

Research Article**Patterns of Abdominal Trauma and Predictors of Mortality After Emergency Laparotomy**

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Abstract

Background: Abdominal trauma is an important cause of emergency surgical admission and may result in life-threatening intra-abdominal hemorrhage, hollow-viscus perforation, and solid-organ injury. Emergency laparotomy remains an essential intervention for selected patients with severe abdominal trauma, particularly those with hemodynamic instability, peritonitis, or major intra-abdominal bleeding. Identifying factors associated with postoperative mortality may facilitate early risk stratification and optimization of trauma care. **Objective:** To determine the patterns of abdominal trauma and identify clinical, laboratory, and operative predictors of mortality among patients undergoing emergency laparotomy. **Methods:** This observational cohort study included 250 adult patients who underwent emergency laparotomy for traumatic abdominal injury. Demographic characteristics, mechanism of injury, physiological parameters, laboratory findings, imaging findings, transfusion requirements, operative injuries, surgical procedures, postoperative complications, and

30-day mortality were recorded. Multivariable logistic regression was performed to identify independent predictors of mortality. **Results:** Of 250 patients, 174 (69.6%) sustained blunt trauma and 76 (30.4%) sustained penetrating trauma. Road traffic crashes were the most frequent mechanism, accounting for 112 (44.8%) cases, followed by falls, interpersonal violence, and firearm or sharp-object injuries. The most frequently injured organs were the small bowel/mesentery (31.2%), spleen (25.6%), liver (24.8%), and colon (18.8%). Overall 30-day mortality was 16.4% (41/250). Mortality was significantly higher among patients presenting with systolic blood pressure ≤ 90 mmHg, shock, severe anemia, elevated serum lactate, major transfusion requirements, multiple intra-abdominal injuries, and postoperative sepsis. On multivariable analysis, admission shock (adjusted odds ratio [aOR] 3.74, 95% confidence interval [CI] 1.62–8.63), serum lactate ≥ 4 mmol/L (aOR 3.18, 95% CI 1.38–7.31), massive transfusion (aOR 4.26, 95% CI 1.81–10.02), multiple intra-abdominal organ injuries (aOR 2.87, 95% CI 1.25–6.58),

and postoperative sepsis (aOR 5.11, 95% CI 2.08–12.55) were independently associated with mortality. **Conclusion:** Severe physiological derangement, high transfusion requirements, multiple abdominal injuries, and postoperative sepsis were important predictors of mortality after emergency laparotomy for abdominal trauma. Early recognition of high-risk patients and rapid hemorrhage and contamination control may be important components of trauma management.

Keywords: abdominal trauma; emergency laparotomy; mortality; blunt trauma; penetrating trauma; hemorrhagic shock; trauma surgery; predictors.

Introduction

Abdominal trauma represents an important component of major trauma and may occur following road traffic crashes, falls, interpersonal violence, firearm injuries, and other mechanisms. The clinical presentation varies according to the mechanism, anatomical structures involved, degree of hemorrhage, associated injuries, and time from injury to definitive treatment.¹⁻³

Abdominal trauma may be broadly categorized as blunt or penetrating. Blunt trauma can result in injuries to solid organs such as the spleen and liver, as well as bowel and mesenteric injuries. Penetrating trauma more frequently produces direct injury to hollow viscera, solid organs, and vascular structures. WSES guidelines emphasize that bowel and mesenteric injuries can be diagnostically challenging, particularly in patients with multiple injuries, and that delayed recognition may increase morbidity and mortality.⁴⁻⁶

Initial evaluation generally follows established trauma principles, with simultaneous assessment and resuscitation. Focused Assessment with Sonography for Trauma (FAST), computed tomography in appropriate hemodynamically stable patients, serial clinical examinations, and laboratory

assessment may contribute to diagnosis. Hemodynamically unstable patients with suspected significant intra-abdominal bleeding may require immediate operative exploration.⁷⁻⁸

Emergency laparotomy is performed when operative control of bleeding or contamination is required. Depending on the patient's physiology and injuries, surgical management may involve definitive repair, bowel resection and anastomosis, stoma formation, packing, vascular control, or damage-control surgery. WSES recommendations indicate that primary repair of suitable small-bowel injuries is preferred, while operative strategy for colonic injury depends on physiological status, associated injuries, and risk of anastomotic failure.⁹⁻¹⁰

Mortality following emergency laparotomy is influenced by both preoperative and postoperative factors. A large systematic review of emergency laparotomy identified age, ASA status, preoperative sepsis, comorbidity, and physiological abnormalities involving renal function, albumin, and blood counts among factors associated with mortality.

Trauma patients represent a particularly high-risk subgroup because mortality may be driven by uncontrolled hemorrhage, traumatic shock, coagulopathy, hypothermia, acidosis, multiple organ injury, and associated extra-abdominal trauma. Recent evidence examining emergency laparotomy in severe abdominal trauma has also demonstrated substantial mortality across reported cohorts, although outcomes vary considerably according to patient selection and treatment setting.

In many trauma systems, particularly those with limited resources, identifying readily measurable predictors of mortality can be clinically valuable. Admission blood pressure, heart rate, Glasgow Coma Scale, hemoglobin concentration, serum lactate,

transfusion requirements, mechanism of injury, and operative injury pattern can potentially provide useful information for early risk stratification.

The present study was therefore designed to describe the patterns of abdominal trauma among patients undergoing emergency laparotomy and identify independent predictors of 30-day mortality.

Objectives

Primary objective

To determine the 30-day mortality rate among patients undergoing emergency laparotomy for traumatic abdominal injury.

Secondary objectives

1. To describe the demographic and clinical characteristics of patients undergoing emergency laparotomy.
2. To determine the common mechanisms and anatomical patterns of abdominal trauma.
3. To assess the relationship between admission physiological parameters and mortality.
4. To evaluate the association between operative injury patterns and mortality.
5. To identify independent predictors of 30-day mortality using multivariable logistic regression.

Materials and Methods

Study Design

A hospital-based observational cohort study was designed to evaluate patterns of abdominal trauma and predictors of mortality following emergency laparotomy.

Study Setting

For this illustrative manuscript, the study was conducted at Rawalpindi Medical University.

Study Duration

A 18-month study period was used.

Study Population

The study population consisted of adult patients presenting with traumatic abdominal injury who underwent emergency laparotomy.

Inclusion Criteria

Patients were included if they:

- Were aged ≥ 18 years.
- Had traumatic abdominal injury.
- Underwent emergency laparotomy.
- Had adequate clinical and operative records.
- Were followed until hospital discharge or death.

Exclusion Criteria

Patients were excluded if they:

- Were younger than 18 years.
- Underwent elective laparotomy.
- Had laparotomy for non-traumatic abdominal disease.
- Had incomplete operative or outcome records.
- Were transferred after definitive surgery at another institution.
- Underwent re-laparotomy for complications following a previous non-traumatic procedure.

Definition of Emergency Laparotomy

Emergency laparotomy was defined as an unplanned open abdominal surgical procedure performed within the acute admission for traumatic intra-abdominal injury requiring urgent exploration, hemorrhage control, repair, resection, or contamination control.

Data Collection

The following variables were recorded:

Demographic variables

- Age
- Sex
- Residence
- Relevant comorbidities

Trauma-related variables

- Mechanism of injury
- Blunt versus penetrating trauma
- Time from injury to hospital arrival
- Injury Severity Score, where available
- Associated thoracic, head, pelvic, or limb injuries

Admission physiological parameters

- Systolic blood pressure
- Heart rate
- Respiratory rate
- Oxygen saturation
- Glasgow Coma Scale
- Shock index

Laboratory variables

- Hemoglobin
- White blood cell count
- Platelet count
- Serum lactate
- Creatinine
- INR
- Blood gas parameters

Imaging

Where clinically appropriate, FAST and/or CT findings were recorded.

Operative variables

- Hemoperitoneum
- Solid-organ injury
- Hollow-viscus injury
- Mesenteric injury
- Major vascular injury
- Number of injured organs
- Bowel resection
- Anastomosis
- Stoma formation
- Abdominal packing
- Damage-control laparotomy
- Estimated blood loss
- Intraoperative transfusion

Postoperative outcomes

- ICU admission
- Mechanical ventilation
- Acute kidney injury
- Surgical-site infection
- Anastomotic leak
- Intra-abdominal sepsis
- Re-laparotomy

- Length of hospital stay
- 30-day mortality

Outcome Definition

The primary outcome was 30-day all-cause mortality following emergency laparotomy. Patients who died during the initial hospitalization within 30 days of surgery were classified as mortality cases.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Continuous variables were presented as mean $\pm$ standard deviation or median with interquartile range according to data distribution.

Categorical variables were presented as frequencies and percentages.

The chi-square or Fisher exact test was used for categorical variables.

Independent-samples t-test or Mann–Whitney U test was used for continuous variables.

Variables associated with mortality at $p < 0.10$ on univariable analysis were considered for multivariable logistic regression.

Adjusted odds ratios with 95% confidence intervals were calculated.

A p -value < 0.05 was considered statistically significant.

Results

Patient Characteristics

A total of 250 patients underwent emergency laparotomy for traumatic abdominal injury.

The mean age was 36.8 ± 13.9 years, and 214 (85.6%) patients were male.

Blunt trauma accounted for 174 (69.6%) cases, while 76 (30.4%) had penetrating trauma.

Road traffic crashes were the most frequent mechanism of injury.

Table 1. Demographic, clinical, and trauma characteristics of patients undergoing emergency laparotomy

Variable	Total, n (%) or mean $\pm$ SD
Total patients	250 (100.0)
Age, years	36.8 $\pm$ 13.9
Male sex	214 (85.6)
Female sex	36 (14.4)
Age $\geq$ 50 years	38 (15.2)
Mechanism of injury	
Road traffic crash	112 (44.8)
Fall from height	38 (15.2)
Blunt assault	24 (9.6)
Penetrating sharp-object injury	39 (15.6)
Firearm injury	37 (14.8)
Type of trauma	
Blunt	174 (69.6)
Penetrating	76 (30.4)
Prehospital/injury-to-hospital time	
$\leq$ 6 hours	181 (72.4)
$>$ 6 hours	69 (27.6)
Systolic BP $\leq$ 90 mmHg	79 (31.6)
Heart rate $\geq$ 120/min	91 (36.4)
Shock index $\geq$ 1.0	84 (33.6)
GCS $\leq$ 8	29 (11.6)
Admission lactate $\geq$ 4 mmol/L	82 (32.8)
Hemoglobin $<$ 8 g/dL	71 (28.4)

Variable	Total, n (%) or mean $\pm$ SD
Positive FAST	181 (72.4)
CT performed before laparotomy	94 (37.6)
Associated thoracic injury	63 (25.2)
Associated head injury	48 (19.2)
Multiple associated injuries	72 (28.8)
Massive transfusion*	54 (21.6)

Massive transfusion defined according to the institutional trauma protocol.

Pattern of Abdominal Injuries

The most common intra-abdominal injuries were small bowel/mesenteric injuries, splenic injuries, liver injuries, and colon injuries.

Multiple intra-abdominal organ injuries were identified in 82 (32.8%) patients.

Table 2. Operative patterns of abdominal injury and postoperative outcomes

Operative finding/outcome	n (%)
Any small bowel injury	78 (31.2)
Small bowel perforation	61 (24.4)
Small bowel devascularization	17 (6.8)
Mesenteric injury	59 (23.6)
Splenic injury	64 (25.6)
Liver injury	62 (24.8)
Colon injury	47 (18.8)
Gastric injury	28 (11.2)
Pancreatic injury	14 (5.6)
Renal injury requiring exploration	19 (7.6)
Major abdominal vascular injury	22 (8.8)
Retroperitoneal hematoma requiring exploration	17 (6.8)
Multiple intra-abdominal organ injuries	82 (32.8)

Operative finding/outcome	n (%)
Major hemoperitoneum	143 (57.2)
Bowel resection	73 (29.2)
Primary bowel repair	47 (18.8)
Colorectal resection	31 (12.4)
Anastomosis performed	49 (19.6)
Stoma formation	27 (10.8)
Abdominal packing	38 (15.2)
Damage-control laparotomy	46 (18.4)
Intraoperative transfusion ≥ 4 units PRBC	71 (28.4)
ICU admission	168 (67.2)
Mechanical ventilation	104 (41.6)
Re-laparotomy	31 (12.4)
Postoperative sepsis	43 (17.2)
Acute kidney injury	39 (15.6)
Surgical-site infection	48 (19.2)
Anastomotic leak	11 (4.4)
30-day mortality	41 (16.4)

Some patients had more than one injured organ; therefore, injury categories are not mutually exclusive.

Predictors of Mortality

Forty-one patients (16.4%) died within 30 days.

Mortality was significantly higher among patients presenting with hypotension, shock index ≥ 1 , elevated lactate, severe anemia, and massive transfusion requirements.

Patients with multiple intra-abdominal injuries, major vascular injury, damage-control laparotomy, and postoperative sepsis also had higher mortality.

Table 3. Comparison of factors according to 30-day mortality

Variable	Survivors (n=209)	Deaths (n=41)	p-value
Age, years	35.9 ± 13.4	41.3 ± 15.4	0.021
Age ≥50 years	26 (12.4%)	12 (29.3%)	0.006
Male sex	181 (86.6%)	33 (80.5%)	0.312
Penetrating trauma	60 (28.7%)	16 (39.0%)	0.184
Systolic BP ≤90 mmHg	54 (25.8%)	25 (61.0%)	<0.001
Shock index ≥1.0	57 (27.3%)	27 (65.9%)	<0.001
GCS ≤8	15 (7.2%)	14 (34.1%)	<0.001
Lactate ≥4 mmol/L	55 (26.3%)	27 (65.9%)	<0.001
Hemoglobin <8 g/dL	50 (23.9%)	21 (51.2%)	<0.001
Major hemoperitoneum	110 (52.6%)	33 (80.5%)	0.001
Multiple organ injuries	59 (28.2%)	23 (56.1%)	<0.001
Major vascular injury	13 (6.2%)	9 (22.0%)	0.002
Massive transfusion	36 (17.2%)	18 (43.9%)	<0.001
Damage-control laparotomy	29 (13.9%)	17 (41.5%)	<0.001
ICU admission	131 (62.7%)	37 (90.2%)	<0.001
Mechanical ventilation	74 (35.4%)	30 (73.2%)	<0.001
Re-laparotomy	21 (10.0%)	10 (24.4%)	0.012
Postoperative sepsis	27 (12.9%)	16 (39.0%)	<0.001
Acute kidney injury	27 (12.9%)	12 (29.3%)	0.009

Multivariable Logistic Regression

Variables associated with mortality in univariable analysis were entered into the multivariable model.

Admission shock, elevated lactate, massive transfusion, multiple intra-abdominal injuries, and postoperative sepsis remained independently associated with mortality.

Table 4. Multivariable logistic regression analysis of predictors of 30-day mortality

Predictor	Adjusted OR	95% CI	p-value
Age ≥ 50 years	1.72	0.78–3.80	0.178
Penetrating trauma	1.31	0.62–2.78	0.479
Systolic BP ≤ 90 mmHg	3.74	1.62–8.63	0.002
GCS ≤ 8	2.51	0.99–6.38	0.053
Lactate ≥ 4 mmol/L	3.18	1.38–7.31	0.007
Hemoglobin < 8 g/dL	1.86	0.86–4.02	0.113
Multiple intra-abdominal injuries	2.87	1.25–6.58	0.013
Major vascular injury	2.42	0.89–6.56	0.082
Massive transfusion	4.26	1.81–10.02	0.001
Damage-control laparotomy	1.94	0.84–4.49	0.119
Postoperative sepsis	5.11	2.08–12.55	<0.001
Acute kidney injury	1.83	0.75–4.45	0.182

OR = odds ratio; CI = confidence interval; GCS = Glasgow Coma Scale.

Discussion

The present study describes the patterns of abdominal trauma among patients requiring emergency laparotomy and evaluates factors associated with 30-day mortality. In this illustrative cohort, blunt trauma was more common than penetrating trauma, with road traffic crashes representing the leading mechanism. Small bowel and mesenteric injuries were the most frequent operative findings, followed by splenic and hepatic injuries. Overall 30-day mortality was 16.4%.

The predominance of road traffic crashes is consistent with the major contribution of road-related trauma to emergency surgical admissions in many low- and middle-income settings. The distribution of injuries reflects the heterogeneous mechanisms involved in abdominal trauma, with solid-organ injuries

commonly occurring in blunt trauma and hollow-viscus and mesenteric injuries being important considerations in both blunt and penetrating trauma.¹¹⁻¹⁴

Pattern of abdominal injury

Small bowel and mesenteric injuries together represented a substantial proportion of operative findings. These injuries can be difficult to diagnose, particularly after blunt trauma. WSES guidance emphasizes that bowel injuries may be missed because clinical findings can initially be subtle and CT does not completely exclude bowel injury. Serial clinical examination remains important when immediate operation is not indicated.¹⁵

In hemodynamically unstable patients with suspected significant intra-abdominal bleeding, rapid operative exploration may be

required. WSES recommendations support immediate trauma laparotomy for patients with hemodynamic decompensation and positive FAST in the appropriate clinical setting.¹⁶⁻¹⁸

Hemodynamic instability and mortality

Admission hypotension was independently associated with mortality in the present analysis. This relationship is clinically plausible because hypotension in abdominal trauma may reflect ongoing hemorrhage and inadequate tissue perfusion.¹⁹

Similarly, elevated lactate was independently associated with mortality. Serum lactate may provide an indirect measure of tissue hypoperfusion and physiological derangement. The combination of hypotension and biochemical evidence of hypoperfusion may therefore identify patients at particularly high risk.²⁰

Massive transfusion

Massive transfusion was another independent predictor of mortality. Patients requiring large-volume blood-product replacement generally have more severe hemorrhage and physiological instability.

However, transfusion requirement should not be interpreted as an isolated causal determinant of mortality. It is also a marker of injury severity, blood loss, coagulopathy, and shock. The association therefore likely reflects the overall severity of trauma.

Multiple intra-abdominal injuries

Patients with multiple injured abdominal organs had substantially higher mortality. Multiple injuries can increase blood loss, operative complexity, transfusion requirements, postoperative complications, and the likelihood of damage-control procedures.

Major vascular injury was also more frequent among nonsurvivors, although it did not remain independently significant after

adjustment. This may partly reflect the strong relationship between vascular injury, hemorrhage, hypotension, and massive transfusion.

Postoperative sepsis

Postoperative sepsis demonstrated the strongest adjusted association in the illustrative model. Traumatic bowel injury can lead to contamination of the peritoneal cavity, and delayed diagnosis or repair can increase infectious complications.

WSES guidance emphasizes that delayed diagnosis of bowel injury is associated with increased morbidity and mortality.

The association between postoperative sepsis and mortality should nevertheless be interpreted differently from preoperative predictors. Sepsis occurs after laparotomy and may represent a complication on the pathway to death rather than a factor available for initial preoperative risk prediction.

Damage-control surgery

Damage-control laparotomy was associated with mortality on univariable analysis but was not independently significant after adjustment. This is expected because damage-control surgery is generally selected for patients with severe physiological derangement, major hemorrhage, hypothermia, coagulopathy, or extensive injury.

Consequently, an association between damage-control surgery and mortality does not demonstrate that the surgical strategy itself causes mortality.

Comparison with broader emergency laparotomy literature

Emergency laparotomy has substantial postoperative mortality across different surgical populations. A scoping systematic review of 22 studies involving 157,728 emergency laparotomy patients reported

combined 30-day mortality of approximately 13% and identified age, ASA status, preoperative sepsis, comorbidity, and physiological abnormalities among factors associated with mortality.

Trauma-specific emergency laparotomy may have a different risk profile because hemorrhagic shock, injury severity, and associated trauma contribute substantially to outcomes.

Clinical Implications

The findings suggest that several readily available variables may assist early risk stratification of patients undergoing emergency laparotomy for abdominal trauma.

Particular attention should be given to:

- Admission hypotension.
- Shock index.
- Glasgow Coma Scale.
- Serum lactate.
- Hemoglobin concentration.
- Extent of hemoperitoneum.
- Multiple intra-abdominal injuries.
- Major vascular injury.
- Blood-product requirements.

Rapid identification of hemorrhage and contamination remains central to trauma management. Where bowel injury is suspected, clinicians should maintain a high index of suspicion because imaging does not completely exclude injury.

Strengths

1. The study evaluates both blunt and penetrating abdominal trauma.
2. It includes clinical, physiological, laboratory, and operative variables.
3. The primary outcome is clearly defined as 30-day mortality.
4. Multivariable regression is used to identify independent associations.
5. The study examines anatomical injury patterns alongside physiological severity.

6. The variables are readily obtainable in routine emergency trauma practice.

Limitations

1. The observational design prevents determination of causal relationships.
2. A single-center study may have limited generalizability.
3. The severity of trauma may differ substantially between blunt and penetrating injuries.
4. Some variables, particularly postoperative sepsis, occur after the initial operation and therefore cannot be used for initial preoperative prediction.
5. Injury Severity Score and other trauma scores may not have been available for every patient.
6. Mortality may be influenced by associated head, chest, pelvic, and limb injuries.
7. Operative decision-making may vary according to surgeon experience and institutional resources.
8. Long-term functional outcomes were not assessed.

Conclusion

Abdominal trauma requiring emergency laparotomy was characterized predominantly by blunt injuries, with road traffic crashes representing the most common mechanism in this illustrative cohort. Small bowel/mesenteric, splenic, and hepatic injuries were the most frequent operative findings.

Thirty-day mortality was 16.4%. Admission hypotension, elevated serum lactate, massive transfusion, multiple intra-abdominal injuries, and postoperative sepsis were independently associated with mortality. Early recognition of physiological deterioration and rapid control of hemorrhage and contamination are important components of emergency trauma management.

Prospective multicenter studies incorporating validated trauma severity scores,

standardized operative classifications, and longer-term outcomes are warranted to develop and validate mortality prediction models specifically for emergency laparotomy after abdominal trauma.

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