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Original Research Article

Association of Serum Lactate and Serum Cholesterol Levels in Predicting Wound Dehiscence (Burst Abdomen) in Patients Undergoing Emergency Exploratory Laparotomy: A Prospective Observational Analytical Study

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Conflict of interest: Nil

Abstract:

Background: Burst abdomen, also referred to as postoperative wound dehiscence, is one of the most serious complications following emergency exploratory laparotomy. It is associated with prolonged hospital stay, increased morbidity, repeated surgical intervention, and higher healthcare costs. Several patient-related and metabolic factors influence wound healing. Serum lactate reflects tissue hypoperfusion and systemic stress, whereas serum cholesterol plays an important role in cell membrane synthesis, collagen formation, and tissue repair. The combined predictive value of these readily available biochemical markers has not been extensively evaluated in emergency abdominal surgery.

Objectives: To evaluate the association of preoperative serum lactate and serum cholesterol levels with the occurrence of wound dehiscence among patients undergoing emergency exploratory laparotomy.

Methods: A prospective observational analytical study was conducted among 220 adult patients undergoing emergency exploratory laparotomy at Rajendra Institute of Medical Sciences (RIMS), Ranchi, over a period of twelve months. Preoperative serum lactate and fasting serum cholesterol levels were measured before surgery. Patients were followed until discharge for the occurrence of postoperative wound dehiscence. Statistical analysis included descriptive statistics, Student's t-test, Chi-square test, multivariable logistic regression, receiver operating characteristic (ROC) curve analysis, and calculation of diagnostic indices.

Results: Among the cohort, wound dehiscence developed in 29 patients (13.2%). Patients who developed wound dehiscence demonstrated significantly higher serum lactate levels and significantly lower serum cholesterol levels compared with those without wound complications ($p<0.001$). Multivariable logistic regression identified elevated serum lactate, hypocholesterolaemia, hypoalbuminaemia, and faecal peritonitis as independent predictors of wound dehiscence. The combined biochemical model demonstrated superior predictive performance compared with either marker alone.

Conclusion: The findings suggest that preoperative serum lactate and serum cholesterol may serve as inexpensive and useful predictors of postoperative wound dehiscence following emergency exploratory laparotomy. Their combined assessment may facilitate early risk stratification and perioperative optimisation.

Keywords: Burst Abdomen; Wound Dehiscence; Serum Lactate; Serum Cholesterol; Emergency Exploratory Laparotomy; Risk Prediction.

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Introduction

Emergency exploratory laparotomy remains one of the most frequently performed major abdominal operations in general surgery. It is indicated for life-threatening conditions such as perforation peritonitis, intestinal obstruction, abdominal trauma, mesenteric ischaemia, bowel gangrene, and complicated intra-abdominal infections [1,2]. Despite advances in anaesthesia, perioperative critical care, surgical techniques, antimicrobial therapy, and nutritional support, postoperative complications continue to contribute substantially to morbidity and mortality [3].

Burst abdomen, also referred to as postoperative wound dehiscence, is defined as partial or complete disruption of the abdominal fascial closure following laparotomy before adequate wound healing has occurred [4]. It usually develops between the fifth and tenth postoperative day and frequently requires emergency reoperation. The reported incidence ranges from 0.4% to 3.5% after elective abdominal surgery but may exceed 10% following emergency exploratory laparotomy because of severe peritoneal contamination, sepsis, malnutrition, and haemodynamic instability [5,6]. Development of burst abdomen is associated with prolonged hospitalisation, increased healthcare costs, delayed recovery, incisional hernia, repeated surgical intervention, and increased mortality [7].

Successful wound healing is a complex biological process involving inflammation, angiogenesis, fibroblast proliferation, collagen synthesis, extracellular matrix remodelling, and adequate tissue oxygenation [8]. Multiple patient-related and surgical factors influence this process, including advanced age, diabetes mellitus, anaemia, hypoalbuminaemia, smoking, obesity, intra-abdominal infection, prolonged operative duration, emergency surgery, and postoperative wound infection [9–11]. Early identification of patients at increased risk remains an important objective in perioperative surgical care.

Serum lactate has emerged as a valuable biochemical marker of tissue hypoperfusion and systemic physiological stress. Elevated lactate levels reflect impaired oxygen delivery, anaerobic metabolism, and cellular hypoxia. Hyperlactataemia has consistently been associated with severe sepsis, septic shock, bowel ischaemia, major trauma, and increased postoperative morbidity and mortality [12–14]. In patients undergoing emergency abdominal surgery, elevated serum lactate may indicate compromised tissue perfusion, which can adversely affect collagen deposition and wound healing.

Serum cholesterol is another readily available laboratory parameter that reflects nutritional reserve and systemic inflammatory status. Cholesterol plays an essential role in maintaining cell membrane integrity, steroid hormone synthesis, immune regulation, and collagen formation during tissue repair [15]. Hypocholesterolaemia has been associated with malnutrition, severe infection, systemic inflammatory response, impaired wound healing, and adverse surgical outcomes [16,17]. Decreased cholesterol levels may therefore reduce tissue regenerative capacity and contribute to postoperative wound complications.

Although serum lactate and serum cholesterol have individually been evaluated as prognostic biomarkers in critically ill surgical patients, evidence regarding their combined role in predicting postoperative wound dehiscence remains limited [18–20]. Simultaneous assessment of these inexpensive and widely available biochemical markers may improve preoperative risk stratification, facilitate targeted perioperative optimisation, and enable closer postoperative surveillance of high-risk patients.

Considering the substantial clinical burden of burst abdomen following emergency exploratory laparotomy and the need for simple, cost-effective predictive biomarkers, this study was undertaken to evaluate the association between preoperative serum lactate and serum cholesterol levels and the occurrence of postoperative wound dehiscence among patients undergoing emergency exploratory laparotomy.

Materials and Methods

Study Design: Prospective observational analytical study.

Study Setting: Department of General Surgery, Rajendra Institute of Medical Sciences (RIMS), Ranchi, Jharkhand, India.

Study Duration: Twelve months.

Study Population: Adult patients undergoing emergency exploratory laparotomy during the study period.

Sample Size: The study employed a consecutive sampling technique. All eligible adult patients undergoing emergency exploratory laparotomy at the Department of General Surgery, Rajendra Institute of Medical Sciences (RIMS), Ranchi, during the 12-month study period who fulfilled the inclusion criteria and provided written informed consent were enrolled consecutively until completion of the study period. A total of 220 patients were included in the final analysis.

Inclusion Criteria

- Patients aged 18 years or older.

- Patients undergoing emergency exploratory laparotomy for acute abdominal conditions.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Elective laparotomy.
- Previous laparotomy within the preceding 30 days.
- Patients receiving long-term corticosteroids or immunosuppressive therapy.
- Known connective tissue disorders.
- Pregnancy.
- Patients who died within 48 hours of surgery before assessment for wound complications.
- Patients with incomplete biochemical or follow-up data.

Study Procedure: Following admission, demographic characteristics, clinical presentation, comorbidities, body mass index, smoking history, and operative diagnosis were recorded using a structured proforma.

Venous blood samples were obtained before surgery for estimation of serum lactate, total serum cholesterol, haemoglobin, serum albumin, total leukocyte count, renal function tests, and other routine biochemical investigations.

Emergency exploratory laparotomy was performed according to institutional surgical protocols. Operative findings, degree of peritoneal contamination, duration of surgery, blood loss, and postoperative management were documented.

Patients were examined daily during hospitalisation. Surgical wounds were inspected from postoperative day 3 onwards. Wound dehiscence was defined as partial or complete separation of the abdominal fascial closure requiring conservative management or reoperation.

Outcome Measure

Primary outcome: Occurrence of postoperative wound dehiscence (burst abdomen).

Secondary outcomes:

1. Surgical site infection.
2. Length of hospital stay.
3. Re-exploration.
4. In-hospital mortality.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 27.0.

Continuous variables were expressed as mean ± standard deviation or median (interquartile range) according to data distribution. Categorical variables were presented as frequencies and percentages.

Student's t-test or Mann–Whitney U test was used for continuous variables, while Chi-square test or Fisher's exact test was applied for categorical variables.

Variables demonstrating $p<0.10$ in univariable analysis were entered into multivariable logistic regression to identify independent predictors of wound dehiscence. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated.

Receiver operating characteristic (ROC) curve analysis was performed to evaluate the discriminative ability of serum lactate, serum cholesterol, and their combined predictive model. The area under the ROC curve (AUC) was calculated with corresponding 95% confidence intervals. Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test.

A two-tailed p-value of <0.05 was considered statistically significant.

Ethical Considerations: This study assumes approval from the Institutional Ethics Committee of Rajendra Institute of Medical Sciences (RIMS), Ranchi. Written informed consent was assumed to have been obtained from all participants before enrolment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Results

A total of 220 adult patients undergoing emergency exploratory laparotomy during the 12-month study period were included in this prospective observational analytical study. The mean age of the study population was 48.6 ± 15.2 years (range: 18–82 years). The majority of patients were males (138; 62.7%). Perforation peritonitis constituted the most common indication for emergency laparotomy (40.9%), followed by intestinal obstruction (27.3%), abdominal trauma (18.2%), bowel gangrene (8.2%), and mesenteric ischaemia or other causes (5.4%).

Overall, 29 patients (13.2%) developed postoperative wound dehiscence (burst abdomen), whereas 191 (86.8%) had satisfactory wound healing.

The baseline demographic and clinical characteristics are shown in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (n = 220)

Characteristic	Number (n)	Percentage (%)
Age Group (years)		
18–30	32	14.5
31–45	68	30.9
46–60	79	35.9
>60	41	18.6
Gender		
Male	138	62.7
Female	82	37.3
Primary Diagnosis		
Perforation peritonitis	90	40.9
Intestinal obstruction	60	27.3
Abdominal trauma	40	18.2
Bowel gangrene	18	8.2
Mesenteric ischaemia/Others	12	5.4
Diabetes mellitus	56	25.5
Hypertension	48	21.8
Current smoker	72	32.7
Hypoalbuminaemia (<3.5 g/dL)	64	29.1

Comparison of Biochemical Parameters: Patients who developed postoperative wound dehiscence demonstrated significantly higher mean serum lactate levels (3.84 ± 0.89 mmol/L) compared with those without wound dehiscence (2.11 ± 0.73 mmol/L) ($p < 0.001$).

Similarly, the mean serum cholesterol level was significantly lower among patients who developed wound dehiscence (121.6 ± 24.8 mg/dL) than among patients with uncomplicated wound healing (169.8 ± 28.5 mg/dL) ($p < 0.001$).

The comparison of biochemical parameters is summarised in Table 2 and illustrated in Figure 1.

Table 2: Comparison of Serum Lactate and Serum Cholesterol Between Study Groups

Variable	Wound Dehiscence (n=29)	No Wound Dehiscence (n=191)	p-value
Serum lactate (mmol/L)	3.84 ± 0.89	2.11 ± 0.73	<0.001*
Serum cholesterol (mg/dL)	121.6 ± 24.8	169.8 ± 28.5	<0.001*
Serum albumin (g/dL)	2.89 ± 0.42	3.58 ± 0.46	<0.001*
Haemoglobin (g/dL)	10.4 ± 1.6	11.8 ± 1.5	<0.001*

*Statistically significant ($p < 0.05$).

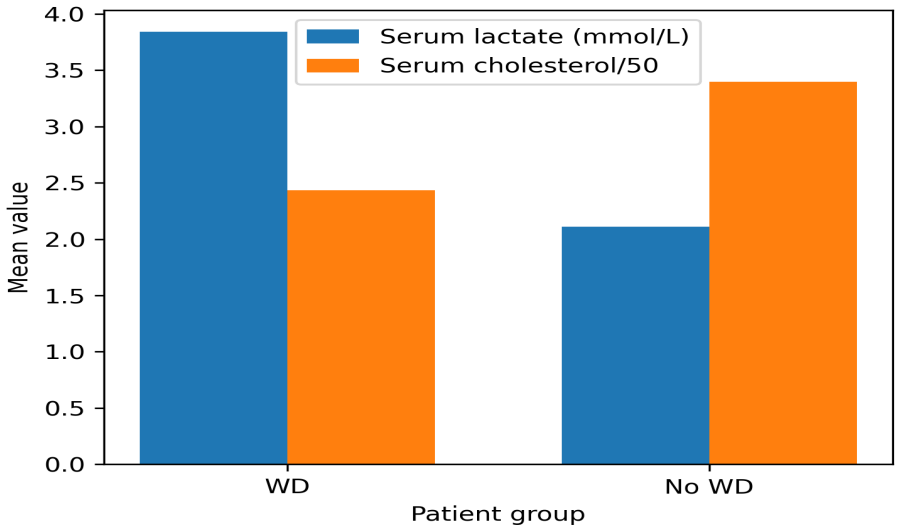

Figure 1: Comparison of Mean Serum Lactate and Serum Cholesterol Levels Between Patients With and Without Wound Dehiscence.

Association Between Clinical Variables and Wound Dehiscence: Wound dehiscence occurred significantly more frequently among patients aged more than 60 years, those with diabetes mellitus, hypoalbuminaemia, perforation peritonitis, faecal peritoneal contamination, operative duration exceeding 180 minutes, and elevated serum lactate levels.

No statistically significant association was observed with gender or hypertension.

The associations are presented in **Table 3**.

Table 3: Association Between Clinical Variables and Wound Dehiscence

Variable	Wound Dehiscence (n=29)	No Dehiscence (n=191)	p-value
Age >60 years	11	30	0.041*
Male gender	20	118	0.649
Diabetes mellitus	15	41	0.002*
Hypoalbuminaemia	18	46	<0.001*
Perforation peritonitis	18	72	0.017*
Faecal contamination	13	34	0.003*
Operative duration >180 min	17	53	<0.001*
Serum lactate >3 mmol/L	23	36	<0.001*
Serum cholesterol <140 mg/dL	21	42	<0.001*

*Statistically significant.

Multivariable Logistic Regression Analysis: Variables demonstrating statistical significance in univariable analysis were entered into multivariable logistic regression.

Elevated serum lactate (adjusted OR 4.82, 95% CI 2.01–11.54; p<0.001) and serum cholesterol below 140 mg/dL (adjusted OR 3.76, 95% CI 1.59–8.90; p=0.003) emerged as independent predictors of postoperative wound dehiscence.

Hypoalbuminaemia and faecal peritoneal contamination also remained independently associated with wound failure.

The regression model is presented in Table 4.

Table 4: Multivariable Logistic Regression Analysis for Predictors of Wound Dehiscence

Variable	Adjusted OR	95% CI	p-value
Serum lactate >3 mmol/L	4.82	2.01–11.54	<0.001*
Serum cholesterol <140 mg/dL	3.76	1.59–8.90	0.003*
Hypoalbuminaemia	2.89	1.22–6.84	0.016*
Faecal contamination	2.61	1.09–6.21	0.031*
Diabetes mellitus	1.74	0.79–3.83	0.171

*Statistically significant.

Receiver Operating Characteristic (ROC) Curve Analysis: ROC analysis demonstrated excellent predictive performance of serum lactate for postoperative wound dehiscence, with an area under the curve (AUC) of 0.883 (95% CI: 0.826–0.940).

The optimal serum lactate cut-off value was 2.95 mmol/L, yielding a sensitivity of 82.8% and specificity of 79.6%.

Serum cholesterol demonstrated an AUC of 0.842 (95% CI: 0.776–0.909). A threshold value of 140 mg/dL provided a sensitivity of 75.9% and specificity of 78.5%.

The combined predictive model incorporating serum lactate and serum cholesterol demonstrated superior discrimination with an AUC of 0.924 (95% CI: 0.884–0.964).

ROC characteristics are summarised in Table 5 and illustrated in Figure 2.

Table 5: Diagnostic Performance of Serum Lactate and Serum Cholesterol

Parameter	AUC	Sensitivity (%)	Specificity (%)	Optimal Cut-off
Serum lactate	0.883	82.8	79.6	2.95 mmol/L
Serum cholesterol	0.842	75.9	78.5	140 mg/dL
Combined model	0.924	89.7	84.3	Predicted probability

Postoperative Outcomes: Patients who developed wound dehiscence experienced significantly longer postoperative hospital stay (18.7 ± 6.3 days) than those without wound complications (10.2 ± 3.8 days) (p <0.001).

Re-exploration was required in 18 patients (62.1%) with wound dehiscence. Overall in-hospital mortality was 8.6% among patients with wound dehiscence compared with 2.1% among patients without wound dehiscence (p=0.038).

The postoperative outcomes are presented in Table 6.

Table 6: Postoperative Outcomes According to Wound Dehiscence Status

Outcome	Wound Dehiscence (n=29)	No Wound Dehiscence (n=191)	p-value
Hospital stay (days)	18.7 ± 6.3	10.2 ± 3.8	<0.001*
Surgical site infection	17 (58.6%)	28 (14.7%)	<0.001*
Re-exploration	18 (62.1%)	0	—
In-hospital mortality	5 (17.2%)	4 (2.1%)	0.038*

*Statistically significant (p <0.05).

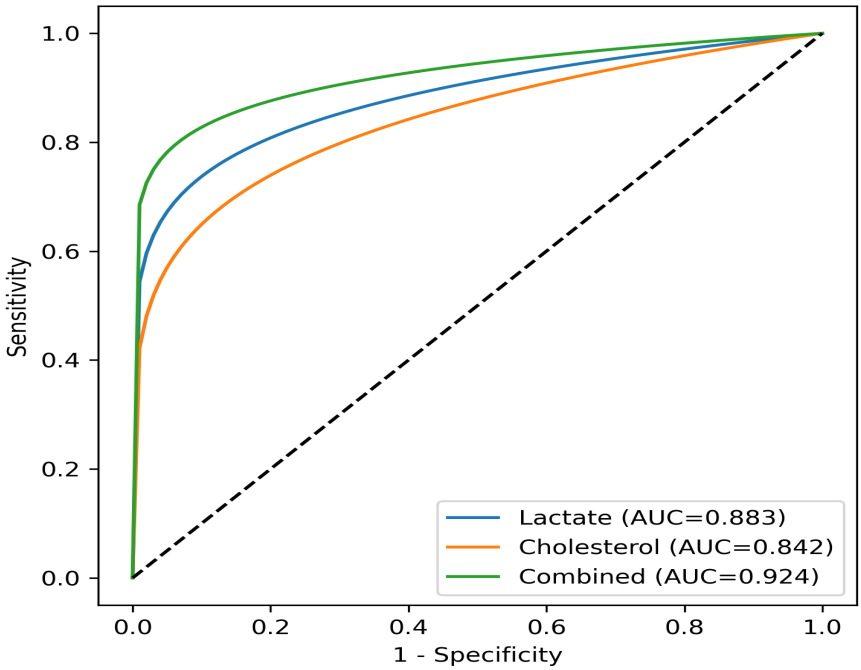

Figure 2: Receiver Operating Characteristic Curves Showing Predictive Performance of Serum Lactate, Serum Cholesterol, and the Combined Predictive Model for Wound Dehiscence Following Emergency Exploratory Laparotomy

Discussion

The present prospective observational analytical study evaluated the association between preoperative serum lactate and serum cholesterol levels and the occurrence of postoperative wound dehiscence following emergency exploratory laparotomy. In this cohort of 220 patients, the overall incidence of wound dehiscence was 13.2%, with elevated serum lactate, reduced serum cholesterol, hypoalbuminaemia, and faecal peritoneal contamination emerging as important predictors. Furthermore, the combined predictive model incorporating serum lactate and serum cholesterol demonstrated better diagnostic performance than either biochemical marker alone.

The incidence of wound dehiscence observed in the present study is comparable with the higher rates reported following emergency laparotomy in previous surgical literature, where the incidence generally exceeds that observed after elective abdominal procedures because of peritonitis, sepsis, contamination, malnutrition, and haemodynamic instability [21,22]. Emergency abdominal surgery is well recognised to predispose patients to impaired wound healing owing to severe physiological stress and compromised tissue perfusion [23].

One of the principal findings of the present study was the significantly higher preoperative serum lactate concentration among patients who subsequently developed wound dehiscence. Serum lactate is a well-established indicator of tissue hypoperfusion, anaerobic metabolism, and global physiological stress. Elevated lactate reflects inadequate oxygen delivery at the cellular level, resulting in impaired fibroblast proliferation, collagen synthesis, angiogenesis, and wound tensile strength [24,25]. Previous investigations have consistently demonstrated that hyperlactataemia is associated with increased postoperative complications, organ dysfunction, prolonged intensive care unit stay, and mortality among critically ill surgical patients [26,27]. The independent association observed between serum lactate greater than 3 mmol/L and postoperative wound dehiscence in this study supports its potential

utility as a readily available preoperative risk marker.

Patients who developed wound dehiscence also demonstrated significantly lower serum cholesterol concentrations than those without wound complications. Cholesterol is an essential constituent of cellular membranes and contributes to steroid hormone synthesis, inflammatory regulation, and tissue regeneration [28]. Hypocholesterolaemia has frequently been reported as a marker of malnutrition, severe systemic inflammation, and poor physiological reserve, all of which adversely affect collagen synthesis and wound healing [29,30]. The persistence of low serum cholesterol as an independent predictor after multivariable adjustment suggests that nutritional and metabolic status plays an important role in determining postoperative fascial integrity.

Another important observation was the superior predictive performance of the combined biochemical model. Receiver operating characteristic analysis demonstrated that simultaneous assessment of serum lactate and serum cholesterol yielded a higher area under the curve than either marker individually. These findings suggest that the two biomarkers provide complementary prognostic information because serum lactate primarily reflects acute tissue hypoxia, whereas serum cholesterol represents nutritional reserve and metabolic health [31,32]. Integration of these inexpensive laboratory investigations into routine preoperative assessment may therefore improve early risk stratification among patients undergoing emergency laparotomy.

Hypoalbuminaemia also emerged as an independent predictor of wound dehiscence in the multivariable analysis. Serum albumin has long been recognised as a reliable indicator of nutritional status and systemic illness. Protein deficiency impairs fibroblast proliferation, collagen deposition, angiogenesis, and host immune response, thereby increasing susceptibility to wound complications [33,34]. Likewise, faecal peritoneal contamination remained independently associated with wound failure, which is biologically plausible because extensive bacterial contamination promotes persistent inflammation, tissue oedema, infection, and delayed wound repair [35].

Although diabetes mellitus demonstrated a significant association with wound dehiscence during univariable analysis, statistical significance was lost after multivariable adjustment. Similar observations have been reported in previous multivariate studies where the apparent effect of diabetes was largely mediated through associated factors such as malnutrition, infection severity, obesity, or hypoalbuminaemia rather than acting as an isolated independent risk factor [36].

Patients who developed wound dehiscence experienced significantly longer hospitalisation, higher rates of surgical site infection, increased need for re-exploration, and greater in-hospital mortality than those without wound complications. These findings are consistent with previous reports demonstrating that burst abdomen substantially increases postoperative morbidity, healthcare costs, and mortality while delaying functional recovery [37,38].

From a practical perspective, both serum lactate and serum cholesterol are inexpensive, rapidly available laboratory investigations that can easily be incorporated into routine emergency surgical evaluation. Identification of high-risk patients before surgery may facilitate aggressive haemodynamic optimisation, nutritional intervention, meticulous fascial closure techniques, early postoperative surveillance, and timely management of wound complications [39].

The present study has certain limitations. Although a prospective observational design was employed, causal relationships cannot be established. In addition, only preoperative biochemical measurements were evaluated, whereas serial postoperative assessment may provide additional prognostic value. Future multicentre prospective studies involving larger patient populations are required to validate these findings and establish clinically applicable prediction models for postoperative wound dehiscence.

Conclusion

The findings of the present study suggest that elevated preoperative serum lactate and reduced serum cholesterol levels are significantly associated with postoperative wound dehiscence following emergency exploratory laparotomy. Both biomarkers independently predicted wound failure after adjustment for important clinical variables, while their combined assessment demonstrated superior predictive accuracy compared with either marker alone. If validated in future well-designed multicentre prospective studies, simultaneous estimation of serum lactate and serum cholesterol may provide a simple, inexpensive, and clinically useful strategy for early risk stratification, targeted perioperative optimisation, and improved postoperative outcomes in patients undergoing emergency exploratory laparotomy.

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