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Systematic review

Clinical Outcomes of Delayed Versus Immediate Source Control in Intra-Abdominal Sepsis Presenting to the Emergency Department: A Systematic Review

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Abstract

Background: The clinical impact of delayed source control in intra-abdominal sepsis is difficult to quantify because of heterogeneity in timing definitions, infection sources, and procedural approaches. This review evaluated delayed versus immediate or early source control mortality and other clinical outcomes in adults with intra-abdominal sepsis. **Methods:** PubMed, Scopus, Web of Science, and

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Embase were searched from inception to January 2026. Eligible studies compared early with delayed operative, percutaneous, or endoscopic source control, or assessed time to intervention. Risk of bias was evaluated using ROBINS-I. Random-effects meta-analyses pooled odds ratios for mortality when studies were comparable. **Results:** Seven observational studies including 1,835 participants were included; three contributed to quantitative synthesis. Delayed drainage was associated with higher in-hospital mortality in the adjusted meta-analysis (pooled OR 2.92, 95% CI 1.51–5.66; I^2=0%). In the harmonized comparison of source control after versus within 12 hours, the random-effects estimate was not significant (OR 1.92, 95% CI 0.44–8.39) and heterogeneity was substantial (I^2=87.8%). Individual studies suggested worse outcomes with prolonged delay, although findings varied by source, threshold, and comparator. **Conclusion:** Delayed source control increase mortality in biliary sepsis, but current evidence does not support a universal timing threshold. Prompt source control is clinically important, while better standardized prospective studies are needed.

Keywords: Intra-abdominal sepsis; intra-abdominal infection; source control; delayed source control; early intervention; biliary drainage; septic shock

Introduction

Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection and is a challenge in acute and critical care (1). Intra-abdominal infections are a source of sepsis because they produce continuous bacterial contamination, tissue necrosis, abscess formation, obstruction, or perforation that cannot be corrected by antimicrobial therapy alone. Management depends on resuscitation, antimicrobials, organ support, and source control. Source control includes operative repair or resection, drainage of collections, debridement of tissue, and decompression of an obstructed biliary or gastrointestinal system. The Surviving Sepsis Campaign recommends identifying an anatomical focus requiring intervention and implementing source control as soon as medically and logistically practical (2).

Persistent contamination maintains microbial burden, promotes inflammatory activation, and prevent reversal of shock despite antibiotics and hemodynamic support. In a multinational cohort of critically ill patients with secondary peritonitis, mortality remained substantial, and delayed or unsuccessful source control was associated with worse outcomes (3). A multicenter cohort of patients with community-acquired sepsis requiring intervention found that source control within six hours of sepsis onset was associated with lower risk-adjusted 90-day mortality than later intervention (4).

The timing of source control in intra-abdominal sepsis is uncertain. Available evidence is dominated by observational studies, and the meaning of “early” or “delayed” differs according to anatomical source, procedure, reference time, and illness severity. In gastrointestinal perforation with septic shock, Azuhata et al. reported a progressive reduction in survival as the interval from admission to surgery increased, suggesting that operative source control within six hours may be important (5). A smaller pilot cohort of free intestinal perforation found higher 30-day survival after surgery within three hours (6). Biliary decompression more than 12 hours after shock onset was associated with higher hospital mortality (7), and drainage after 48 hours was associated with increased mortality, whereas drainage within 24 hours was not independently protective (8). Zhu et al. found no significant relationship between drainage delay and mortality in severe acute cholangitis, although later drainage was associated with longer intensive-care and hospital stays (9).

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In patients with septic shock caused by intra-abdominal infection, Önal et al. (10) found lower mortality in those who received source control than in those who did not; mortality did not differ between procedures performed within or after 12 hours in treated patients. A focused synthesis is needed to separate delayed intervention from no intervention, in this systematic review and meta-analysis we aimed to compare delayed versus immediate or early source control in adults with intra-abdominal sepsis.

Methods

Study design and reporting

This systematic review and meta-analysis was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement (PRISMA 2020). The PRISMA 2020 checklist and flow diagram were used to document the identification, screening, eligibility assessment, and inclusion of studies (11).

Eligibility criteria

Studies were selected according to predefined criteria. Eligible studies included adults aged 18 years or older with intra-abdominal infection, intra-abdominal sepsis, septic shock secondary to an abdominal source, gastrointestinal perforation with sepsis, or severe acute cholangitis requiring biliary decompression. Source-control interventions included operative management, percutaneous drainage, endoscopic biliary drainage, debridement, removal of infected tissue, or another procedure intended to eliminate or control the intra-abdominal infectious focus.

Studies should compare immediate or early source control with delayed source control, or to evaluate the association between time to source control and clinical outcomes. Because definitions varied in literature, the timing categories reported by the original investigators were initially retained. The primary outcome was short-term all-cause mortality, including in-hospital, 30-day, or 60-day mortality. Secondary outcomes included intensive care unit and hospital length of stay, duration of organ support, complications, repeat interventions, and treatment failure.

Original randomized or non-randomized comparative studies, including prospective and retrospective cohort studies, were eligible. Reviews, systematic reviews, meta-analyses, editorials, commentaries, conference abstracts without adequate outcome data, case reports, small uncontrolled case series, animal studies, pediatric studies, and studies that did not evaluate source-control timing were excluded. Studies involving mixed populations were included only when data for patients with intra-abdominal sepsis or an eligible abdominal source could be separately extracted.

Information sources and search strategy

PubMed/MEDLINE, Scopus, Web of Science, and Embase were searched from database inception to Jan 2026. The search combined controlled vocabulary and free-text terms related to intra-abdominal infection and sepsis, source control, intervention timing, and clinical outcomes. The principal search concepts included “intra-abdominal infection,” “intra-abdominal sepsis,” “peritonitis,” “gastrointestinal perforation,” “acute cholangitis,” “septic shock,” “source control,” “surgery,” “drainage,” “biliary decompression,” “endoscopic retrograde cholangiopancreatography,” “early,” “immediate,” “urgent,” “delayed,” “timing,” “mortality,” and “survival.” Medical Subject Headings were used in

PubMed, Emtree terms were used in Embase, and equivalent title, abstract, and keyword fields were used in Scopus and Web of Science. The complete database-specific search strategies should be presented in Supplementary Table S1.

Study selection

All retrieved records were imported into Mendeley software, and duplicate records were removed. Screening was undertaken in two stages. Titles and abstracts were assessed against the eligibility criteria. One reviewer performed the screening and rechecked all included articles and full-text exclusions to reduce classification errors. Reasons for exclusion at the full-text stage were recorded. The study-selection process was summarized using the PRISMA 2020 flow diagram.

Data extraction

Data were extracted using a standardized form developed for this review. Extracted information included first author, publication year, country, study setting, study period, study design, sample size, participant characteristics, type and severity of intra-abdominal infection, diagnostic criteria, source-control procedure, starting point used to calculate timing, definitions of early and delayed source control, mortality follow-up period, secondary outcomes, effect estimates, confidence intervals, and variables included in adjusted analyses.

Adjusted effect estimates were extracted when available in preference to unadjusted estimates. For studies reporting raw event data, mortality events and total participants in each timing group were extracted to construct 2×2 tables. All extracted numerical data were rechecked against the original articles before analysis. Authors' reported timing definitions were preserved in the characteristics and narrative-synthesis tables.

Risk-of-bias assessment

Risk of bias was assessed using the original 2016 Risk Of Bias In Non-randomized Studies of Interventions tool (ROBINS-I) (12). Seven domains were evaluated: bias due to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. Each domain was rated as low, moderate, serious, critical risk of bias, or no information. The overall judgment corresponded to the highest risk identified in any domain. Attention was given to confounding by disease severity, hemodynamic instability, anatomical source, antimicrobial timing, procedure availability, contraindications to intervention, immortal-time bias, and the inclusion of untreated patients in delayed-source-control comparator groups. Risk-of-bias assessments were performed for the mortality outcome and were considered when interpreting the pooled estimates.

Data synthesis and meta-analysis

Studies were pooled only when their populations, source-control interventions, comparator definitions, and mortality outcomes were judged sufficiently similar. Different infection sources and timing thresholds were not combined indiscriminately in a single overall estimate. The effect measure was the odds ratio for mortality with delayed compared with early source control. An odds ratio greater than 1 indicated higher mortality in the delayed group. For adjusted analyses, reported odds ratios and 95% confidence intervals were transformed to the logarithmic scale, and standard errors were derived from the confidence

limits. For analyses based on raw data, crude odds ratios and corresponding 95% confidence intervals were calculated from mortality events and total participants. Adjusted and crude estimates were analyzed separately.

Adjusted estimates from studies of biliary sepsis were pooled using the study-defined threshold for delayed biliary drainage. A harmonized analysis compared source control performed after 12 hours with source control performed within 12 hours and included only patients who received a source-control intervention. Inverse-variance random-effects models were used and between-study variance was estimated using restricted maximum likelihood. Results were presented as pooled odds ratios with 95% confidence intervals and displayed in forest plots. Statistical heterogeneity was evaluated using Cochran's Q test, the I^2 statistic, and τ^2.

Funnel plots, Egger's regression test, meta-regression, and formal subgroup-difference tests were not performed because the number of studies in each pooled analysis was insufficient. Statistical calculations were conducted using Stata 16. Two-sided P values below 0.05 were considered statistically significant for pooled effects, while P<0.10 was considered indicative of possible heterogeneity because of the low power of Cochran's Q test when few studies are available.

Results

Study selection

The database search identified 154 records from PubMed, Scopus, Web of Science, and Embase. Before screening, 47 records were removed, comprising 20 duplicate records, 18 records classified as ineligible by automated tools, and nine records removed for other reasons. Consequently, 107 titles and abstracts were screened, of which 50 were excluded. Fifty-seven reports were sought for retrieval, but 25 could not be retrieved. The remaining 32 full-text reports were assessed against the predefined eligibility criteria, and 25 were excluded. Seven studies were included in the qualitative synthesis, while three unique studies contributed data to at least one quantitative meta-analysis. The complete study-selection process is presented in the PRISMA flow diagram in Figure 1.

Characteristics of the included studies

The seven included studies comprised 1,835 eligible participants and were published between 2014 and 2024. One study used a prospective observational design, whereas the remaining were retrospective cohorts or prospectively recorded cohorts analyzed retrospectively. The studies were conducted in Japan, Germany, France, the United States, China, Türkiye, and an international multicenter setting. Sample sizes ranged from 76 to 467 eligible participants.

Two studies evaluated surgical source control for gastrointestinal perforation and peritonitis (5,6). Four studies investigated the timing of biliary decompression in severe acute cholangitis or cholangitis-associated septic shock (7–9,13). One study included patients with septic shock arising from mixed intra-abdominal infections and assessed surgical or percutaneous source control (10). Source-control procedures included laparotomy, endoscopic retrograde cholangiopancreatography, percutaneous transhepatic biliary drainage, and other percutaneous interventions. Definitions of early source control varied, with thresholds ranging from three to 48 hours and different starting points, including hospital admission, radiological diagnosis,

septic-shock onset, and ICU admission. Detailed study characteristics are provided in Table 2.

Findings of the individual studies

Among patients with gastrointestinal perforation and septic shock survivors underwent surgery earlier than nonsurvivors, and each additional hour before surgery was independently associated with lower odds of 60-day survival. Survival declined progressively with increasing delay and reached 0% when surgery began more than six hours after admission. 30-day survival rates of 80% with surgery within three hours and 73% with later surgery, although the difference was not statistically significant.

In cholangitis-associated septic shock that successful biliary decompression delayed beyond 12 hours was independently associated with increased hospital mortality, with an adjusted odds ratio of 3.40. Biliary decompression more than 48 hours after ICU admission was associated with increased in-hospital mortality.

We found no significant association between increasing drainage delay and either in-hospital or 30-day mortality. Each additional day of delay was associated with a 1.49-day increase in hospital length of stay, and drainage after 48 hours was associated with a 5.56-day increase in ICU length of stay. In the Grade III acute-cholangitis subgroup, we observed lower mortality among patients who underwent biliary drainage compared with those who did not. Mortality was lower in patients receiving any source-control intervention than among those receiving no intervention. Among patients who underwent source control, 30-day mortality did not differ significantly between intervention within 12 hours and intervention after 12 hours. The principal clinical findings of all included studies are summarized in Table 3.

Risk of bias

Using ROBINS-I, one study was judged to have an overall moderate risk of bias, five were judged to have a serious risk, and one was judged to have a critical risk of bias. Lavillegrand et al. (2021) had moderate overall risk, whereas Azuhata et al. (2014), Hecker et al. (2015), Karvellas et al. (2016), Zhu et al. (2021), and Önal et al. (2024) had serious overall risk. The Grade III analysis reported by Lu et al. (2022) was judged to have critical risk because the comparator groups combined delayed drainage with no drainage. The most important concerns were confounding by disease severity, participant selection, missing data, immortal-time bias, and differences in the clinical reasons for source-control delay. Mortality measurement was considered to have a low risk of bias. The domain-level judgments are shown in Table 1.

Meta-analysis of adjusted estimates

Two studies contributed adjusted mortality estimates to the exploratory biliary-sepsis meta-analysis (7,8). The definitions of delayed drainage differed between the studies, with thresholds of more than 12 hours and more than 48 hours, respectively. Under the random-effects model, delayed biliary source control was associated with greater odds of in-hospital mortality compared with earlier source control, with a pooled OR of 2.92 (95% CI 1.51–5.66). No statistical heterogeneity was detected, although the estimate was based on only two studies (I^2=0%, τ^2=0.000; heterogeneity P=0.740). The study-level data and pooled results are presented in Tables 4 and 5, and the forest plot is shown in Figure 2.

Harmonized 12-hour meta-analysis

Karvellas et al. (2016) and Önal et al. (2024) provided mortality data that permitted a harmonized comparison of source control performed after 12 hours versus within 12 hours among patients who received source control. The random-effects analysis showed a pooled OR of 1.92 (95% CI 0.44–8.39). Heterogeneity was present (I^2=87.8%, τ^2=0.998; heterogeneity P=0.004), reflecting the differing results of the two studies. The fixed-effect sensitivity analysis produced an OR of 1.96 (95% CI 1.17–3.27); this result was not considered the principal estimate because the fixed-effect assumption was inappropriate in the presence of marked heterogeneity. These findings are reported in Table 5 and Figure 3.

Table 1. ROBINS-I assessment of the included non-randomized studies

Study	D1: Confounding	D2: Participant selection	D3: Intervention classification	D4: Deviations from intervention	D5: Missing data	D6: Outcome measurement	D7: Selective reporting	Overall risk
Azuhata et al., 2014 (5)	Serious	Serious	Low	Low	Low	Low	Moderate	Serious
Hecker et al., 2015 (6)	Serious	Serious	Low	Moderate	Moderate	Low	Moderate	Serious
Karvellas et al., 2016 (7)	Moderate	Serious	Low	Moderate	Serious	Low	Moderate	Serious
Lavillegrand et al., 2021 (8)	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Moderate
Zhu et al., 2021 (9)	Moderate	Serious	Low	Moderate	Low	Low	Moderate	Serious
Lu et al., 2022 (13)	Serious	Critical	Serious	Serious	Moderate	Low	Serious	Critical
Önal et al., 2024 (10)	Serious	Serious	Low	Serious	Moderate	Low	Moderate	Serious

Fig 1: PRISMA flow chart

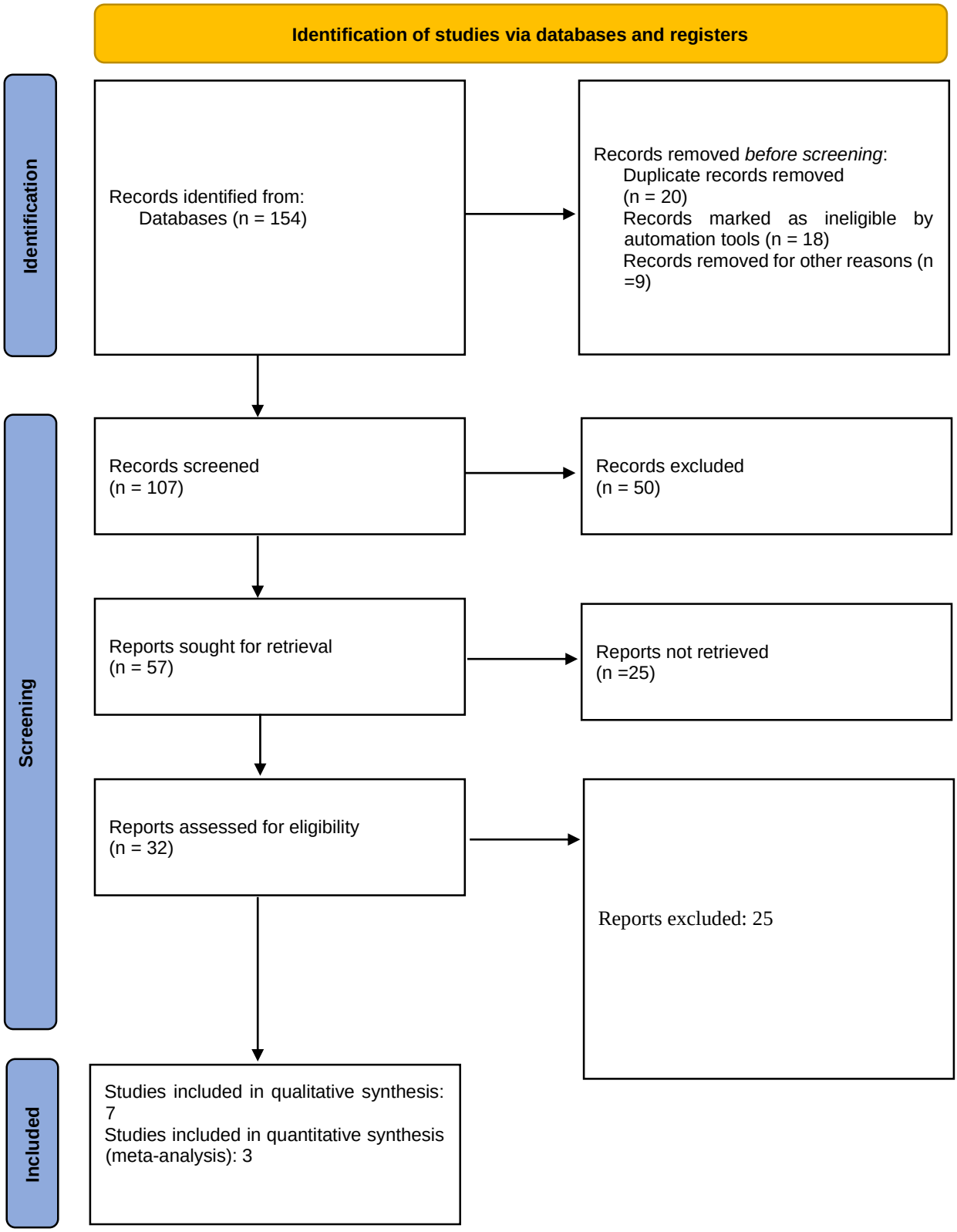


Table 2. Characteristics of the included studies

Study	Country, setting, and study period	Study design	Eligible population and sample	Source-control procedure	Timing definition
Azuhata et al., 2014 (5)	Japan; single urban academic emergency and critical-care center; January 2007–December 2011	Prospective observational study	154 adults with gastrointestinal perforation, diffuse peritonitis, and associated septic shock	Emergency operative source control, predominantly laparotomy, supported by early goal-directed resuscitation	Time from hospital admission to initiation of surgery, analyzed continuously and in 2-hour intervals; clinically important threshold approximately ≤6 vs >6 hours
Hecker et al., 2015 (6)	Germany; University Hospital Giessen; August 2008–February 2012	Single-center retrospective pilot cohort	76 adult septic patients with radiologically and operatively confirmed free intestinal perforation	Surgical source control, mainly open surgery	Time from radiological diagnosis to surgical incision: <3 hours (n=25), 3–9 hours (n=36), and >9 hours (n=15)
Karvellas et al., 2016 (7)	International multicenter CATSS database; 1996–2011	Nested retrospective multicenter cohort	260 patients with acute cholangitis-associated septic shock requiring vasopressors	Successful ERCP (n=91), percutaneous transhepatic drainage (n=90), or surgical decompression (n=34); 42 patients had unsuccessful/no source control	Time from onset of septic shock to successful biliary decompression; principal comparison ≤12 vs >12 hours
Lavillegrand et al., 2021 (8)	France; 11 ICUs; January 2005–March 2018	Retrospective multicenter cohort	382 critically ill adults with acute cholangitis; 370/382 (97%) had sepsis and 170/382 (44%) had septic shock	ERCP in 76%, percutaneous drainage in 21%, and surgery in 7%; some patients received more than one procedure	Time from ICU admission to biliary decompression; evaluated at <24 hours, 24–48 hours, and >48 hours
Zhu et al., 2021 (9)	United States; MIMIC-III database, Beth Israel Deaconess Medical Center; 2001–2012	Retrospective single-center database cohort	106 ICU patients with severe acute cholangitis meeting Tokyo Guidelines 2018 Grade III criteria; all underwent drainage	ERCP-related procedures and/or percutaneous biliary drainage; 20.8% received percutaneous drainage	Time from admission to first drainage: <24 hours (n=72), 24–48 hours (n=13), and >48 hours (n=21); median 14.14 hours
Lu et al., 2022 (13)	China; Beijing Friendship Hospital; July 2016–December 2020	Single-center retrospective cohort	Full cohort: 1,305 acute cholangitis patients. Eligible Grade III subgroup: 467 patients, including 307 who	ERCP in 272/307 and percutaneous transhepatic biliary drainage in 35/307 Grade III patients receiving drainage	Drainage <12 hours (n=89), 12–24 hours (n=89), 24–48 hours (n=47), and >48 hours (n=82). Published comparisons combined

Study	Country, setting, and study period	Study design	Eligible population and sample	Source-control procedure	Timing definition
			underwent drainage and 160 who did not		later drainage with absence of drainage
Önal et al., 2024 (10)	Türkiye; tertiary university hospital, İzmir; December 2013–October 2022	Prospectively recorded cohort analyzed retrospectively	390 patients with intra-abdominal infection-associated septic shock	Source control in 123 patients: laparotomy/invasive surgery in 77 and percutaneous intervention in 46	Source control within 12 hours (n=44) versus after 12 hours (n=79) among source-controlled patients; additional analyses compared source control with no source control

Table 3. Main findings and clinical outcomes of the included studies

Study	Mortality findings	Outcomes
Azuhata et al., 2014 (5)	Overall 60-day survival was 77.9% (120/154). Surgery began after a mean of 2.6±1.0 hours in survivors versus 4.6±1.6 hours in nonsurvivors (P<0.0001).	Mean overall time to surgery was 3.1±1.5 hours. All patients received protocolized hemodynamic resuscitation alongside urgent surgical source control.
Hecker et al., 2015 (6)	Thirty-day survival was 80% with surgery within 3 hours, compared with 73% in both the 3–9-hour and >9-hour groups. Differences were not statistically significant.	Timing was not significantly associated with hospital length of stay, duration of surgery, ventilation duration, vasopressor requirement, or laboratory trends.
Karvellas et al., 2016 (7)	Overall hospital mortality was 37%. Survivors underwent decompression earlier than nonsurvivors: median 8.8 vs 21.5 hours (P<0.001).	Only 2/42 patients without successful source control survived to hospital discharge. Delayed appropriate antimicrobial therapy was also independently associated with mortality.
Lavillegrand et al., 2021 (8)	Overall in-hospital mortality was 29%.	Median drainage time was 24 hours (IQR 9–48). ICU and hospital lengths of stay were 5 and 6 days, respectively.
Zhu et al., 2021 (9)	In-hospital mortality was 11.1% with drainage <24 hours, 15.4% at 24–48 hours, and 19.0% after 48 hours.	Each additional day of delay increased hospital stay by 1.49 days (95% CI 1.09–1.89; P<0.0001). Drainage after 48 hours increased ICU stay by 5.56 days (95% CI 1.43–9.68; P=0.0096).
Lu et al., 2022 (13)	Any drainage was associated with lower in-hospital mortality than no drainage: 11/307 (3.6%) vs 22/160 (13.8%), P<0.001.	Early drainage was associated with longer length of stay and higher hospitalization cost, likely partly because the comparison groups included untreated patients with short stays or early deaths. Subgroups

Study	Mortality findings	Outcomes
		with neurological dysfunction or lactate ≥2 mmol/L appeared to benefit from drainage within 12 hours.
Önal et al., 2024 (10)	Overall 30-day mortality was 71.3%. Mortality was lower with any source control than without it: 65/123 (52.8%) vs 213/267 (79.8%), P<0.001.	Surgical source control had higher mortality than percutaneous intervention, 67.5% versus 28.3%, probably reflecting differences in disease type and severity rather than procedure effectiveness.

Table 4. Data included in the quantitative syntheses

Analysis	Study	Definition of delayed source control	Mortality outcome	Delayed group	Early group	Individual effect
Adjusted biliary-sepsis analysis	Karvellas et al., 2016	Successful biliary decompression >12 hours after septic-shock onset	In-hospital mortality	Adjusted estimate	Adjusted estimate	OR 3.40 (95% CI 1.12–10.31)
Adjusted biliary-sepsis analysis	Lavillegrand et al., 2021	Biliary decompression >48 hours after ICU admission	In-hospital mortality	Adjusted landmark estimate	Adjusted landmark estimate	OR 2.69 (95% CI 1.18–6.13)
Harmonized 12-hour crude analysis	Karvellas et al., 2016	Source control >12 versus ≤12 hours after shock onset	In-hospital mortality	36/94 deaths	13/98 deaths	OR 4.06 (95% CI 1.98–8.31)
Harmonized 12-hour crude analysis	Önal et al., 2024	Source control >12 versus ≤12 hours during septic shock	30-day mortality	41/79 deaths	24/44 deaths	OR 0.90 (95% CI 0.43–1.88)

Table 5. Meta-analysis results

Quantitative synthesis	Studies	Pooled OR	95% CI	I^2	τ^2	Heterogeneity P value
Adjusted biliary-sepsis analysis: study-defined delayed drainage	2	2.92	1.51–5.66	0%	0.000	0.740
Crude analysis: source control >12 versus ≤12 hours	2	1.92	0.44–8.39	87.8%	0.998	0.004
Fixed-effect sensitivity analysis for the 12-hour comparison	2	1.96	1.17–3.27	87.8%	—	0.004

Figure 2. Adjusted biliary-sepsis meta-analysis

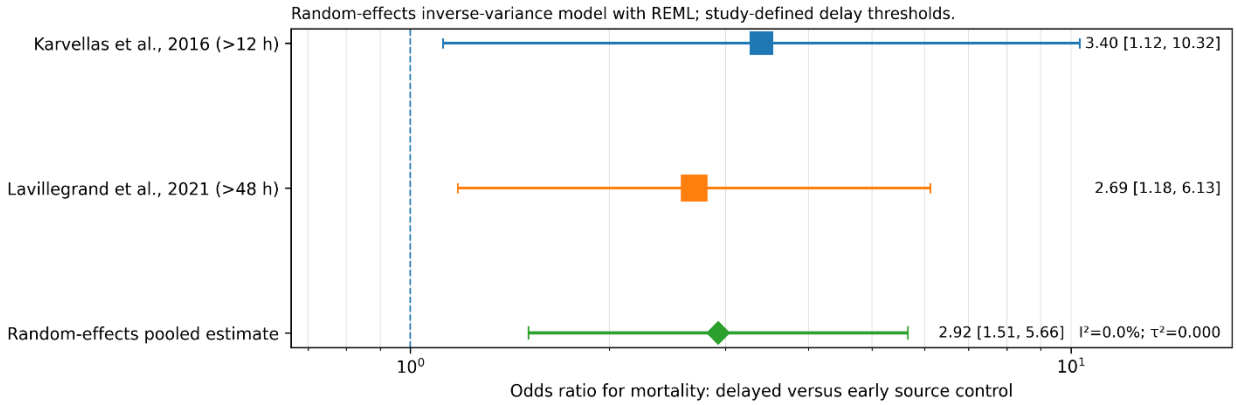
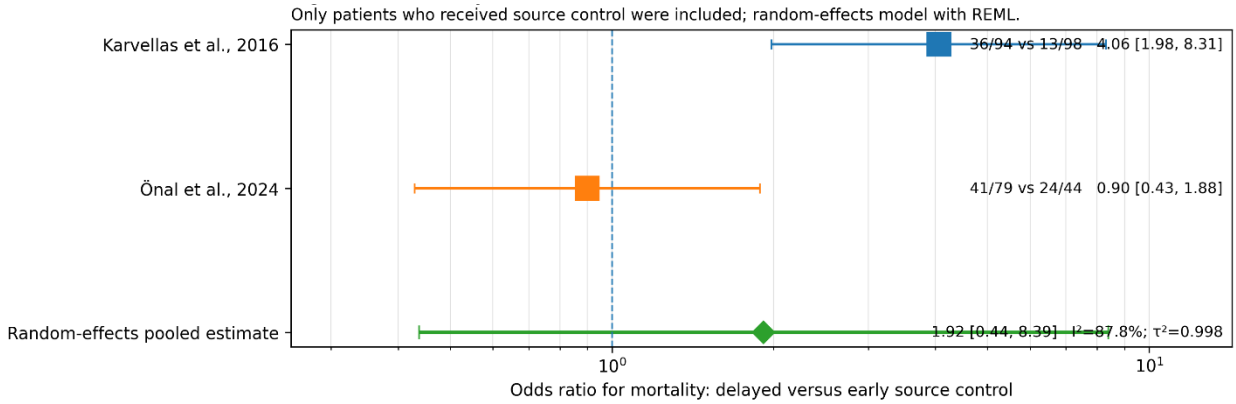


Figure 3. Source control after versus within 12 hours



Discussion

This systematic review and meta-analysis found that delayed source control was associated with poorer outcomes in adults with intra-abdominal sepsis, although the association depended on the anatomical source, procedure, timing threshold, and analytical method. In the adjusted biliary-sepsis synthesis, delayed drainage was associated with threefold higher odds of in-hospital mortality, without detected statistical heterogeneity. The harmonized comparison of source control after versus within 12 hours produced an imprecise, non-significant random-effects estimate with substantial heterogeneity. Although the fixed-effect sensitivity analysis was significant, the random-effects estimate is more appropriate given this heterogeneity.

The pooled biliary result is consistent with Karvellas et al., who found that successful decompression more than 12 hours after septic-shock onset independently increased hospital mortality (7). Lavillegrand et al. found worse mortality when decompression occurred beyond 48 hours, although drainage within 24 hours was not associated with improved survival (8). Zhu et al. (9) found no significant mortality association with increasing delay, but later drainage was associated with longer intensive-care and hospital stays. Lu et al. (13) reported lower mortality in patients with severe acute cholangitis who underwent drainage; their timing comparisons combined delayed drainage with no drainage, limiting causal interpretation. Prolonged untreated obstruction is harmful.

Azuhata et al. (5) observed a progressive decline in survival as the admission-to-surgery interval increased in patients with gastrointestinal perforation and septic shock, proposing a favorable target within six hours. Hecker et al. (6) found higher 30-day survival with surgery within three hours. The broader sepsis literature supports timely source control. Reitz et al. (4) in a cohort of 4,962 patients undergoing procedures for community-acquired sepsis, found lower risk-adjusted 90-day mortality when source control occurred within six hours. De Pascale et al. identified poor timing and failure of source control as mortality risk factors in critically ill patients with secondary peritonitis (3). The present review suggests that obtaining source control were more important than meeting a specific 12-hour threshold. Önal et al. (10) reported lower mortality with any source-control intervention than with no intervention.

All included studies were observational, most had serious risk of bias, and procedural timing was influenced by disease severity, hemodynamic instability, anatomical complexity, contraindications, and local availability. Confounding by indication favor early treatment in suitable patients or direct the sickest patients to the earliest procedures. Immortal-time bias and the inclusion of untreated patients within delayed groups exaggerate apparent benefits. The small number of studies also prevented reliable subgroup, meta-regression, and publication-bias analyses.

These findings support rapid recognition, antimicrobial treatment, resuscitation, and early multidisciplinary planning for operative, percutaneous, or endoscopic source control, consistent with international sepsis guidance (2). Timing should be considered a continuum rather than an absolute dichotomy, and stabilization

should proceed in parallel without avoidable procedural delay. Future multicenter studies should standardize the timing origin, distinguish delayed from absent source control, document reasons for delay, and report adjusted outcomes according to infection source and intervention.

Conclusion

The present study found that delayed source control worsen clinical outcomes in adults with intra-abdominal sepsis in biliary sepsis, where delayed drainage was associated with higher in-hospital mortality. Considerable clinical heterogeneity, inconsistent timing definitions, and serious risk of bias limited certainty. Prompt recognition, resuscitation, antimicrobial therapy, and timely operative, percutaneous, or endoscopic source control remain essential.

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