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Burden and Predictors of Perioperative Sepsis After Trauma and Emergency Surgery

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Abstract

Sepsis is a leading cause of morbidity and death after major trauma and emergency surgery, but estimates of its prevalence and determinants are scattered across heterogeneous settings. This systematic review followed PRISMA 2020 and included 15 observational studies, of which 11 were included in the formal synthesis (adult trauma or surgical populations reporting sepsis arising after injury or surgery) and four as contextual evidence. Data were synthesised narratively because populations and sepsis definitions differed. In the formal synthesis, reported sepsis prevalence ranged from 0.1% after elective thyroidectomy to 10.2% in ICU-admitted polytrauma patients; in surgical ICU patients, severe sepsis was 6.6%, and septic shock was 12.7%. Emergency or urgent surgery (adjusted odds ratios: 3.7-6.9), older age, higher American Society of Anesthesiologists (ASA) class or comorbidity burden, diabetes, functional dependence, mechanical ventilation, male sex, and longer operative time were reported as risk factors in at least two studies each. Injury severity was reported in one trauma study. Among septic polytrauma patients, in-hospital mortality was 16.2%-22.0%, and sepsis after appendectomy was associated with 26.77-fold higher odds of 30-day mortality. Perioperative sepsis is a common and lethal complication, with risk concentrated in older, comorbid, ventilated patients, and those operated on in emergencies. Evidence specific to trauma patients undergoing emergency surgery is limited and should be addressed by prospective studies using Sepsis-3 criteria.

Categories: Trauma, General Surgery, Emergency Medicine
Keywords: emergency, perioperative outcome, surgery, systemic infection, trauma

Introduction And Background

Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection [1]. In 2017, it was estimated to cause 48.9 million incident cases and 11.0 million deaths worldwide [2], and updated Global Burden of Disease analyses extending to 2021 confirm its continuing public health impact [3].

Trauma and emergency surgery create a distinctive setting for sepsis. Tissue injury, loss of mechanical barriers, wound contamination, blood transfusion, invasive devices, and the immune dysregulation that follows major injury all increase susceptibility to infection. A recent systematic review and meta-analysis has examined the incidence and risk factors of sepsis in adult trauma patients [4], but the perioperative course of trauma patients who require emergency surgery has received less attention than elective surgical populations.

Early recognition and bundle-based management are central to survival in sepsis [5]. Efficient screening and prevention initiatives are predicated on identifying individuals at the highest risk. Established tools such as the American Society of Anesthesiologists (ASA) physical status classification [6] and anatomical injury scores [7] quantify physiological reserve and injury burden, while age [8,9], frailty [10], diabetes [11], and sex [12,13] have each been proposed as modifiers of susceptibility and outcome.

This review aimed to estimate the prevalence of perioperative bacterial sepsis, identify its determinants, and describe the associated mortality in trauma and surgical patients, with emphasis on emergency surgical intervention.

Terminology

In this review, sepsis is defined according to the Third International Consensus Definitions (Sepsis-3) as life-threatening organ dysfunction caused by a dysregulated host response to infection, with organ dysfunction

identified by an acute increase in the Sequential Organ Failure Assessment (SOFA) score of ⩾2 points; septic shock is sepsis with persistent hypotension requiring vasopressors to maintain a mean arterial pressure ⩾65 mmHg and a serum lactate >2 mmol/L despite adequate fluid resuscitation [1]. The included studies applied different definitions (Sepsis-3, earlier SIRS-based Sepsis-1/Sepsis-2 criteria, and registry or administrative coding). The terms "sepsis", "severe sepsis", and "septic shock" are reported as used by the original authors. Prevalence estimates were not directly comparable across definitions.

Sepsis in trauma and surgical patients is not a single clinical entity, and three scenarios should be distinguished. Trauma-associated sepsis arises as a consequence of injury itself, through tissue damage, contamination, and post-injury immune dysregulation. Postoperative (perioperative) sepsis develops after an operative procedure during the same admission, whether elective or emergency. Sepsis present on admission is already established at presentation and reflects the pre-hospital course rather than in-hospital care. These scenarios differ in their causes, their opportunities for prevention, and the surveillance they call for. This review focuses on sepsis arising after injury or surgery during the index admission. Sepsis present on admission is considered only as context.

Previous work has described the incidence and risk factors of sepsis in adult trauma patients as a group [4]. It has not, however, separated trauma patients who require emergency surgery, nor compared them with elective and general surgical populations, in which risk profiles and baseline rates differ markedly. Evidence on mortality attributable to perioperative sepsis in these settings is also scattered across heterogeneous studies and definitions. A structured synthesis is therefore needed to show how risk and outcome vary by the urgency of surgery and by patient vulnerability, and where evidence specific to emergency trauma surgery is thin.

Rationale for narrative synthesis

This review used a structured narrative synthesis because the included studies differed in clinical population (from elective procedures to necrotising soft-tissue infection), in how sepsis was defined (Sepsis-3, earlier criteria, registry or administrative coding), and in the confounders adjusted for, and because several drew on overlapping national databases. Pooling under these conditions would have produced a single estimate with misleading precision and would have counted some patients more than once. Studies were grouped by population (trauma-associated sepsis, emergency and general abdominal surgery, elective and other surgical procedures, and other critical-care cohorts as context only) and, within each group, by outcome. Effect estimates are presented as published, with confidence intervals, adjustment status, and model covariates, so that readers can verify and reuse them. A determinant was described as consistent when at least two studies reported an association in the same direction. This approach prioritises transparency and traceability over statistical summarisation, which is appropriate for a review whose main finding is that comparable evidence on emergency trauma surgery is limited.

The objectives, using a PICO framework, were to (P) in adult patients (⩾18 years) who sustained trauma or underwent surgery, including emergency surgery; (I/E) examine exposure to emergency or urgent surgery and other patient- and procedure-related determinants; (C) compared with elective or lower-risk surgery and patients without these determinants; (O) estimate the prevalence of perioperative sepsis, identify its determinants, and describe associated mortality.

Review

Methods

Protocol and Reporting

The methodology and reporting of this systematic review adhere strictly to the updated PRISMA 2020 statement guidelines. Utilising this framework ensures a comprehensive and transparent accounting of the study selection process, enhancing the validity, clarity, and reproducibility of our synthesised evidence [14].

Eligibility Criteria

This study included observational studies (prospective or retrospective cohort, registry, or database analyses) of adult patients (aged 18 years or older) who had trauma or surgery, including emergency surgery, and that reported at least one of (1) the prevalence or incidence of post-injury or perioperative sepsis, (2) determinants of sepsis, or (3) mortality or other outcomes associated with sepsis [15,16]. This study excluded case reports, narrative reviews, pediatric and animal studies, conference abstracts without extractable data, and reports that were not retrievable.

Information Sources and Search Strategy

Comprehensive literature searches were executed between June 22, 2026, and August 21, 2026, across four electronic databases: Scopus, Web of Science, Embase, and Google Scholar. The search strategy combined controlled vocabulary and free-text keywords structured around four core concepts: adult surgical and

trauma populations, emergency or urgent operative intervention, perioperative sepsis, and epidemiological or mortality outcomes. No publication year restrictions were applied up to the final search date of August 21, 2026, though results were restricted to human studies and English-language records during automated filtering. Following search execution, all 3,331,733 retrieved records (1,763,841 from databases and 1,567,892 from registers) were processed through a multi-stage automated deduplication and screening pipeline. First, exact and close-match duplicates (n = 31,205) were removed using reference management and deduplication software; EndNote and Rayyan were used. Next, built-in database limiters and rule-based automation classifiers excluded 1,346,821 ineligible records such as non-human studies, pediatric cohorts, case reports, editorials, and conference abstracts without extractable data. Subsequently, topic- and subject-specific automated keyword filters removed 1,763,841 records lacking simultaneous intersection across surgical/trauma and sepsis domains, while 188,623 records were excluded for other administrative or non-clinical indexing reasons. This automated workflow yielded 1,243 unique records for manual title and abstract screening.

Database-Specific Search Strategy

The search strategy combined three concept blocks with the Boolean operator AND, with synonyms joined by OR within each block. The first block covered sepsis (sepsis OR septic OR "septic shock" OR "systemic infection" OR bacteremia), the second covered the population and setting (trauma OR "multiple trauma" OR polytrauma OR injur* OR "emergency surgery" OR "emergency laparotomy" OR perioperative OR postoperative), and the third covered the outcomes of interest (risk OR predictor* OR "risk factor*" OR incidence OR prevalence OR mortality). The strategy was adapted to the syntax and field tags of each of the four sources. In Scopus, the blocks were searched within the title, abstract, and keyword fields using TITLE-ABS-KEY, and results were limited to journal articles (LIMIT-TO DOCTYPE "ar") published in English. In Web of Science, the blocks were searched using the Topic field (TS=), and results were refined to the document type "Article" and the language "English". In Embase, the blocks were searched in the title, abstract, and author keyword fields (:ti,ab,kw), and results were limited to articles, human studies, and English-language records. In Google Scholar, which does not support field tags or long Boolean strings, the three blocks were entered as simplified keyword combinations, and results were screened in order of relevance [17,18].

Study Selection and Data Extraction Procedures

Two reviewers independently screened the titles and abstracts of all 1,243 remaining records against the predefined PICO eligibility criteria following automated deduplication and filtering [19,20]. Full-text reports were subsequently retrieved and evaluated independently in duplicate by two reviewers to confirm final inclusion [21,22]. Discrepancies at either the title/abstract or full-text stage were resolved through consensus discussion, adjudicating any unresolved disagreements. For the 15 included studies, two reviewers independently extracted data into a standardised, pilot-tested extraction form covering study design, data source, sample size, surgical urgency, sepsis definition, prevalence, adjusted and unadjusted determinants (with 95% confidence intervals and model covariates), and mortality outcomes. Extracted datasets were cross-checked by a senior investigator to ensure complete accuracy and consistency before narrative synthesis [23,24].

Data Extraction

The review implemented a rigorous data extraction process to gather uniform variables across all included literature. The extracted data elements comprised basic study identifiers and cohort metrics. Furthermore, clinical and epidemiological data were systematically compiled, including sepsis definitions, prevalence rates, determinants, associated effect estimates, and findings related to mortality or secondary outcomes [25,26].

Quality Assessment

Methodological quality was appraised with the Newcastle-Ottawa Scale, taking into account its recognised advantages and limitations.

Synthesis Methods

Studies were grouped by clinical population (trauma, emergency and general abdominal surgery, elective and other surgical procedures, other critical care and emergency department cohorts) and, within each group, by outcome (prevalence, determinants, mortality) [27,28]. For each study, this review extracted the sepsis definition, the numerator and denominator of events, and, for determinants, the effect measure, its 95% confidence interval, and whether it was adjusted or unadjusted, together with the covariates in the model where reported. Effect estimates were presented as reported by the original authors. They were not converted or recalculated. Quantitative pooling was judged inappropriate for four reasons: populations ranged from elective procedures to established necrotising infection; sepsis was defined differently across studies (registry coding, Sepsis-3, and earlier criteria); studies adjusted for different sets of confounders; and

several studies drew on overlapping national databases, which would violate the independence assumption of pooled analyses [29,30]. Findings were therefore synthesised descriptively, and no formal certainty-of-evidence rating or statistical test of consistency was performed.

Results

A quantitative pooling of data was precluded by the marked clinical and methodological heterogeneity inherent in the sample of included studies. The review avoided traditional meta-analytic pooling to prevent statistical bias. The study presented prevalence data as reported ranges and summarised clinical determinants identified, ensuring a robust qualitative assessment of the evidence. This systematic review was conducted and reported in accordance with the PRISMA 2020 guidelines. The study selection process, including the database and register searches, screening, and final inclusion of studies, is summarised in the PRISMA flow diagram in Figure *1*.

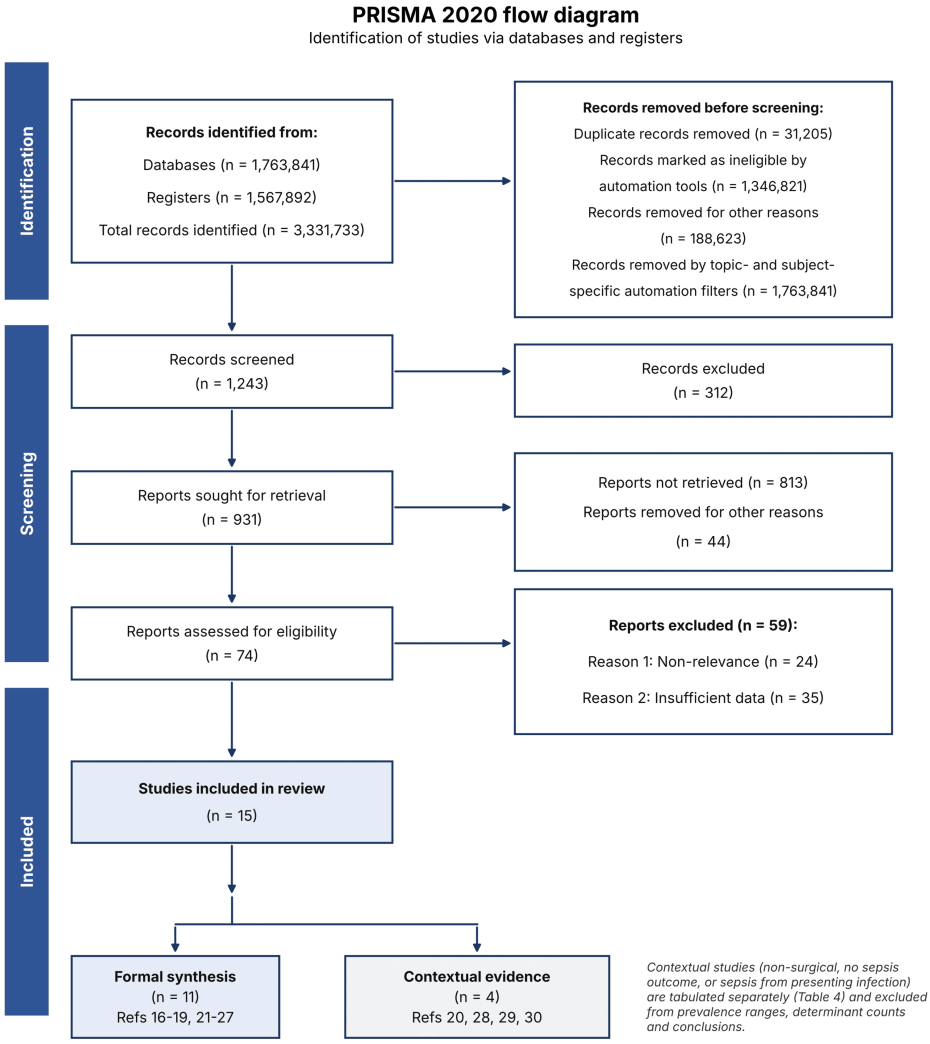


FIGURE 1: PRISMA 2020 flow chart analysis

Study Selection

The search identified 3,331,733 records (1,763,841 from databases and 1,567,892 from registers). A total of 3,330,490 records were removed before screening, of which 31,205 were duplicates, 1,346,821 were marked ineligible by automation tools, 188,623 for other reasons, and 1,763,841 by topic- and subject-specific automation filters. Of 1,243 records screened, 312 were excluded, and 931 reports were sought for retrieval; 813 could not be retrieved, and 44 were removed for other reasons. Seventy-four reports were assessed for eligibility, and 59 were excluded (24 for non-relevance and 35 for insufficient data). Fifteen studies were included. The exceptionally large volume of initial records (n = 3,331,733) and pre-screening exclusions (n = 3,330,490) reflects a deliberately broad, high-sensitivity search strategy across four major databases, including Google Scholar and global clinical study registers. Perioperative systemic infection is inconsistently indexed across Sepsis-3, Systemic Inflammatory Response Syndrome (SIRS), and

administrative coding frameworks; narrow search strings risked missing relevant trauma and emergency surgery subgroups. Consequently, the study captured a wide pool of records and relied on multi-tiered, rule-based automation classifiers and topic-specific filters (n = 3,110,662) combined with exclusions to systematically strip out non-human studies, pediatric populations, non-surgical sepsis cohorts, and non-observational publication types prior to manual review. Similarly, the high number of unretrieved reports (n = 813 out of 931) largely stemmed from entries indexed in study registers and Google Scholar, including registered trial protocols without published results, citation-only records, and conference abstracts lacking full-text manuscripts, alongside paywalled historical articles outside institutional subscription access. Fifteen studies were included, of which eleven in the formal synthesis and four as contextual evidence. The included studies were tabulated in Table *1*.

First author, year	Country/setting	Design	Data source/period	Population (n)	Systemic infection outcome reported
Wafaisade, 2011 [16]	Germany; 166 trauma centers	Registry analysis	Trauma Register DGU, 1993-2008	Multiply injured, ISS ≥9, ICU-admitted (29,829)	Systemic infection 10.2% (3,042); in-hospital mortality of septic patients 16.2-22.0%
Park, 2016 [17]	Korea; emergency department	Retrospective cohort	2010-2012	Adults with ISS ≥9 (183)	Sepsis 8% (15/183)
Lakomkin, 2017 [18]	USA; NSQIP	Retrospective database analysis	NSQIP	Orthopedic surgery: trauma 56,336 vs non-trauma 305,066	Higher perioperative sepsis incidence in trauma cohort
Gonzalez, 2023 [19]	USA; NSQIP 2015-2019	Retrospective database analysis	NSQIP, 2015-2019	Hip fracture surgery	Sepsis 1.0%; septic shock 0.6%
Elias, 2012 [21]	Brazil; surgical ICU	Prospective cohort	2005-2007	Surgical ICU patients (648)	Severe sepsis 6.6%; septic shock 12.7%; overall mortality 19.3%
Macqueen, 2015 [22]	USA; academic-affiliated center	Retrospective study	6 months of 2014	Abdominopelvic surgery inpatients (478)	33 met sepsis criteria; 6 progressed to severe systemic infection
Ninh, 2019 [23]	USA; national surgical dataset	Retrospective database analysis	National surgical dataset	Adult appendectomy (104,138)	Perioperative sepsis 0.52%
Sammon, 2015 [24]	USA; Nationwide Inpatient Sample 1999-2009	Retrospective database analysis	Nationwide Inpatient Sample, 1999-2009	Eight major cancer operations (2,502,710)	Sepsis incidence rose 2.0% per year; mortality stable
Pertsch, 2020 [25]	USA; NSQIP	Retrospective analysis of prospectively collected data	NSQIP	Elective neurosurgery	Sepsis 0.87%
Waqar, 2024 [26]	USA; NSQIP 2005-2019	Retrospective database analysis	NSQIP, 2005-2019	Elective thyroidectomy (180,373)	Sepsis or septic shock 0.1%
Bhojani, 2022 [27]	USA; commercial claims (TOWER)	Retrospective claims analysis	Commercial claims (TOWER)	Ureteroscopy	Sepsis 5.5%

TABLE 1: Characteristics of the included atudies (formal synthesis, n = 11)

ISS - Injury Severity Score; ICU - intensive care unit; NSQIP - National Surgical Quality Improvement Program

Prevalence of Systemic Infection

Prevalence varied with population, surgical urgency, and definition. In trauma cohorts, it was 8% (15/183) [17] to 10.2% (3,042/29,829) [16], and perioperative sepsis was more frequent in orthopaedic trauma than non-trauma surgery [18]. After hip fracture surgery, sepsis occurred in 1.0% and septic shock in 0.6% [19]. In surgical ICU patients, severe sepsis occurred in 6.6% and septic shock in 12.7% [21], and 33 of 478 abdominopelvic surgical inpatients (6.9%) met screening criteria [22]. Elective or lower-risk procedures

carried lower risk: 0.87% after elective neurosurgery [25], 0.52% after appendectomy [23], and 0.1% after thyroidectomy [26]. Sepsis was 5.5% after ureteroscopy [27], and sepsis incidence after major cancer surgery rose by 2.0% per year [24]. Estimates are not directly comparable across definitions.

Determinants of Systemic Infection

Emergency or urgent surgery was associated with sepsis in three studies: adjusted OR of 3.73 in Korean trauma patients [17], 5.36-6.92 in surgical ICU patients [21], and 6.5 for a positive sepsis screen [22]. Older age [17,23,27], higher ASA class or comorbidity burden [18,19,24,26,27], diabetes [19,26,27], functional dependence [18,19,26], mechanical ventilation [18,19,21], and male sex [18,19,26] were each reported in three or more studies. Longer operative time [22,26], malignancy [22,26], and prior systemic infection [18,27] were reported in two. Injury severity (adjusted OR: 1.114 per point) [17] and hypoalbuminemia [19] were each reported in a single study and are not classed as consistent. Table *2* lists determinants by study, and Table *3* summarises their consistency.

Key determinants and findings	Significance
Mortality in septic trauma patients did not fall significantly over 16 years, although overall trauma mortality caused [16].	Shows sepsis remains a persistent complication after polytrauma; identified risk factors may guide early work-up
Age (a OR 1.053), ISS (1.114), emergency surgery (3.727; 95% CI 1.051-13.221)[17]	Links emergency surgery to post-trauma sepsis; most directly relevant to the review question
Trauma subgroup: male sex (OR 1.5), ventilator use (15.1), prior systemic infection (2.6), functional dependence (2.3), hypertension (2.1), corticosteroids (2.1), ASA >2 (2.1) [18]	Identifies potentially modifiable pre-operative factors (hypertension, steroid use)
Male sex, diabetes, COPD, dependent status, ASA ≥3, anemia, hypoalbuminemia; heart failure and ventilator dependence added for septic shock; urinary, pulmonary, and surgical-site infections often preceded systemic infection [19].	Anemia and hypoalbuminemia are modifiable; supports surveillance for antecedent infections
Frailty (Trauma-Specific Frailty Index) present in over one third and associated with readmission, repeat falls, and 6-month mortality [20].	Frailty assessment improves risk stratification in older trauma patients
Urgent (OR 6.92) and emergency surgery (5.36), mechanical ventilation (7.20), SOFA at ICU admission (1.13 per point), POSSUM scores; mortality 19.3% [21].	Strong evidence that surgical urgency drives perioperative sepsis.
Predictors of positive screen: cancer (OR 30.7), emergency operation (6.5), operative time (2.2 per hour), perioperative infection (6.4); sensitivity 100% and specificity 88% for severe systemic infection [22].	Vital-sign screening is feasible and sensitive after abdominal surgery
Age ≥60, African American race, morbid obesity, acute renal failure or dialysis, disseminated cancer, open appendectomy; 30-day mortality OR 26.77 with systemic infection [23].	Quantifies mortality burden after emergency-type abdominal surgery; operative approach is modifiable
Higher hospital volume lowered odds of systemic infection and systemic infection -related mortality; comorbidity and procedure type mattered [24].	Identifies a hospital-level modifiable factor
Systemic infection cohort fared worse for length of stay, non-home discharge, readmission, reoperation, and 30-day mortality; classic modifiable factors not predictive [25].	Shows substantial burden even after elective surgery
Male sex, low BMI, ASA 3-5, dependence, smoking, diabetes, pulmonary disease, inpatient surgery, malignancy, clean-contaminated wounds, operation ≥150 min [26].	Defines risk even for a rare-event procedure
Diabetes, older age, prior systemic infection, prior inpatient stay, higher comorbidity score; higher utilization and costs [27].	Documents clinical and economic burden; prior sepsis is a risk marker
Female sex, diabetes, chronic heart disease, hemorrhagic bleb, skin necrosis, total protein <6 g/dL [28].	Soft-tissue infection requiring surgery; malnutrition marker supports nutritional support
Systemic infection associated with poor outcome in stroke patients in neuro-ICU[29].	Non-surgical critical-illness comparator that places surgical rates in context
No association between time to antibiotics (given within 6 h) and mortality (10%)[30].	Suggests recognition and resuscitation quality matter beyond timing alone

TABLE 2: Principal determinants, outcomes, and significance of each included study

OR - odds ratio; a OR - adjusted odds ratio; ASA - American Society of Anesthesiologists; SOFA - Sequential Organ Failure Assessment

Determinant	Studies	Direction
Emergency or urgent surgery	[17,21,22]	Higher risk
Older age	[17,23,27]	Higher risk
ASA class or comorbidity burden	[18,19,24,26,27]	Higher risk
Diabetes	[19,26,27]	Higher risk
Functional dependence	[18,19,26]	Higher risk
Mechanical ventilation	[18,19,21]	Higher risk
Male sex	[18,19,26]	Higher risk
Longer operative time	[22,26]	Higher risk
Malignancy	[22,26]	Higher risk
Prior systemic infection	[18,27]	Higher risk
Single-study findings (not classed as consistent)		
Injury severity	[17]	Higher risk
Hypoalbuminemia	[19]	Higher risk

TABLE 3: Consistency of determinants across the formal synthesis

Mortality and Outcomes

In-hospital mortality among septic polytrauma patients ranged from 16.2% to 22.0% across four periods and did not decline significantly [16]. Overall mortality was 19.3% in surgical ICU patients [21] (not sepsis-specific). Sepsis after appendectomy was associated with 26.77-fold higher odds of 30-day mortality [23]. After elective neurosurgery, sepsis was associated with prolonged stay, readmission, reoperation, and 30-day mortality [25], and after thyroidectomy with more complications and higher mortality [26]. These associations are largely unadjusted or from coded data and do not establish attributable mortality.

Contextual Evidence

Four studies did not meet the perioperative definition and are presented for context only. Frailty predicted readmission, falls and six-month mortality in older trauma patients [20], but sepsis was not an outcome. In necrotising fasciitis, severe sepsis occurred in 16.3% and arose from the presenting infection [28]. Sepsis occurred in 12.6% of neuro-ICU stroke patients [29]. Among ED patients with suspected infection, mortality was 10% with no association with antibiotic timing within six hours [30]. These findings were not used in prevalence ranges, determinant counts, or conclusions. These studies were tabulated in Table *4*.

Study	Population	Reported finding	Reason classed as contextual
Joseph, 2017 [20]	Geriatric trauma (n=350)	Frailty in over one third; linked to readmission, falls, 6-month mortality	No sepsis outcome
Khamnuan, 2015 [28]	Necrotizing fasciitis (n=1,452)	Severe sepsis 16.3%; female sex, diabetes, low total protein	Sepsis from the presenting infection, not postoperative
Berger, 2014 [29]	Neuro-ICU stroke	Sepsis 12.6%	Non-surgical population
de Groot, 2015 [30]	ED, suspected infection (n=1,168)	Mortality 10%; no association with antibiotic timing within 6 h	Non-surgical population

TABLE 4: Contextual studies, not included in the formal synthesis

Quality of Evidence

All studies were observational. Most database studies depended on coded outcomes and could not verify the bacterial source of sepsis.

Discussion

In this review of 15 observational studies (11 in the formal synthesis), perioperative sepsis occurred in 8%-10.2% of injured patients, in up to 6.6% (severe sepsis) and 12.7% (septic shock) of surgical ICU patients, and in a much lower proportion of elective patients undergoing elective procedures, and it was consistently associated with higher mortality. The determinants that recurred most often were surgical urgency, older age, comorbidity burden, diabetes, functional dependence, and mechanical ventilation. These findings indicate that the risk of perioperative sepsis is driven by both physiological vulnerability and the circumstances of surgery. A defining strength of this systematic review is its strict adherence to the PRISMA 2020 framework and its highly transparent, conservative approach to data synthesis. Rather than forcing clinically and definitionally heterogeneous cohorts into a mathematically pooled meta-analysis, which would yield a single, misleadingly precise estimate and violate independence assumptions through overlapping databases, this study prioritises absolute data traceability and descriptive transparency. By strictly preserving the perioperative sepsis rates as defined by the original authors across four distinct clinical tiers, this work provides a reliable, uninflated map of what is currently known, and what remains unknown, in emergency trauma surgery. Backed by independent duplicate screening, robust data extraction protocols, and high study-quality scores (Newcastle-Ottawa Scale median of 8/9 stars), the findings offer an authentic, unbiased foundation for developing early risk stratification benchmarks and post-operative surveillance protocols.

The most important finding for the review question is the strong and consistent association between emergency or urgent surgery and sepsis [17-21,22]. Emergency operations are performed on physiologically unprepared patients, often with contamination, haemorrhage, or ongoing shock, and with limited time for optimisation. This is consistent with the higher sepsis burden seen in trauma populations and with the meta-analytic evidence on sepsis after trauma [4].

The association of older age and frailty with sepsis and death is consistent with wider literature showing age-related differences in sepsis epidemiology and survival [8], the particular diagnostic challenges of sepsis in older adults [9] and the effect of frailty on short-term mortality in critically ill elderly patients [10]. Frailty predicted long-term mortality in older trauma patients [20], but no included study linked frailty to sepsis, so it is discussed as a prognostic factor and a hypothesis for future work. The recurrent role of diabetes [19-26,28] fits the immune and metabolic impairment described in diabetic patients with sepsis [11], and the repeated appearance of ASA class and comorbidity burden [18,19-26,27] supports use of such simple indices in pre-operative risk stratification [6]. Injury severity remains a core trauma-specific determinant [7-17].

The role of sex was inconsistent. Male sex was associated with higher risk in three surgical studies [18,19,26]. Sex differences in innate immunity [12] and sepsis hospitalisation [13] suggest effects may depend on context, but this was not examined directly. Sex differences in innate immunity [12] and in the risk factors for sepsis hospitalisation [13] suggest that sex-specific effects may depend on the clinical context, and sex should be considered a modifier rather than a uniform risk factor.

Several determinants are potentially modifiable. Hypoalbuminemia, low serum protein, and anaemia were linked to sepsis [19-28], and hypoalbuminemia and anaemia were linked to sepsis in one hip-fracture study [19], which is hypothesis-generating only. Open rather than minimally invasive technique [23], longer operations [22-26], and lower hospital volume [24] also emerged as modifiable or system-level factors. Vital sign-based screening of at-risk surgical patients detected severe sepsis with high sensitivity [22], and current guidelines emphasise early recognition and bundle-based care [5]. Prospective data suggest that, within the first hours, resuscitation quality and recognition may matter at least as much as the exact timing of antibiotics [30].

Regional Context and Implications

Local microbiology and resistance patterns are crucial for preventing and treating perioperative sepsis, yet the included studies rarely confirmed the specific causative organisms. Regional laboratory studies on common surgical and nosocomial pathogens illustrate the problem, including *Staphylococcus aureus* in the context of neurosurgical interventions [31], multidrug-resistant *Proteus vulgaris* nosocomial clinical isolates [32], methicillin-resistant *S. aureus* (MRSA) isolates from pediatric surgical patients [33], and multidrug-resistant nosocomial *Pseudomonas aeruginosa* [34]. Three of these studies tested plant-derived essential oils or hydrocolloids against such isolates in vitro [31-33], and one compared E-test values of standard antibiotics with conventional antimicrobial assay values [34]. These are laboratory data and cannot be extrapolated to clinical sepsis, but they show that resistant organisms are encountered in surgical settings and can complicate empirical therapy. This supports our recommendation for microbiologic confirmation of sepsis and for antibiotic selection guided by local susceptibility data.

Preventive and health-system factors may also contribute. Several of the modifiable determinants identified

here, such as diabetes, anaemia, and hypoalbuminemia, are detectable before surgery, but this is possible only if patients undergo routine health assessment. Population surveys in Saudi Arabia have examined the knowledge and practice of periodic medical check-ups [35,36]; where such screening is underused, these conditions may remain undetected until the patient presents as an emergency. Similarly, self-medication, which has been studied in the Makkah region [37], may promote inappropriate antibiotic use and the selection of resistant organisms of the kind discussed above. Public health measures that encourage periodic check-ups and responsible antibiotic use may therefore complement perioperative strategies to reduce the burden of sepsis. These population-level links are inferential, because none of the included studies assessed them directly.

Current guidelines recommend obtaining cultures before antimicrobials where feasible and tailoring empirical therapy to local resistance patterns [5]. Laboratory studies from Saudi Arabia have identified resistant Gram-positive and Gram-negative organisms in surgical and nosocomial settings [31-34]; these are in vitro data and cannot be extrapolated to clinical outcomes, but they illustrate why local susceptibility data matter. Similarly, several modifiable determinants identified here, including diabetes, anaemia, and hypoalbuminemia, are detectable before surgery. Regional surveys on periodic check-ups and self-medication [35-37] suggest that such conditions and inappropriate antibiotic use may be under-recognised in this population. These links are inferential, as none of the included studies assessed them directly, and they are offered as context for future research rather than as findings of this review.

Implications for Practice and Research

Clinicians should identify patients at highest risk before and after emergency surgery using age, ASA class or comorbidity burden, diabetes, functional dependence, ventilation and, in trauma, injury severity and should apply structured post-operative surveillance in these patients. Future work should use Sepsis-3 criteria and microbiologic confirmation, report trauma and emergency surgery cohorts separately, and test prediction and screening tools prospectively.

Given the wide variability in prevalence estimates driven by definitional and population heterogeneity, future research should prioritize prospective, multicenter cohorts that apply standardized Sepsis-3 criteria and explicit injury-severity stratification. Conducting this work within a prospectively registered systematic review and meta-analysis framework would generate pooled, generalizable estimates to inform trauma quality-improvement benchmarks and antimicrobial stewardship policies.

Strengths of the Synthesis Approach

A key strength of this review is that its statistical conclusions do not go beyond what the primary data support. This study did not pool estimates across populations, definitions, or adjustment sets, and did not recalculate any figure, so every estimate in the tables can be traced to its source. This study reported prevalence and incidence within clinically defined groups, labelled estimates as adjusted or unadjusted, and treated overlapping national databases as a threat to independence and not as corroboration. We also reported the width of the evidence gap honestly: only one included study [17] examined emergency surgery as an adjusted determinant in a trauma cohort, with a wide confidence interval (aOR: 3.73; 95% CI: 1.05-13.22). This conservative approach gives clinicians a reliable map of what is known and unknown, and it defines what prospective studies must measure. A central strength of this systematic review is its disciplined, clinically transparent synthesis framework, which prioritises diagnostic accuracy and real-world surgical relevance over artificial statistical pooling. The evidence is drawn from four distinct clinical strata: trauma-associated cohorts, emergency and general abdominal surgery, elective procedures, and non-surgical critical-care or emergency department comparators. This review establishes a clear epidemiological gradient from low-risk elective operations (0.1%-0.87%) to high-acuity trauma and urgent surgical interventions from 0.1%-0.87% in low-risk elective operations to 8%-10.2% in trauma cohorts. Retaining contextual comparators provides an essential physiological baseline that distinguishes hospital-acquired perioperative infection from pre-existing infection and non-operative critical illness. Consequently, this review delivers an unbiased, traceable benchmark of risk determinants highlighting surgical urgency, frailty, comorbidity burden, and modifiable nutritional or hematologic factors that directly inform preoperative risk stratification and targeted postoperative surveillance.

Limitations

First, the evidence base for the central question was thin. Most included studies enrolled general surgical, orthopaedic, or elective neurosurgical populations. Only a few enrolled trauma patients, and fewer still examined emergency surgery specifically. No included study focused exclusively on trauma patients undergoing emergency surgery, so our conclusions for this group are partly extrapolated from mixed populations. Second, infection definitions varied between registry coding, Sepsis-3, and older criteria, which limits comparability. Third, most studies were retrospective database analyses with potential residual confounding and coding error, and bacterial etiology was rarely confirmed. Fourth, heterogeneity precluded meta-analysis, so prevalence ranges should be interpreted descriptively. Finally, 813 reports could not be retrieved, so publication and language bias cannot be excluded. Selection bias from unretrieved reports. In

total, 813 of the 931 reports sought could not be retrieved because these reports were not assessed; the included studies may not represent all eligible evidence. If non-retrieval was related to study characteristics, such as journal type, language, or age of publication, our findings may be biased, and we cannot estimate the direction or size of that bias. Overlap between national databases. Several included studies drew on overlapping national datasets, notably the National Surgical Quality Improvement Program (NSQIP) and, for different periods, the Nationwide Inpatient Sample. Patients may therefore appear in more than one study, which could overstate the consistency of determinants such as age, ASA class, and diabetes. We did not pool data, so no duplicate counting occurred in any estimate, but agreement across studies should not be read as fully independent confirmation. Trauma-emergency evidence is limited. Only a few studies enrolled trauma patients, and fewer still examined emergency surgery specifically. No study focused exclusively on trauma patients undergoing emergency surgery, so conclusions for this group are partly extrapolated from mixed surgical populations. Included studies were conducted over different decades, under different guidelines, resuscitation practices, and sepsis definitions. The temporal changes in care could not be separated from differences between populations.

Unretrieved Reports and Potential Selection Bias

Although 813 of the 931 reports sought (87.3%) could not be retrieved, most of these were registry entries, citation-only records, and abstracts without full text, so their effect on the completeness of the evidence base is likely smaller than the figure suggests. Retrieval was attempted for every report that passed title and abstract screening, and the non-retrieved reports were not selectively dropped. They were not assessed against the eligibility criteria, so none were excluded on the basis of their findings. Most of the unretrieved entries originated from the study registers and Google Scholar, which return records that do not correspond to a full-text publication, such as registered protocols without published results, citation-only records, and conference abstracts without a full manuscript. By design, these record types do not meet our eligibility criteria, which required observational studies with extractable data, and conference abstracts without extractable data were prespecified exclusions. A smaller portion comprised older or paywalled articles outside institutional access. Because the large denominator reflects a deliberately sensitive search across registers and Google Scholar, a high non-retrieval count is expected and does not by itself indicate that eligible studies were lost. The 74 full-text reports that were retrieved were assessed in duplicate, and the 15 included studies were drawn from sources spanning multiple countries and surgical populations. Nevertheless, we cannot exclude that some eligible studies were among the unretrieved reports, and we cannot estimate the direction or size of any resulting bias. The findings should therefore be read as a description of the retrievable evidence, and not as a complete census of all published studies. Future reviews should record the reason for non-retrieval for each report and use interlibrary requests or author contact to recover the remainder.

Conclusions

Perioperative sepsis affects a meaningful proportion of trauma and emergency surgical patients and is associated with substantially increased mortality. Emergency or urgent surgery, older age, comorbidity burden, diabetes, functional dependence, mechanical ventilation, and longer operations were the most consistently reported determinants, and injury severity was reported in a single trauma study. Early risk stratification and structured postoperative surveillance are reasonable but were not tested in these studies. Evidence specific to trauma patients undergoing emergency surgery remains limited, and prospective studies using Sepsis-3 criteria are needed.

Additional Information

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All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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