ISSN: 2583-7354

International Journal of Emerging Knowledge Studies

Publisher's Home Page: https://www.ijeks.com/

Fully Open Access Research Paper

Outcomes of Laparotomy for Penetrating Abdominal Trauma in Military and Conflict Settings: A Scoping Review

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DOI: https://doi.org/10.70333/ijeks-05-03-005

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Article Info: - Received : 08 February 2026 **Accepted** : 25 March 2026 **Published** : 30 March 2026

Abstract

Penetrating abdominal trauma in military and conflict settings remains a major cause of preventable morbidity and mortality. In these environments, laparotomy remains the definitive surgical procedure for hemorrhage control, contamination management, and organ repair. Although literature on this topic is growing, outcomes following laparotomy in different conflict settings remain scattered and inconsistently reported. This scoping review aimed to map the available evidence on laparotomy outcomes in penetrating abdominal trauma across military, conflict, and conflict-adjacent environments. The review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). A structured search was performed in MEDLINE/PubMed, Embase, and Google Scholar. Studies reporting outcomes after laparotomy for penetrating abdominal trauma in military, deployed, or conflict environments were included. Data were extracted on mortality, surgical site infection, non-therapeutic laparotomy rates, anastomotic outcomes, and length of hospital stay. A total of 10 studies involving 2,776 patients from military deployed settings, mixed military–civilian environments, and civilian hospitals operating in active conflict zones were included. In-hospital mortality ranged from 2.1% in evacuated military populations to 15.2% in integrated military–civilian systems. Surgical site infection rates were reported in up to 14.4% of cases. Non-therapeutic laparotomy rates ranged from 16.8% to 19.9% in military settings, while anastomotic failure occurred in up to 9.8% of intestinal anastomosis cases. Hollow viscus injury, massive transfusion requirements, and delayed evacuation were consistent predictors of poor outcomes. Overall, laparotomy outcomes vary across conflict settings due to differences in surgical capacity, patient population, and resource availability. However, common predictors of morbidity and mortality were identified. Significant gaps remain in standardized outcome reporting, particularly in humanitarian and non-governmental surgical settings, highlighting the need for coordinated data collection systems to strengthen the evidence base in conflict surgery.

Keywords: *Penetrating Abdominal Trauma, Laparotomy, Military Surgery, Conflict Surgery.*

1. Introduction

One of the most life-threatening patterns of injury in armed conflict is penetrating abdominal trauma. Gunshot wounds, blast injuries caused by improvised explosive devices (IEDs), and fragmentation injuries from artillery or mine blasts often result in complex visceral and vascular injuries that require immediate operative intervention **(Eastridge et al., 2012; Holcomb et al., 2007)**. The abdominal region is the third most frequently injured body region in military casualties, following the extremities and head, and penetrating abdominal injuries have a disproportionately high case fatality rate, particularly when definitive surgical capability is unavailable at the point of injury or when prompt evacuation to a higher level of care is not possible **(Eastridge et al., 2012)**. In such situations, laparotomy remains the cornerstone of definitive surgical management for hemorrhage control, management of gastrointestinal contamination, and organ repair **(Biffl et al., 2015)**.

Over the past two decades, the surgical context of conflict medicine has changed significantly. Conflicts in Iraq and Afghanistan generated a large body of clinical evidence on combat trauma, leading to innovations in damage control resuscitation, widespread tourniquet use, and the development of forward surgical teams capable of performing damage control laparotomy in the early phase of injury **(Walker et al., 2024; Bozzay et al., 2021)**. The introduction of tranexamic acid, balanced blood product resuscitation, and improvements in damage control surgery practices have contributed to reductions in preventable trauma mortality **(Walker et al., 2024; Bozzay et al., 2021)**. At the same time, the increased presence of humanitarian non-governmental organizations (NGOs) and civilian hospitals operating in conflict-affected areas such as Syria, Yemen, and the Democratic Republic of Congo has expanded the environments in which laparotomy is performed, often in resource-limited settings without reliable blood banks, advanced imaging, intensive care facilities, or organized evacuation systems **(Cardi et al., 2019)**.

The care environment in which laparotomy is performed significantly influences both operative strategy and clinical outcomes. Within structured military trauma systems, casualties with penetrating abdominal injuries may undergo hemostatic resuscitation at the point of injury, damage control surgery at a forward surgical facility, and definitive reconstructive surgery after evacuation to a higher-level hospital **(Wren et al., 2020)**. This echeloned model of care is highly effective for survivors of initial injury and evacuation but differs substantially from the experience of civilian casualties treated in under-resourced hospitals without the possibility of transfer **(Larson et al., 2025)**. Understanding outcomes across this range of care settings is essential for contextualizing published data, setting realistic standards, and guiding policy on conflict surgical capacity.

Although a considerable amount of literature exists on abdominal trauma outcomes in military registries, deployed surgical units, and conflict-zone hospitals, the evidence base remains fragmented. Studies differ significantly in patient populations, care settings, outcome definitions, and analytical methods, making direct comparison difficult **(Wild et al., 2020)**. Mortality rates reported in evacuated military populations are often compared with those from frontline civilian hospitals without sufficient contextualization. Therefore, an overview of the existing literature is necessary to map available evidence, identify trends across care settings, and determine gaps that should be addressed by future research **(Wild et al., 2020)**.

The objective of this scoping review was to map the available evidence on outcomes after laparotomy for penetrating abdominal trauma in military, deployed, and conflict-adjacent environments. A scoping review methodology was selected instead of a systematic review with meta-analysis because the aim was to describe the breadth and heterogeneity of the evidence rather than to generate a pooled effect estimate. This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) framework **(Tricco et al., 2018)** and was guided by the following research question: What is the nature and extent of published evidence on laparotomy outcomes in penetrating abdominal trauma in conflict settings, and how does this evidence inform the determinants of surgical outcomes across different care environments?

2. Methodology

2.1 Review Design and Framework

This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines **(Tricco et al., 2018)** and was informed by the methodological framework developed by **Arksey and O'Malley (2005)**, as later refined by **Levac et al. (2010)**. The scoping review methodology was selected instead of a systematic review with meta-analysis due to the heterogeneity of the available literature, the diversity of care settings described, and the descriptive rather than quantitative nature of the review objectives. Scoping reviews are particularly appropriate when the evidence base is broad, heterogeneous, and multifaceted, and when the aim is to identify key concepts, types of evidence, and knowledge gaps rather than to produce a pooled effect estimate **(Arksey & O'Malley, 2005; Levac et al., 2010)**. No formal protocol was registered prior to conducting this review.

2.2 Research Question

The primary research question guiding this review was: What is the evidence on the outcomes of laparotomy for penetrating abdominal trauma in military and conflict contexts, and what patterns and gaps exist in this evidence base?

This question was structured using the Population, Concept, and Context (PCC) framework recommended for scoping reviews by the Joanna Briggs Institute (Levac et al., 2010).

- **Population:** Adult and adolescent patients who sustained penetrating abdominal injuries during armed conflict or military operations, including both military personnel and civilians injured in conflict settings.
- **Concept:** Clinical outcomes of laparotomy, including in-hospital mortality, surgical site infection, non-therapeutic laparotomy rates, anastomotic failure, open abdomen management, and length of hospital stay.
- **Context:** Military deployed environments, forward surgical teams, military–civilian integrated health systems, humanitarian and non-governmental surgical centers, and civilian hospitals operating in or near active conflict areas.

2.3 Search Strategy

A systematic literature search was conducted in MEDLINE/PubMed, Embase, and Google Scholar. The search was performed in February 2025. Search terms were developed iteratively using Medical Subject Headings (MeSH) and free-text terms related to penetrating abdominal trauma, laparotomy, and conflict or military settings. The primary PubMed search query included combinations of the following terms: "laparotomy," "exploratory laparotomy," "damage control laparotomy," "penetrating abdominal trauma," "abdominal gunshot," "abdominal blast," "war wound," "military," "conflict," "war," "combat," "deployed," "humanitarian," and "forward surgical."

Equivalent search strategies were adapted for Embase using Emtree terms. Additional searches were conducted in Google Scholar to identify grey literature, conference proceedings, and publications from humanitarian surgical organizations. Reference lists of eligible articles were manually reviewed to identify additional relevant studies. No language restrictions were applied during the search phase; however, only English-language studies were included due to translation limitations. The search focused on literature published from 2016 onward to ensure relevance to modern conflict surgical practice.

2.4 Eligibility Criteria

Studies were eligible for inclusion if they reported clinical outcomes following laparotomy performed for penetrating abdominal trauma in a military, deployed, or conflict-related environment. Both retrospective and prospective observational studies, trauma registry studies, cohort studies, and case series were eligible for inclusion. Randomized controlled trials were not expected due to the ethical and operational limitations inherent in conflict settings. Studies were required to report at least one key outcome of interest, including mortality, surgical site infection, non-therapeutic laparotomy rate, anastomotic failure, open abdomen management, or length of hospital stay.

Civilian hospital studies conducted in conflict areas were included if the majority of injuries were directly related to armed conflict, as these settings represent an important and distinct component of conflict surgical care. Case reports

involving fewer than ten patients, review articles, editorials, commentaries, and studies focusing exclusively on blunt abdominal trauma were excluded. Studies primarily evaluating a specific surgical technique or equipment without reporting patient outcomes were also excluded.

2.5 Data Extraction and Study Selection

Titles and abstracts were screened according to predefined eligibility criteria to identify potentially relevant studies. Full-text review was then conducted for all studies that met initial screening criteria. Data were extracted using a standardized data charting form. Extracted variables included author and year, country and setting, study design, sample size, study period, patient population (military, civilian, or mixed), mechanism of injury, operative approach (damage control laparotomy versus definitive laparotomy versus both), and reported outcomes such as in-hospital mortality, surgical site infection, non-therapeutic laparotomy rate, anastomotic failure, open abdomen management, and length of hospital stay. Where studies reported outcomes for specific subgroups only, such as patients with hollow viscus injury, only relevant subgroup data were extracted.

2.6 Data Synthesis

Due to the heterogeneity of included studies in terms of setting, patient population, outcome definitions, and study design, a narrative synthesis approach was used in accordance with PRISMA-ScR guidance (Tricco et al., 2018). Results were summarized descriptively and grouped according to outcome domains and care settings. Where similar outcomes were reported across multiple studies, ranges were presented to provide contextual interpretation. The narrative synthesis aimed to identify converging findings, diverging findings, and areas of evidentiary uncertainty across the included literature.

3. Results

3.1 Study Selection

This scoping review included ten studies that met the inclusion criteria. The studies represented military deployed environments, primarily from the conflicts in Iraq and Afghanistan, integrated military civilian medical systems in Israel, and civilian hospitals operating in active conflict zones in Afghanistan, Iraq, Yemen, and Syria. Across all included studies, a total of 2,776 patients underwent laparotomy for penetrating abdominal trauma in these various operational settings.

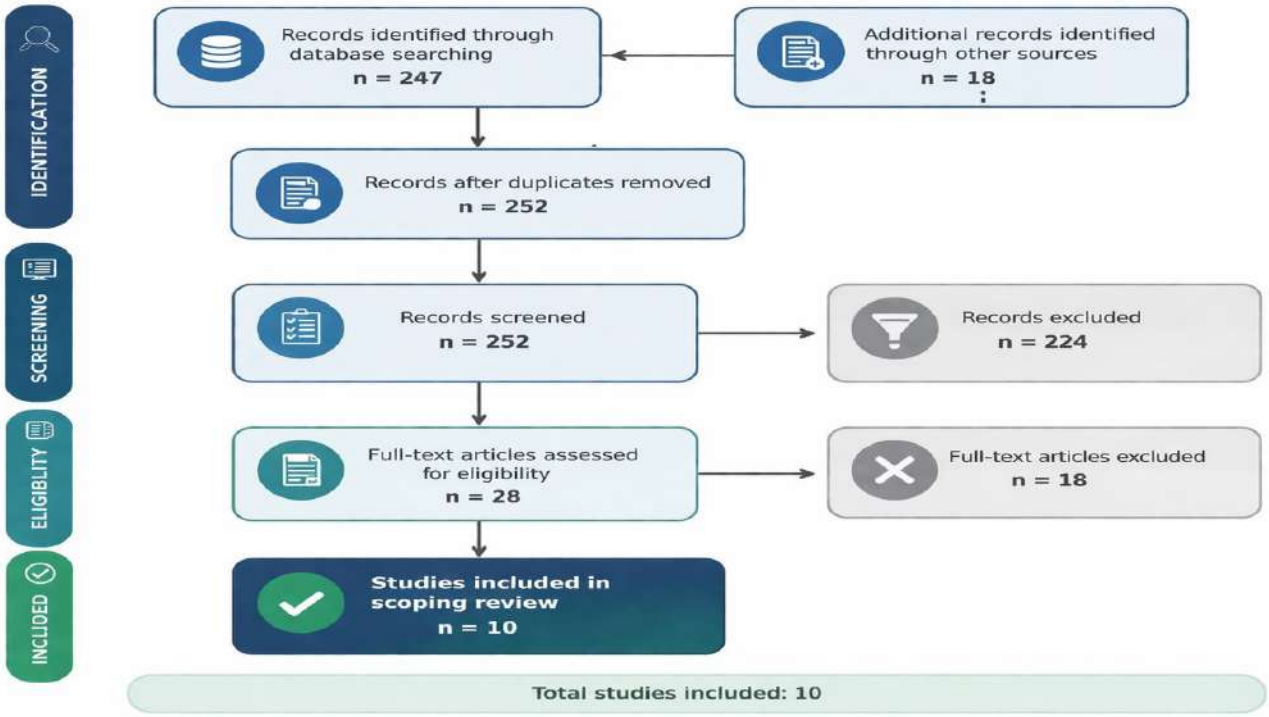

Figure 1: PRISMA-Scr Flow Diagram

3.2 Characteristics of Included Studies

Most included studies were retrospective observational cohort studies, with one prospective observational study included (Issa et al., 2024). Sample sizes ranged from 61 patients (Issa et al., 2024) to 953 patients (Cardi et al., 2019), and the study periods covered more than two decades of modern conflict surgical practice from 1997 to 2023.

Three studies were based on the United States military trauma registry, including the Trauma Infectious Disease Outcomes Study (TIDOS), and reported outcomes for casualties evacuated from Iraq and Afghanistan to higher-level military treatment facilities (Bozzay et al., 2021; Walker et al., 2024; Mitchell et al., 2016). One study described a military–civilian integrated cohort in Israel over a 23-year period (Gendler et al., 2024). Two studies reported outcomes from civilian hospitals in active conflict zones, including a non-governmental organization (NGO) hospital in Lashkargah, Afghanistan (Cardi et al., 2019), and a military referral hospital in Sana'a, Yemen (Issa et al., 2024). Additional studies were conducted in conflict-affected civilian settings in Iraq and Syria.

The majority of patients were male (88.9% to 98.4%), reflecting the demographic distribution of combatant and conflict-exposed populations. However, the study by Cardi et al. (2019) included 12.1% female patients and 21% pediatric patients, which is more typical of civilian conflict populations.

Table 1. Characteristics of Included Studies

Author (Year)	Country/Setting	Study Design	N	Mechanism of Injury	Primary Outcome	Key Findings
Walker et al. (2024)	USA/Military (Iraq & Afghanistan)	Retrospective cohort	244	Blast (65.2%), GSW, Other	NTL rate; SSI; Outcomes	NTL rate 16.8%; No SSIs in NTL group; Lower ISS in NTL patients
Gendler et al. (2024)	Israel/Military-civilian integrated	Retrospective cohort	217	Penetrating (55.8%), Blunt	Mortality predictors; LOS	Prehospital ETI, GCS 3-8, thoracotomy independently predicted mortality
Hamdawi et al. (2022)	Iraq/Baghdad civilian hospital	Retrospective cohort	523	Shrapnel (56.9%), GSW (39.3%)	Organ injury frequency; outcomes	GSW highest case fatality; mortality rises with organs injured and delayed arrival
Bozzay et al. (2021)	USA/Military (Iraq & Afghanistan)	Retrospective cohort	341	IED blast (56.9%), Non-blast	SSI incidence; abdominal closure	SSI in 14.4%; hollow viscus injury and massive transfusion key risk factors
Cardi et al. (2019)	Afghanistan/NGO hospital	Retrospective cohort	953	Bullet (61.8%), Shell (25.8%)	Mortality; injury patterns	hemorrhagic shock 73.7% of deaths; delay >5h, ISS >17 predicted mortality

Issa et al. (2024)	Yemen/Military referral hospital	Prospective observational	61	GSW (69%), Blast (31%)	Anastomotic failure rate; risk factors	Anastomotic failure 9.8%; large bowel injury and preop transfusion key risk factors
Pengelly et al. (2018)	UK/Military (Afghanistan)	Prospective observational	NR	Blast/GSW	Open abdomen outcomes	Primary closure achievable in majority after damage control laparotomy
Syrian war study (2011-2017)	Syria/Civilian conflict hospital	Retrospective cohort	NR	GSW, blast, shrapnel	Laparotomy outcomes	High bowel injury rates; damage control approach associated with improved survival
Mitchell et al. (2016)	USA/Military deployed	Retrospective cohort	NR	Blast/GSW	DCL vs definitive laparotomy	DCL and definitive laparotomy had comparable outcomes in deployed settings
SSI Risk Factors (2021)	USA/Military	Retrospective registry	NR	Blast/GSW	Risk factors for abdominal SSI	Hollow viscus injury and transfusion volume predicted SSI development

GSW = gunshot wound; NTL = non-therapeutic laparotomy; ISS = Injury Severity Score; SSI = surgical site infection; DCL = damage control laparotomy; NR = not reported.

3.3 In-Hospital Mortality

In-hospital mortality was the most commonly reported primary outcome, although mortality rates varied significantly depending on the care environment and patient population. In evacuated military cohorts, mortality rates were relatively low, reported at 2.1% and 3.5%, reflecting the benefits of advanced protective equipment, damage control resuscitation, and structured evacuation systems **(Walker et al., 2024; Bozzay et al., 2021)**. However, these figures are subject to survival bias, as only patients who survived initial injury and evacuation were included in these datasets.

Higher mortality rates were reported in studies that included the full spectrum of war casualties treated in civilian or forward medical facilities. The NGO hospital in Lashkargah, Afghanistan, reported a mortality rate of 12.8%, with 73.7% of deaths attributed to hemorrhagic shock **(Cardi et al., 2019)**. A study conducted in Baghdad reported a mortality rate of 8.99%, with gunshot wounds associated with the highest case fatality rate **(Hamdawi et al., 2022)**. Another study from Yemen reported a mortality rate of 8.2% **(Issa et al., 2024)**. The Israeli military–civilian cohort reported the highest mortality rate of 15.2%, reflecting a high burden of injury severity **(Gendler et al., 2024)**.

Across all settings, higher Injury Severity Scores, hemodynamic instability on presentation, multiple intra-abdominal organ injuries, and delays in reaching the operating theatre were consistently associated with increased mortality.

3.4 Surgical Site Infection

Three studies reported abdominal surgical site infection (SSI). **Bozzay et al. (2021)** reported an abdominal SSI rate of 14.4% among 341 military casualties. Deep space infections were the most common (7.9%), followed by deep incisional (4.1%) and superficial incisional infections (3.5%). Despite the highly contaminated nature of battlefield injuries, this rate was comparable to civilian penetrating abdominal trauma SSI rates reported in the literature. Hollow viscus injury,

massive transfusion, and multiple laparotomies were significant risk factors for SSI (Bozzay et al., 2021).

Walker et al. (2024) reported no abdominal SSIs in patients who underwent non-therapeutic laparotomy, compared to a 16.7% SSI rate in patients who underwent therapeutic laparotomy. In the Afghanistan NGO cohort, the overall complication rate was 38.9%, including intra-abdominal infections in 7.9% and wound infections in 5.9% of patients (Cardi et al., 2019). The overall incidence of anastomotic leak in this cohort was 2.8%.

3.5 Non-Therapeutic Laparotomy

Two studies reported non-therapeutic laparotomy (NTL) rates. Walker et al. (2024) reported an NTL rate of 16.8% among 244 military patients, which was lower than rates reported in earlier conflicts. The authors attributed this reduction to improved imaging availability, increased surgical experience, and maturation of the military trauma system. Bozzay et al. (2021) reported a negative laparotomy rate of 19.9%, with 22.9% of laparotomies performed for proximal vascular control or fecal diversion rather than direct abdominal injury. These findings highlight the ongoing challenges of surgical decision-making in conflict environments, where the risk of missed intra-abdominal injury often justifies exploratory laparotomy.

3.6 Intestinal Outcomes and Anastomotic Failure

Issa et al. (2024) reported an anastomotic failure rate of 9.8% among patients treated in a conflict hospital in Yemen. Complications included anastomotic leak, intra-abdominal abscess, and enterocutaneous fistula. Patients with anastomotic failure had significantly longer hospital stays and higher rates of sepsis. Preoperative blood transfusion and large bowel injury were identified as major risk factors.

Cardi et al. (2019) reported an anastomotic leak rate of 2.8% among 464 intestinal anastomoses, with higher leak rates in colonic anastomoses compared to small bowel repairs. Bozzay et al. (2021) reported that 31.7% of military casualties were left in bowel discontinuity after surgery, and 26.7% required ostomy formation as part of staged damage control surgery. Primary fascial closure was achieved within five days in 94.4% of patients.

3.7 Open Abdomen Management and Length of Stay

Bozzay et al. (2021) reported that 70 out of 341 military casualties were managed with an open abdomen following laparotomy. Negative pressure wound therapy was used in 71.9% of cases, and mesh closure was required in a small proportion of patients. Pengelly et al. (2018) reported that primary fascial closure was achievable in most military casualties managed with open abdomen techniques in Afghanistan. In contrast, Cardi et al. (2019) reported that damage control laparotomy was used in only 4.5% of patients in the NGO hospital setting, reflecting differences in resource availability.

Length of hospital stay varied significantly across settings. Median hospital stay in evacuated U.S. military cohorts ranged from 26 to 35 days (Bozzay et al., 2021; Walker et al., 2024). The Israeli military–civilian cohort reported a median hospital stay of 11 days (Gendler et al., 2024). In the Yemeni cohort, the median hospital stay was 38 days in patients with anastomotic failure compared to 12 days in uncomplicated cases (Issa et al., 2024).

4. Discussion

This scoping review mapped the published evidence on outcomes following laparotomy for penetrating abdominal trauma in military and conflict settings, based on ten studies representing more than 2,700 patients across a wide range of operational environments over more than two decades of modern conflict surgical practice. The results demonstrate both the clinical importance of this surgical problem and the significant heterogeneity in outcomes, reflecting differences in care environments, surgical capacity, patient populations, and evacuation capabilities. Although direct quantitative comparison between settings is not possible due to methodological heterogeneity, several clinically important patterns emerged from the narrative synthesis.

The most notable finding across included studies is the significant difference in in-hospital mortality depending on the care environment. Mortality rates in evacuated military populations (2.1–3.5%) are substantially lower than those reported in forward conflict hospitals and civilian

conflict-zone hospitals (8–15%) **(Bozzay et al., 2021; Walker et al., 2024; Cardi et al., 2019; Gendler et al., 2024; Issa et al., 2024)**. This difference is not solely due to higher quality surgical care in military systems but is largely explained by survival bias inherent in echeloned military trauma systems. Military registry datasets typically include only casualties who survive initial injury, survive evacuation from the point of injury, survive initial damage control surgery, and survive transfer to higher-level military hospitals. These multiple stages of survival selection result in a fundamentally different patient population compared to the unfiltered civilian conflict population presenting to local hospitals. This survival bias is well recognized in military trauma literature and must be considered when interpreting and comparing mortality statistics **(Eastridge et al., 2012)**.

Despite this limitation, the low mortality observed in evacuated military cohorts likely reflects genuine improvements in the organization and delivery of military trauma care over the past two decades. The systematic application of damage control resuscitation principles, including permissive hypotension, early hemostatic resuscitation using balanced blood product transfusion, and early administration of tranexamic acid, has demonstrated survival benefits in combat casualties with hemorrhagic shock **(Bozzay et al., 2021; Walker et al., 2024)**. In addition, the development of modern damage control surgical techniques, including staged laparotomy and temporary abdominal closure, has improved outcomes in patients with complex abdominal injuries.

An important observation from the integrated military–civilian cohort study by **Gendler et al. (2024)** was that prehospital endotracheal intubation was associated with increased mortality. This finding should be interpreted cautiously, as it likely reflects confounding by indication, where more severely injured and hemodynamically unstable patients are more likely to require advanced airway management. Although multivariate analysis attempted to adjust for confounding variables, residual confounding due to unmeasured injury severity variables likely persists. This finding aligns with emerging evidence from both military and civilian trauma systems questioning the survival benefit of prehospital advanced airway interventions in patients with hemorrhagic shock.

Non-therapeutic laparotomy (NTL) rates of 16.8–19.9% in military settings remain higher than those reported in modern civilian trauma systems (approximately 3.9–6%), but are significantly lower than rates reported in earlier conflicts (greater than 28–38%) **(Walker et al., 2024; Bozzay et al., 2021)**. The reduction in NTL rates over time is likely due to improved access to computed tomography imaging in deployed settings and increased surgical experience in high-volume trauma environments. Importantly, the absence of infectious complications in the NTL group reported by **Walker et al. (2024)** supports the continued use of a low threshold for exploratory laparotomy in high-risk patients with equivocal clinical findings, as the consequences of missed intra-abdominal injury in conflict settings are often fatal.

The reported abdominal surgical site infection (SSI) rate of 14.4% in military cohorts is comparable to rates reported in civilian penetrating abdominal trauma despite the highly contaminated nature of battlefield injuries **(Bozzay et al., 2021)**. This finding suggests that adherence to fundamental infection prevention principles, including early debridement, adequate washout, temporary abdominal closure when indicated, and protocol-driven antimicrobial prophylaxis, can effectively reduce infection rates even in resource-limited and contaminated operative environments. Hollow viscus injury and massive transfusion were consistently identified as major predictors of SSI, which has implications for postoperative monitoring and targeted infection prevention strategies in high-risk patients.

Anastomotic failure represents a major contributor to postoperative morbidity in conflict surgical care, with rates of up to 9.8% reported in the Yemeni cohort and 2.8% reported in the Afghanistan NGO cohort **(Issa et al., 2024; Cardi et al., 2019)**. The difference in anastomotic failure rates between settings likely reflects differences in patient selection, the proportion of colonic versus small bowel anastomoses, intraoperative hemodynamic stability, and postoperative nutritional and antimicrobial support. The significantly prolonged hospital stay associated with anastomotic failure has major implications for hospital capacity and resource allocation in

already resource-constrained conflict hospitals. These findings support the selective use of protective stomas or delayed anastomosis in high-risk patients, particularly in austere surgical environments.

Civilian conflict hospitals in Afghanistan, Iraq, and Yemen represent care environments that differ substantially from structured military trauma systems. These hospitals often function without organized evacuation systems, advanced imaging, reliable blood banks, or intensive care facilities, and they treat a broader demographic population that includes women, children, and elderly patients **(Cardi et al., 2019; Issa et al., 2024)**. These differences in infrastructure, patient population, and resource availability likely explain much of the variation in outcomes observed across studies.

This review has several important limitations. Most included studies were retrospective, making them susceptible to selection bias and outcome misclassification. Outcome definitions were not standardized across studies, particularly for surgical site infection, which limits direct comparison. The literature search was conducted by a single reviewer, which may have resulted in missed studies. Publication bias is also likely, particularly in humanitarian settings where data collection is resource-intensive. Finally, long-term outcomes such as incisional hernia, bowel dysfunction, psychological outcomes, and quality of life are largely absent from the current literature and represent a major gap in knowledge.

Future research should focus on prospective data collection in conflict surgical settings, particularly in civilian and humanitarian hospitals, which remain underrepresented in the literature. Research focusing on outcomes in women and pediatric patients in conflict settings is also needed. In addition, prospective studies comparing damage control laparotomy and definitive laparotomy in resource-limited environments would be valuable. Registry-based follow-up studies should also aim to identify long-term morbidity following laparotomy in conflict-affected populations.

5. Conclusions

This scoping review is a detailed map of the evidence published on the outcomes of laparotomy on penetrating abdominal trauma, as it occurs in military and conflict environments. Ten studies including 2,776 patients in military deployed, integrated military-civilian, and civilian conflict hospital settings were identified and narratively synthesized. The in-hospital death rates were between 2.1% in evacuated military cohorts and 15.2% in integrated systems, with survival bias playing a role of significant influence in the lower limit of this range. The most prevalent cause of mortality in all settings was hemorrhagic shock. Abdominal SSI, non-therapeutic laparotomy, anastomotic failure, and extended open abdomen care are clinically significant secondary outcome domains that directly relate to surgical education, resource distribution, and clinical guideline formulation in conflict surgical care.

The evidence base is highly heterogenous in design, setting, and outcome reporting and mostly retrospective registry studies with major gaps in prospective reporting - especially by civilian humanitarian settings. There is an urgent need to have standardized, prospective, data collection frameworks in all the conflict surgical care settings to facilitate meaningful comparison, fortify guideline development, and ultimately enhance outcomes among one of the most vulnerable and underserved surgical populations in the world.

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Cite this article as: Dr. Ajagunna Muhammed Adeleye et al., (2026). Outcomes of Laparotomy for Penetrating Abdominal Trauma in Military and Conflict Settings: A Scoping Review. International Journal of Emerging Knowledge Studies. 5(3), pp. 347–356.
https://doi.org/10.70333/ijeks-05-03-005