bowel resection ($p = 0.0004$), reinforcing its established role as a marker of transmural bowel ischaemia (10, 39). Likewise, pneumatosis intestinalis, observed in 4.1% of patients, was associated with bowel resection in all affected cases ($p = 0.015$), consistent with its role as a radiological indicator of advanced mural necrosis (40). However, neither of these CECT findings independently predicted mortality on multivariable analysis, suggesting their prognostic utility lies mainly in identifying patients requiring operative intervention rather than predicting survival. Increased small bowel diameter was associated with the need for surgical intervention and postoperative complications on univariable analysis (AUC 0.65–0.76), but lost significance after adjustment, which was consistent with previous reports indicating that isolated CECT parameters rarely demonstrate independent predictive value within multivariable models (37, 41).

The overall surgical intervention rate of 67.6% observed in the present study was higher than the 41–51% reported in other cohorts (42, 43). The observation that surgical intervention itself did not independently predict mortality ($p = 0.205$) suggests that mortality is primarily determined by the underlying biological severity of disease, including bowel ischaemia, gangrene, perforation, and sepsis.

Respiratory complications constituted the most common postoperative adverse event (23%), followed by surgical site infection (21.3%), septicaemia (9.8%), burst abdomen (9.8%), and paralytic ileus (9.8%). The predominance of respiratory complications likely reflects the systemic inflammatory burden associated with IO and is consistent with findings from other studies (44, 45). The relatively high incidence of

surgical site infection reflects the emergent setting of surgical procedures and the consequent risk of bowel contamination during surgery.

LIMITATIONS

The modest sample size in our study may have limited the power of multivariable analyses, particularly for infrequent outcomes, potentially contributing to the loss of significance of some biomarkers after adjustment. Additionally, reliance on a single preoperative LDH measurement precluded assessment of temporal trends, warranting validation in larger multicentre studies.

CONCLUSION

Intestinal obstruction remains a common surgical emergency associated with significant morbidity and mortality, requiring timely diagnosis, adequate resuscitation, appropriate operative management, and intensive postoperative care. Delayed presentation, fever, and shock at admission were significantly associated with mortality, while abnormal laboratory parameters were associated with adverse outcomes. Serum LDH emerged as a strong independent predictor of hospital stay, need for surgical intervention, bowel resection, and postoperative complications. CECT findings such as bowel wall hypoenhancement and pneumatosis intestinalis were strongly associated with bowel resection and may indicate intestinal ischaemia. Early diagnosis, aggressive resuscitation, and prompt surgical intervention remain the cornerstones of improving outcomes in IO. In resource-limited settings, the combination of admission LDH, haemodynamic parameters, and targeted CECT assessment offers a pragmatic, accessible framework for prognostic stratification.

Abbreviations

A:G — albumin-to-globulin ratio

ALP — alkaline phosphatase

ALT — alanine aminotransferase

AST — aspartate aminotransferase

AUC — area under the curve

BP — blood pressure

BUN — blood urea nitrogen

CECT — contrast-enhanced computed tomography

CI — confidence interval

CRP — C-reactive protein

ELISA — enzyme-linked immunosorbent assay

Hb — haemoglobin

IL-6 — interleukin-6

IO — intestinal obstruction

LDH — lactate dehydrogenase

NLR — neutrophil-to-lymphocyte ratio

OR — odds ratio

ROC — receiver operating characteristic

SD — standard deviation

SpO₂ — peripheral oxygen saturation

SPSS — Statistical Package for the Social Sciences

TLC — total leucocyte count

TSP — total serum protein

Declarations

Ethics approval and consent to participate: The study was approved by the Institutional Ethics Committee (IEC), Jawaharlal Nehru Medical College & Hospital, Faculty of Medicine, Aligarh Muslim University, Aligarh, India, vide Ref. No. IEC/JNMC/1003 dated 28/08/2023. The research proposal was reviewed and approved by the IEC in its meeting held on 15 July 2023, prior to commencement of the study.

Written informed consent was obtained from all participants or their next of kin prior to inclusion in the study.

Consent for publication: Written informed consent was obtained from the patient for publication of individual clinical data, ensuring strict preservation of confidentiality and anonymity.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests

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Authors' contributions: KV curated and analysed the data, conducted the investigations, and drafted the manuscript. AZR conceptualised and supervised the study, contributed to the methodology and manuscript revision. SM contributed to the investigations, resources and validation. MA contributed to the acquisition, interpretation, and analysis of CECT abdomen. IA contributed to validation and supervision. All authors read and approved the final manuscript.

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Figures

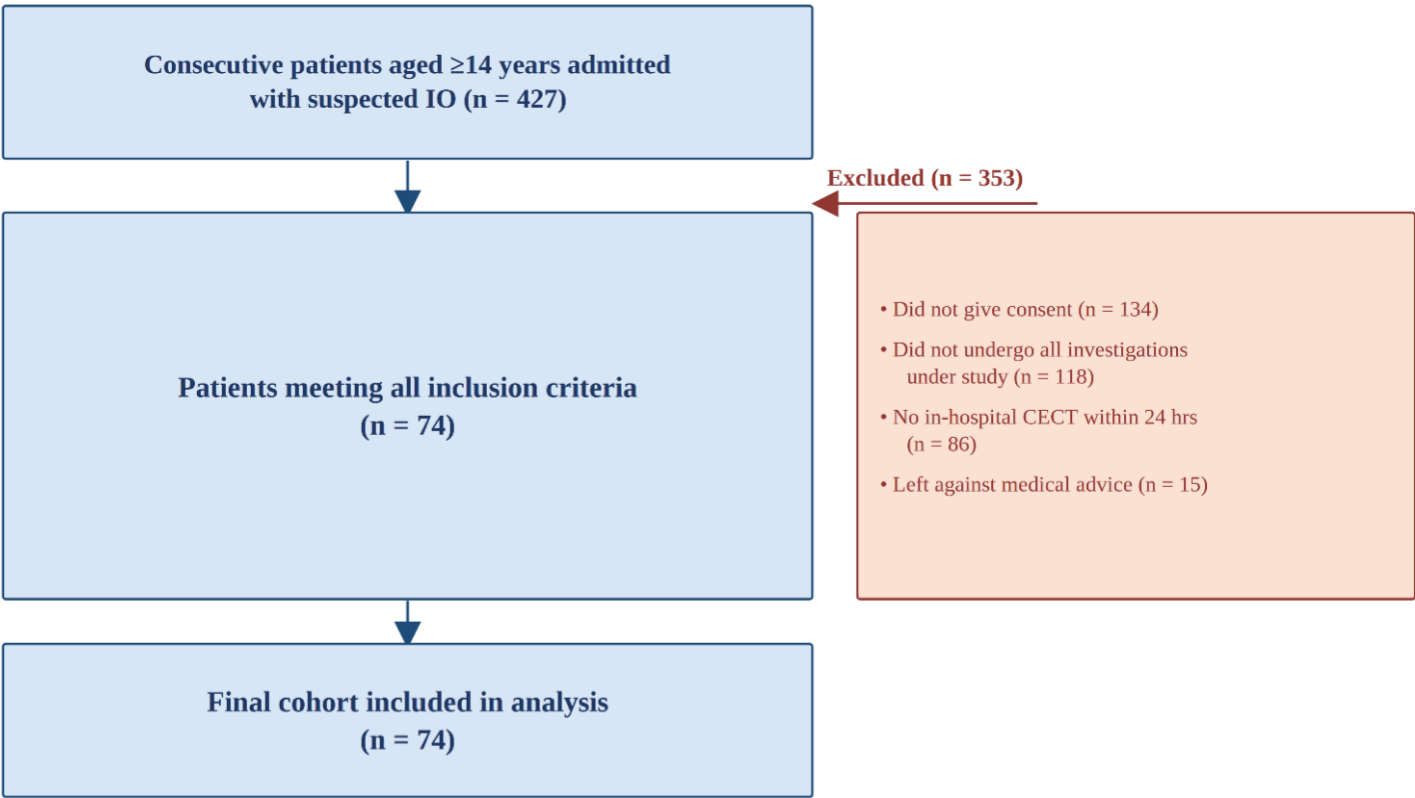


Figure 1

Flow diagram of study cohort selection.

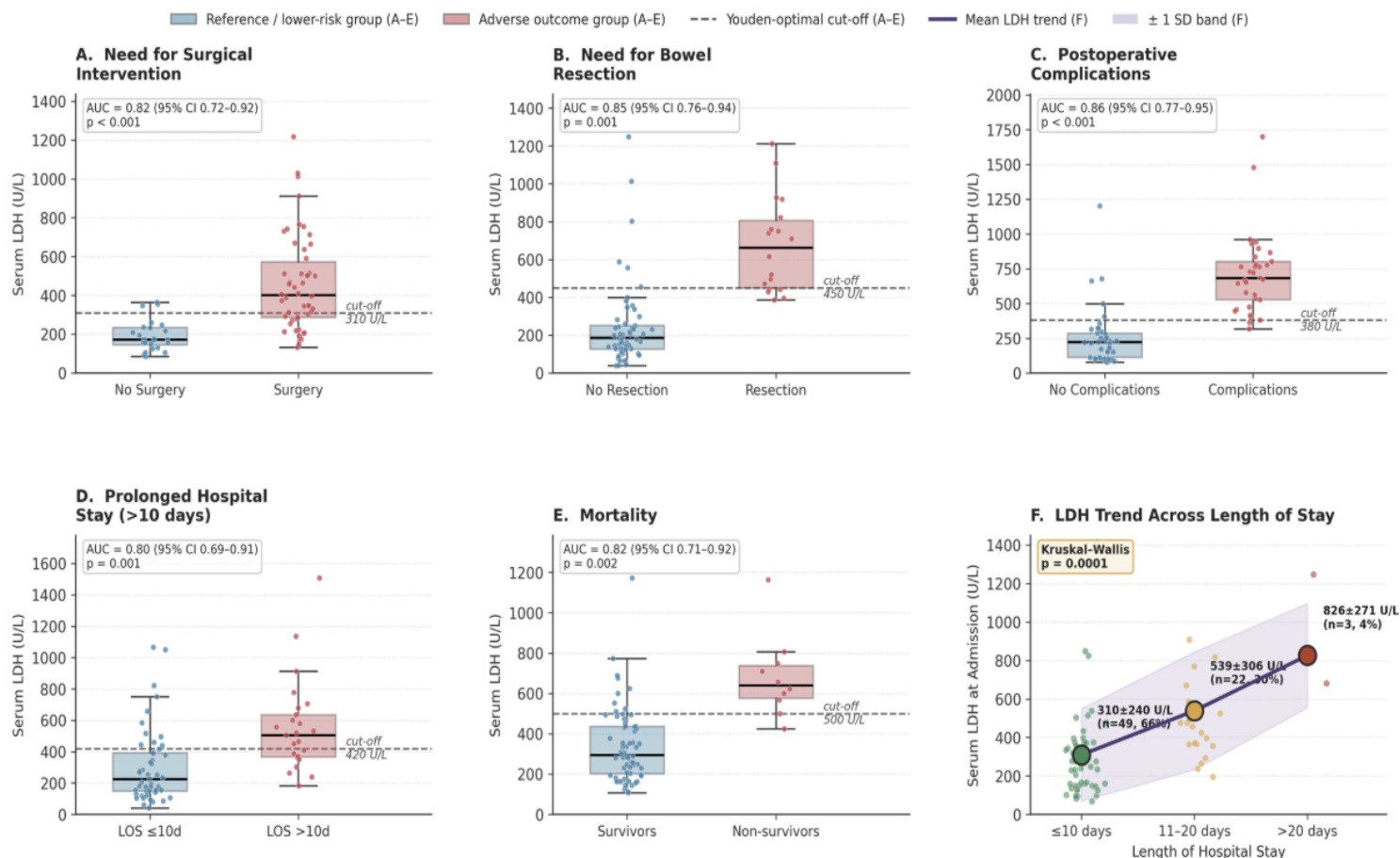


Figure 2

Serum LDH distribution across clinical outcomes in patients with IO. (A) Need for surgical intervention. (B) Need for bowel resection. (C) Postoperative complications. (D) Prolonged hospital stay (>10 days). (E) Mortality. (F) LDH trend across the length of hospital stay.

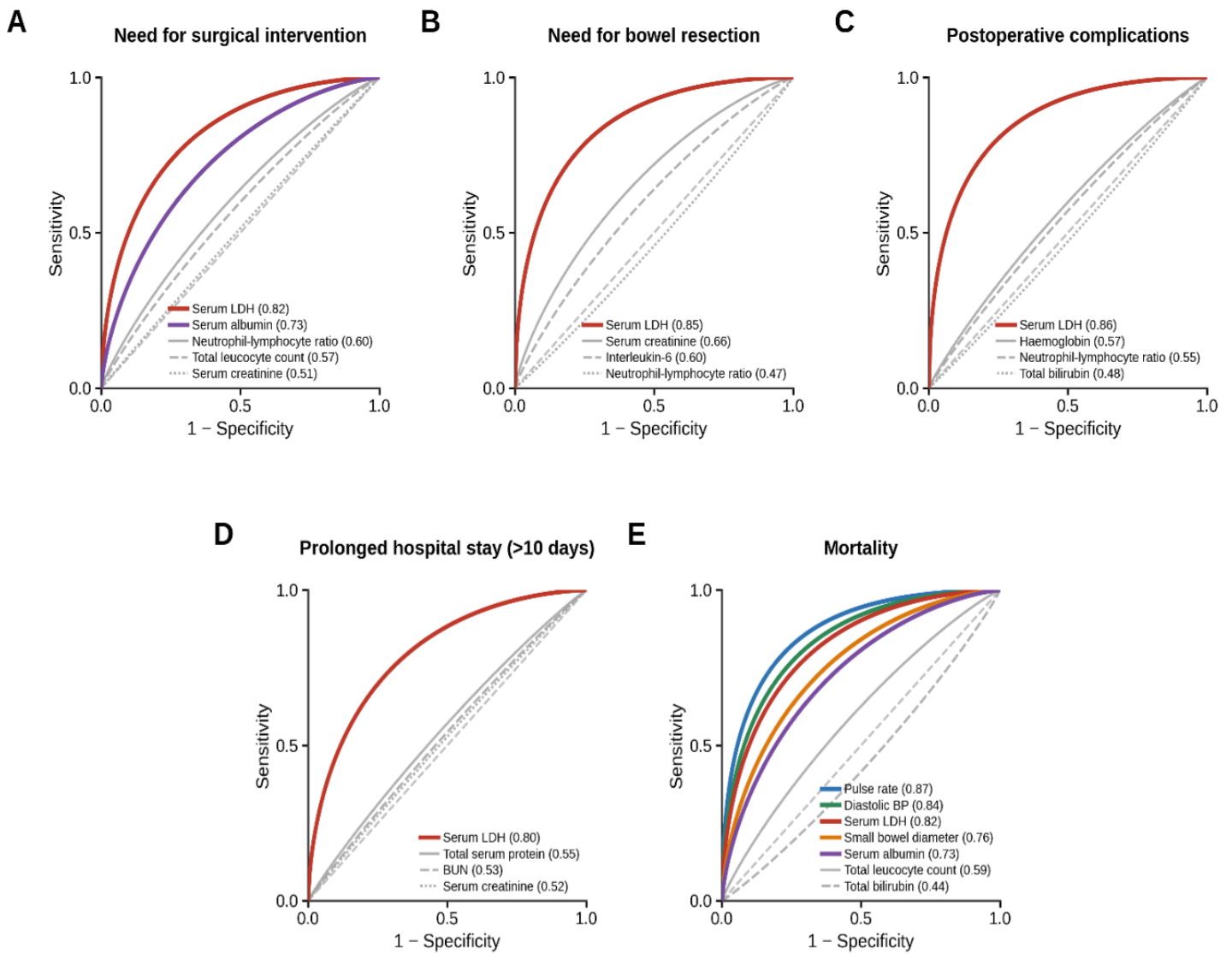


Figure 3

Receiver operating characteristic (ROC) curves for univariable predictors of adverse outcomes in intestinal obstruction. (A) Need for surgical intervention; (B) Need for bowel resection; (C) Postoperative complications; (D) prolonged hospital stay (>10 days); (E) Mortality. Coloured curves denote statistically significant predictors; grey curves denote non-significant variables shown for comparison.