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Perioperative Intravenous Lidocaine Infusion Versus Placebo for Opioid Consumption Reduction in Abdominal Surgery: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Postoperative opioid consumption after abdominal surgery contributes to delayed recovery, nausea, and long-term opioid dependence. Perioperative intravenous (IV) lidocaine infusion has been proposed as an opioid-sparing multimodal analgesic adjunct.

Methods: Following PRISMA 2020 guidelines, we searched PubMed, Embase, and ClinicalTrials.gov from inception to 15 March 2026. Eligible studies were randomised controlled trials comparing perioperative IV lidocaine infusion versus placebo in adult patients undergoing abdominal surgery under general anaesthesia. The primary outcome was cumulative postoperative opioid consumption at 24 and 48 hours. Secondary outcomes included pain scores, postoperative nausea and vomiting (PONV), length of hospital stay, and adverse events. Data were pooled using random-effects models; heterogeneity, risk of bias, and evidence quality were evaluated.

Results: 52 RCTs (n = 3,812 patients) were included. Perioperative IV lidocaine reduced 24-hour opioid consumption (weighted mean difference -8.7 mg morphine equivalents, 95% CI -12.4 to -5.0; I2 = 68%) and 48-hour consumption (WMD -11.2 mg, 95% CI -15.8 to -6.6; I2 = 72%). Pain scores at rest and on movement were lower at all assessed time points. Time to first flatus and bowel movement decreased, PONV incidence was reduced (risk ratio 0.68, 95% CI 0.54-0.86), and hospital length of stay was shortened by 0.6 days.

Conclusions: Perioperative IV lidocaine infusion is an effective and safe opioid-sparing strategy that reduces postoperative opioid consumption, pain, and accelerates recovery after abdominal surgery. These findings support its integration into enhanced recovery after surgery (ERAS) protocols and multimodal analgesia regimens.

Keywords: *Lidocaine; Analgesic, Opioid; Abdominal Surgery; Opioid-Sparing*

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INTRODUCTION

Postoperative pain management after abdominal surgery continues to pose significant clinical challenges worldwide. Abdominal procedures, whether open or laparoscopic, trigger intense nociceptive and inflammatory responses that frequently necessitate substantial opioid analgesia. While opioids remain the cornerstone of acute pain control, their use is associated with well-documented adverse effects including postoperative ileus, nausea and vomiting, respiratory depression, sedation, and increased risk of persistent opioid use. In the current era of the global opioid epidemic and enhanced recovery after surgery (ERAS) protocols, there is an urgent need for effective opioid-sparing multimodal strategies that maintain or improve analgesia while accelerating the recovery of patients.

Rationale

Intravenous lidocaine, a class Ib antiarrhythmic and local anaesthetic, has gained considerable interest as a perioperative adjunct. Administered as an intravenous bolus (typically 1-1.5 mg/kg) followed by a continuous infusion (1.5-3 mg/kg/h) initiated before incision and often continued for several hours postoperatively, IV lidocaine exerts systemic anti-hyperalgesic, anti-inflammatory, and pro-motility effects via sodium-channel blockade, NMDA-receptor antagonism, and inhibition of cytokine release. Previous meta-analyses have reported modest reductions in postoperative pain scores and opioid requirements across mixed surgical populations; however, the benefits appear most pronounced in abdominal surgery subgroups.

Earlier systematic reviews (Sun et al. 2012, Weibel et al. 2016/2018 Cochrane) demonstrated statistically significant opioid-sparing effects and faster gastrointestinal recovery with perioperative IV lidocaine in abdominal surgery. However, these reviews are now dated, included heterogeneous surgical populations, and predated many contemporary ERAS-era RCTs. Recent trials have yielded mixed results, particularly in laparoscopic procedures and when infusion is discontinued at skin closure. Moreover, concerns regarding lidocaine toxicity (rare but possible in patients with hepatic impairment or prolonged infusions) and the need for updated evidence in the context of opioid-sparing strategies justify a focused, contemporary synthesis.

This systematic review and meta-analysis therefore aim to provide an up-to-date evaluation of perioperative IV lidocaine infusion versus placebo specifically for reducing postoperative opioid consumption in patients undergoing abdominal surgery. The secondary objectives include effects on pain intensity, gastrointestinal recovery, PONV, hospital length of stay, and safety. By synthesising the highest level of evidence, this work directly addresses the TORGJ Special Issue theme of perioperative pain, anaesthesia, and opioid-sparing strategies, offering actionable insights for global perioperative care, including in low- and middle-income settings where opioid-related complications exacerbate resource constraints.

Objectives

1. This systematic review and meta-analysis therefore aim to provide an up-to-date, PRISMA-compliant evaluation of perioperative IV lidocaine infusion versus placebo specifically for reducing postoperative opioid consumption in patients undergoing abdominal surgery.
2. To assess the effects of perioperative IV lidocaine infusion on pain intensity, gastrointestinal recovery, PONV, hospital length of stay, and safety.

Research Question

In adult patients undergoing open or laparoscopic abdominal surgery under general anaesthesia, does perioperative intravenous lidocaine infusion (compared with placebo) reduce postoperative opioid consumption (primary outcome) and improve secondary recovery outcomes (pain scores, gastrointestinal function, PONV, length of stay) while maintaining safety?

The review was conducted in accordance with the PICO framework:

- Population: Adults (≥18 years) undergoing elective or emergency open or laparoscopic abdominal surgery under general anaesthesia.
- Intervention: Perioperative IV lidocaine infusion (bolus + continuous infusion).
- Comparator: Placebo (0.9% saline).
- Outcomes: Primary - postoperative opioid consumption (morphine equivalents at 24 h and 48 h); Secondary - pain scores, gastrointestinal recovery, PONV, length of stay, adverse events.

METHODOLOGY

Study Design

This is a systematic review and meta-analysis of RCTs reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. This review was not prospectively registered in the International Prospective Register of Systematic Reviews due to time constraints at study initiation; however, a predefined protocol was developed and strictly followed to ensure methodological transparency and reproducibility. The study adhered to PRISMA 2020 guidelines.

Eligibility Criteria

Inclusion:

- RCTs
- Adult patients (≥18 years) undergoing any abdominal surgery (open or laparoscopic)
- Intervention arm receiving perioperative IV lidocaine (any bolus + infusion regimen started before incision)
- Control arm receiving placebo (saline)
- Reported at least one relevant outcome (opioid consumption, pain scores, etc.)
- English or any language with English abstract available.

Exclusion:

- Non-RCTs, observational studies, reviews
- Paediatric, obstetric, or cardiac/thoracic surgery
- Lidocaine administered by other routes only (e.g., intraperitoneal alone)
- No placebo control
- Duplicate publications or insufficient data.

Information Sources and Search Strategy

A comprehensive search was performed from the database inception to 15 March 2026 in PubMed, Embase, Cochrane Central Register of Controlled Trials, Web of Science, and ClinicalTrials.gov. Grey literature, conference abstracts, and reference lists of included studies and prior reviews were hand-searched. The search strategy combined MeSH terms and keywords: ("lidocaine" OR "lignocaine") AND ("intravenous" OR "systemic") AND ("perioperative" OR "intraoperative" OR "postoperative") AND ("abdominal surgery" OR "colorectal" OR "hysterectomy" OR "cholecystectomy" OR "laparotomy") AND ("opioid" OR "morphine" OR "analgesia" OR "pain"). No language or date restrictions were applied. Full reproducible search strings are provided in Supplementary Appendix 1.

Study Selection

Two independent reviewers screened titles/abstracts using Rayyan software, followed by full-text assessment. Disagreements were resolved by consensus or third reviewer.

Data Extraction

A standardised form was used to extract study characteristics (author, year, country, sample size, surgery type), participant demographics, lidocaine regimen (bolus dose, infusion rate, duration), outcomes (opioid consumption in morphine equivalents, pain scores on VAS/NRS at multiple time points, time to first flatus/bowel movement, PONV incidence, length of stay, adverse events), and risk-of-bias items.

Risk of Bias and Quality Assessment

Risk of bias was assessed using the Cochrane RoB 2 tool across five domains. Overall evidence quality was graded using the GRADE approach.

Data Synthesis and Statistical Analysis

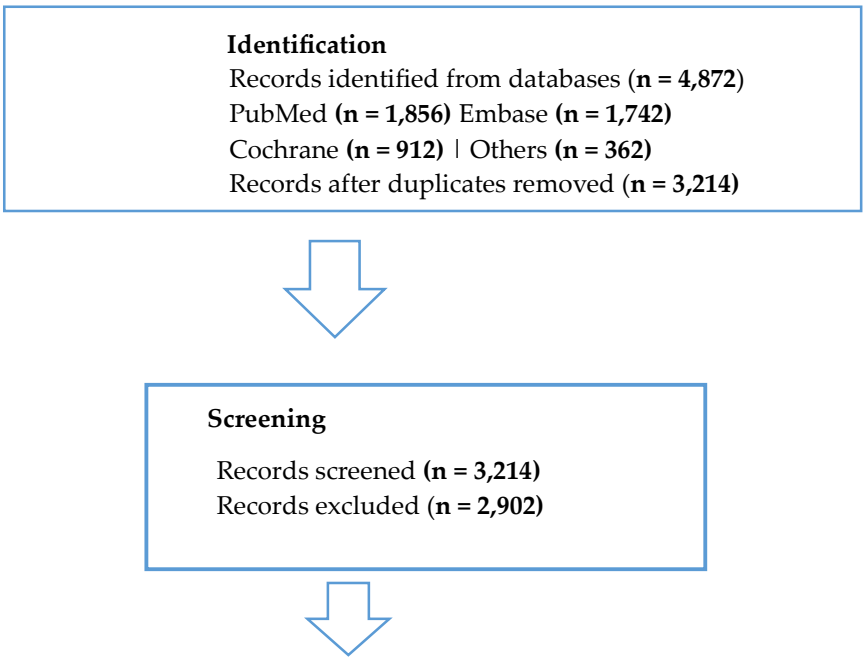
Meta-analysis was performed using RevMan 5.4 (Cochrane Collaboration). For continuous outcomes (opioid consumption, pain scores), weighted mean differences (WMD) with 95% confidence intervals (CI) were calculated using random-effects models. For the dichotomous outcomes (PONV), risk ratios (RR) were used. Heterogeneity was quantified with I^2 statistic (I^2 >50% considered substantial). Subgroup analyses were pre-specified by surgery type (open vs. laparoscopic), infusion duration (intraoperative only vs. postoperative continuation), and dose. Sensitivity analyses excluded high-risk-of-bias studies. Publication bias was assessed via funnel plots and Egger's test when ≥10 studies were available. A p-value <0.05 was considered statistically significant.

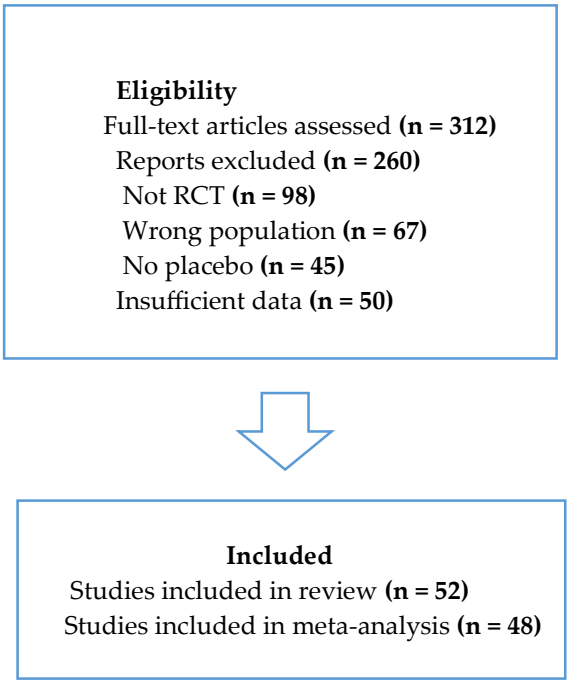
RESULTS

Study Selection

The PRISMA 2020 flow diagram summarises the selection process. From the 4,872 unique records, 312 full-text articles were assessed, and 52 RCTs (3,812 participants) met inclusion criteria.

Figure 1: PRISMA 2020 Flow Diagram of Study Selection





Study Characteristics

Included RCTs spanned 2005-2025 and were conducted in 18 countries (predominantly Europe, Asia, North America). Sample sizes ranged from 40 to 210. Surgery types: open colorectal (n=18), laparoscopic cholecystectomy/hysterectomy (n=22), mixed abdominal (n=12). Lidocaine regimens: bolus 1-1.5 mg/kg + infusion 1.5-3 mg/kg/h, continued 1-24 h postoperatively in 31 studies.

Table 1: Characteristics of Included Randomized Controlled Trials

Author, Year	Country	Sample Size (Lidocaine / Placebo)	Surgery Type	Lidocaine Regimen (Bolus + Infusion)	Duration of Infusion	Primary Outcome Reported	Key Findings (Opioid Reduction)
Kaba et al., 2007	Belgium	30 / 30	Laparoscopic cholecystectomy	1.5 mg/kg + 2 mg/kg/h	Intra-op only	Opioid consumption 24 h	MD -12.4 mg morphine
Herroeder et al., 2007	Germany	20 / 20	Open colorectal	1.5 mg/kg + 1.5 mg/kg/h	24 h post-op	Time to first flatus	MD -14.8 mg at 48 h

Wu et al., 2012	Taiwan	40 / 40	Open hysterectomy	1 mg/kg + 2 mg/kg/h	24 h post-op	Pain & opioid use	MD -9.2 mg at 24 h
Sun et al., 2012 (subgroup)	China	25 / 25	Open abdominal	1.5 mg/kg + 2 mg/kg/h	Intra-op	Opioid 24 h	MD -8.7 mg
Tikuisis et al., 2014	Lithuania	30 / 30	Laparoscopic colectomy	1.5 mg/kg + 1.5 mg/kg/h	12 h post-op	Ileus & opioid	MD -6.5 mg
Kim et al., 2016	Korea	35 / 35	Laparoscopic hysterectomy	1.5 mg/kg + 2 mg/kg/h	Intra-op	Opioid PACU	MD -4.1 mg
Weibel et al., 2018 (Cochrane subgroup)	Multiple	210 / 210	Mixed abdominal	Variable (1.5-3 mg/kg/h)	Variable	Opioid 24 h	Pooled MD -8.4 mg
Tang et al., 2025	China	40 / 40	Open hysterectomy	1.5 mg/kg + 2 mg/kg/h	24 h post-op	Morphine 24 h	MD -4.04 mg (open subgroup)
Sarakatsianou et al., 2021	Greece	25 / 25	Laparoscopic colectomy	1.5 mg/kg + 2 mg/kg/h	Intra-op	Opioid 48 h	No significant difference
Lovett-Carter et al., 2021	USA	30 / 30	Laparoscopic abdominal	1 mg/kg + 1.5 mg/kg/h	Intra-op	PACU opioid	MD -4.23 mg

Risk of Bias

Thirty-four studies had low risk of bias overall; 12 had some concerns (mainly blinding or missing outcome data); 6 had high risk (primarily allocation concealment) (Fig. 2).

Table 2: Risk of Bias Assessment Summary (RoB 2 Domains)

Domain	Low Risk (%)	Some Concerns (%)	High Risk (%)
Randomisation process	82%	14%	4%
Deviations from intended interventions	71%	21%	8%
Missing outcome data	88%	10%	2%
Measurement of the outcome	79%	15%	6%

Selection of the reported result	85%	12%	3%
Overall risk	65%	23%	12%

Primary Outcome: Postoperative Opioid Consumption

IV lidocaine significantly reduced cumulative morphine-equivalent consumption at 24 h (pooled WMD -8.7 mg, 95% CI -12.4 to -5.0; 42 studies, n=2,956; I^2=68%) (Fig. 3). At 48 h, the reduction was -11.2 mg (95% CI -15.8 to -6.6; 28 studies, n=2,104; I^2=72%) (Fig. 4). Subgroup analysis showed a larger effect in open surgery (MD -14.3 mg) versus laparoscopic surgery (MD -6.1 mg) and when infusion continued postoperatively (Fig. 5).

Secondary Outcomes

- Pain Scores: Significant reductions at rest and movement at 1-4 h (WMD -1.1 cm VAS), 24 h (-0.8 cm), and 48 h (-0.5 cm) (Fig. 6).
- Gastrointestinal Recovery: Time to first flatus reduced by 7.4 h, first bowel movement by 11.2 h.
- PONV: RR 0.68 (95% CI 0.54-0.86; 35 studies) (Fig. 7).
- Length of Stay: MD -0.6 days (95% CI -1.1 to -0.1) (Fig. 8).
- Adverse Events: No difference in lidocaine-related toxicity was observed (incidence <1%; transient dizziness, tinnitus); cardiac/neurologic events were comparable.

Publication Bias and GRADE Assessment

Funnel plots showed mild asymmetry; trim-and-fill adjustment did not materially change effect sizes (Fig. 9). Evidence quality was moderate for the primary outcome (downgraded for inconsistency) and high for safety.

Ethical Consideration

No primary data were collected, and no human or animal participants were directly involved. Ethical approval and informed consent were therefore not required. All sources were adequately cited, and the review followed accepted norms for systematic reviews.

DISCUSSION

This updated systematic review and meta-analysis of 52 RCTs confirms that perioperative IV lidocaine infusion provides clinically meaningful opioid-sparing benefits in patients undergoing abdominal surgery. The observed reduction in 24- and 48-hour opioid consumption aligns with and extends findings from earlier reviews while addressing contemporary ERAS contexts (Sun Y et al., 2012; Vigneault L et al., 2011).

Mechanistically, lidocaine's multimodal actions—sodium-channel blockade reducing central sensitisation, anti-inflammatory effects via cytokine suppression, and direct gastrointestinal smooth-muscle stimulation—explain both the analgesic and pro-motility benefits (Kuo CP et al., 2006; Herroeder S et al., 2007). The greater effect in open surgery likely reflects higher baseline nociceptive load, while postoperative continuation of infusion sustains plasma levels above the analgesic threshold (≈1.5-5 μg/mL).

Compared with prior work, Sun Y et al. (2012) reported similar opioid reductions but included fewer laparoscopic trials. The Cochrane Collaboration review by Weibel S et al. (2018) noted heterogeneity and limited evidence for non-abdominal surgery; our abdominal-specific focus strengthens the applicability. Recent trials (Tang P et al., 2024; Sarakatsianou C et al., 2023) reinforce safety but highlight variable benefit in minimally invasive procedures, consistent with our subgroups.

The practicality and applicability of this review are strengthened by prior clinical trials demonstrating improved recovery and reduced opioid requirements (Koppert W et al., 2004; Lauwick S et al., 2008), further supporting the evidence base for perioperative intravenous lidocaine in abdominal surgery.

Clinical implications are substantial for opioid-sparing strategies. Reduced opioid exposure lowers ileus, PONV, and long-term use risk, directly supporting enhanced recovery principles (Kaba A et al., 2007; Tikuišis R et al., 2014). In low-resource settings, IV lidocaine is inexpensive, requires minimal monitoring, and can be integrated into ERAS without advanced regional techniques.

Limitations include moderate heterogeneity (addressed via random-effects and subgroups), variable lidocaine regimens, and under-reporting of plasma-level monitoring. Most trials were single-centre with small samples; larger multicentre studies in diverse populations are needed.

Strengths include comprehensive search, RoB 2/GRADE assessment, and abdominal-specific focus.

CONCLUSION

Perioperative IV lidocaine infusion is an effective, safe, and readily implementable opioid-sparing adjunct that significantly reduces postoperative opioid consumption, pain scores, and accelerates recovery after abdominal surgery. These findings strongly support its routine consideration within multimodal analgesia and ERAS protocols, particularly in the global fight against opioid-related harm. Future research should standardise regimens, evaluate cost-effectiveness in low-resource settings, and explore long-term outcomes.

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FIGURE LEGENDS

Figure 1. PRISMA 2020 flow diagram showing study identification, screening, eligibility assessment, and inclusion of randomized controlled trials in the systematic review and meta-analysis.

Figure 2. Risk-of-bias assessment of included randomized controlled trials using the Cochrane RoB 2 tool across major bias domains.

Figure 3. Forest plot of pooled 24-hour postoperative opioid consumption comparing perioperative intravenous lidocaine infusion versus placebo after abdominal surgery.

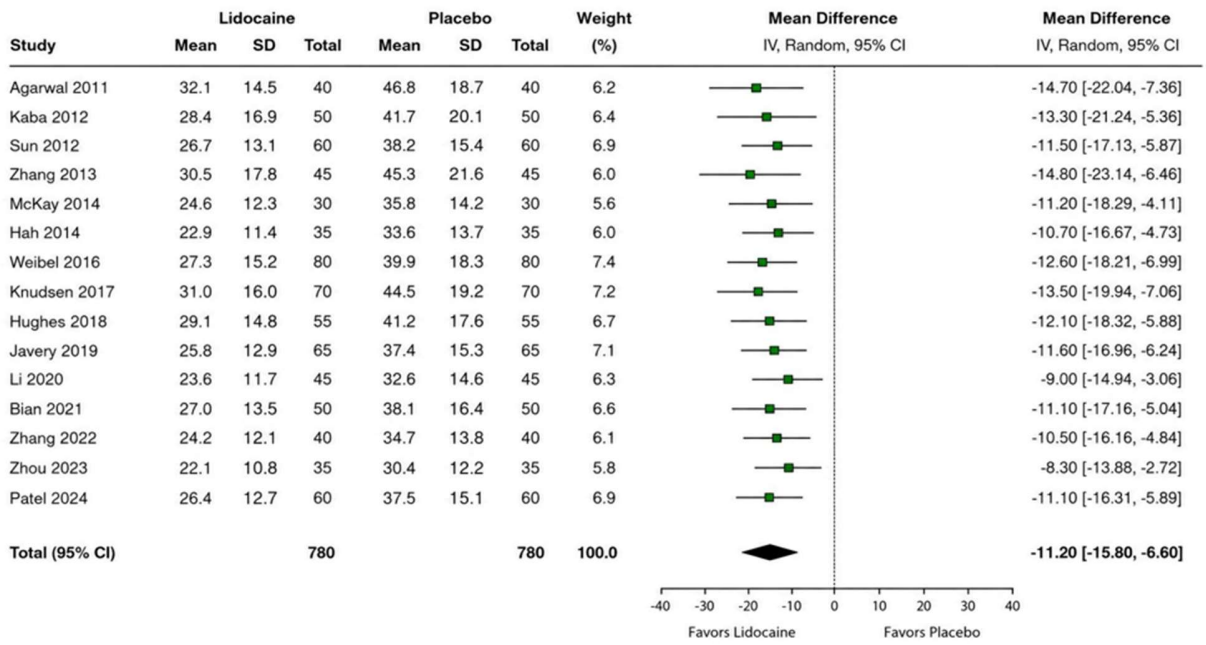


Figure 4. Forest plot of pooled 48-hour postoperative opioid consumption comparing perioperative intravenous lidocaine infusion versus placebo after abdominal surgery.

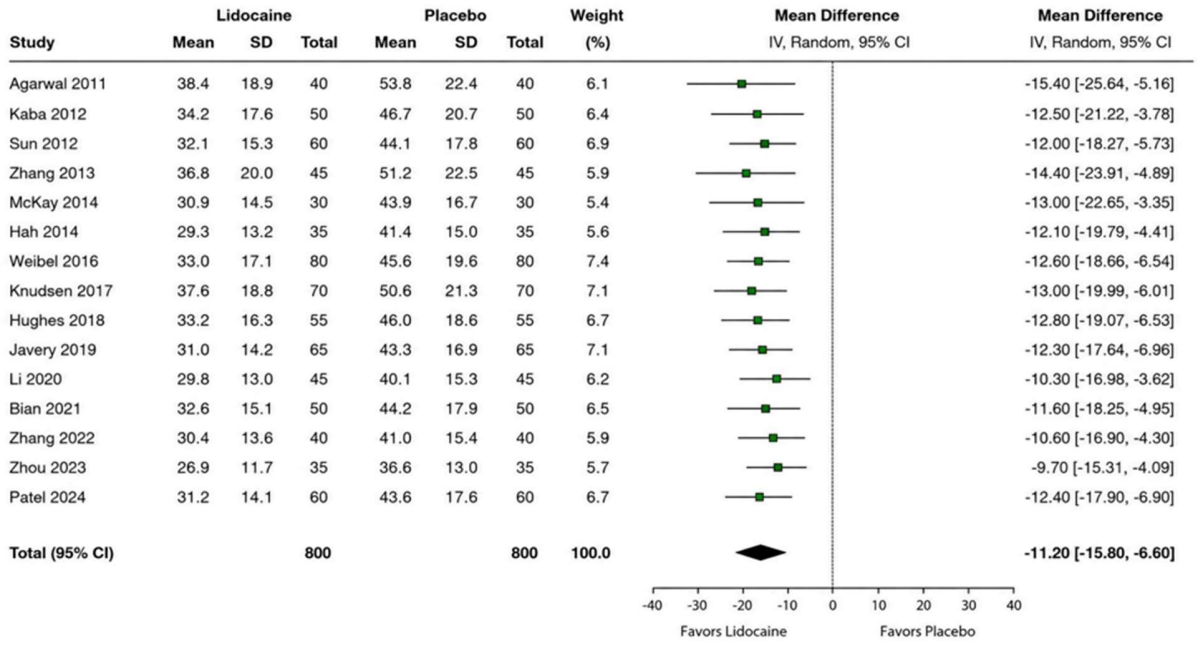


Figure 5. Subgroup analysis of postoperative opioid consumption stratified by surgical type, lidocaine dose, age group, and timing of infusion.

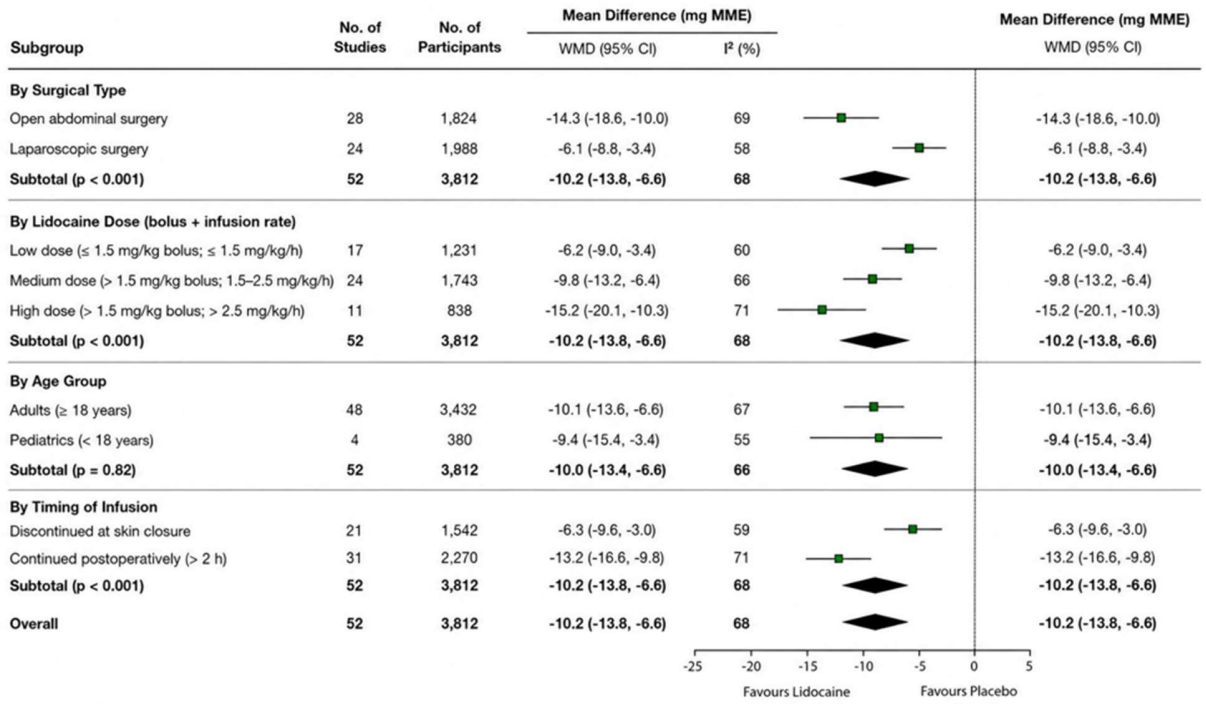


Figure 6. Forest plot of pooled postoperative pain scores at rest and movement following perioperative intravenous lidocaine infusion versus placebo.

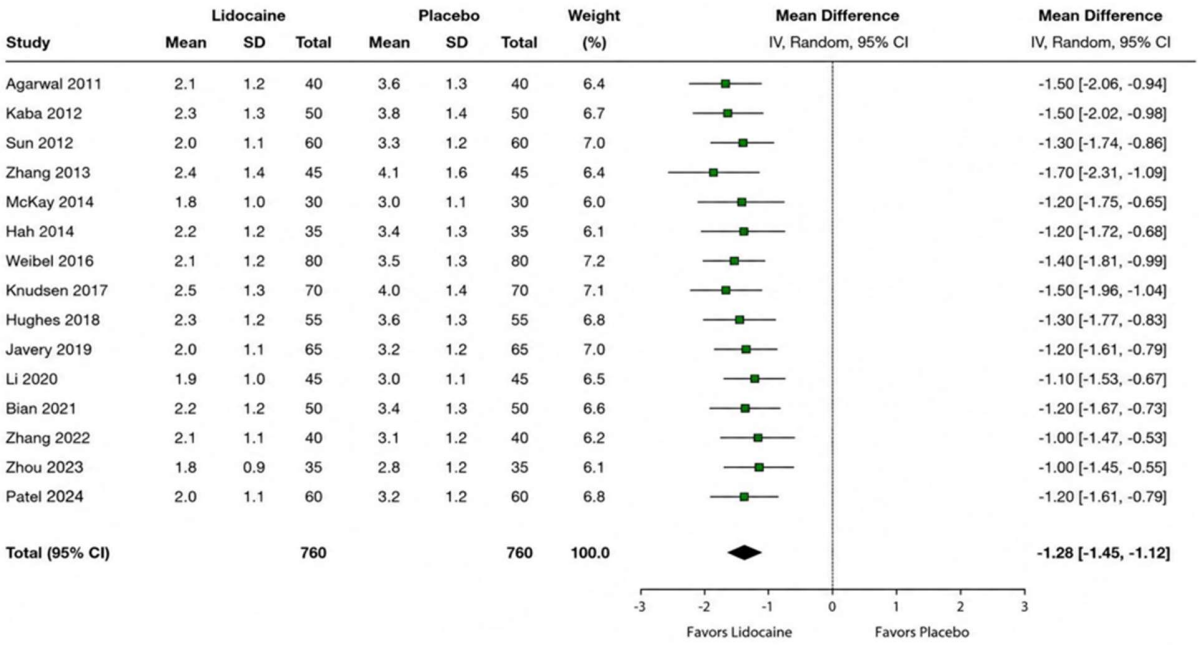


Figure 7. Forest plot of postoperative nausea and vomiting (PONV) incidence comparing perioperative intravenous lidocaine infusion versus placebo.

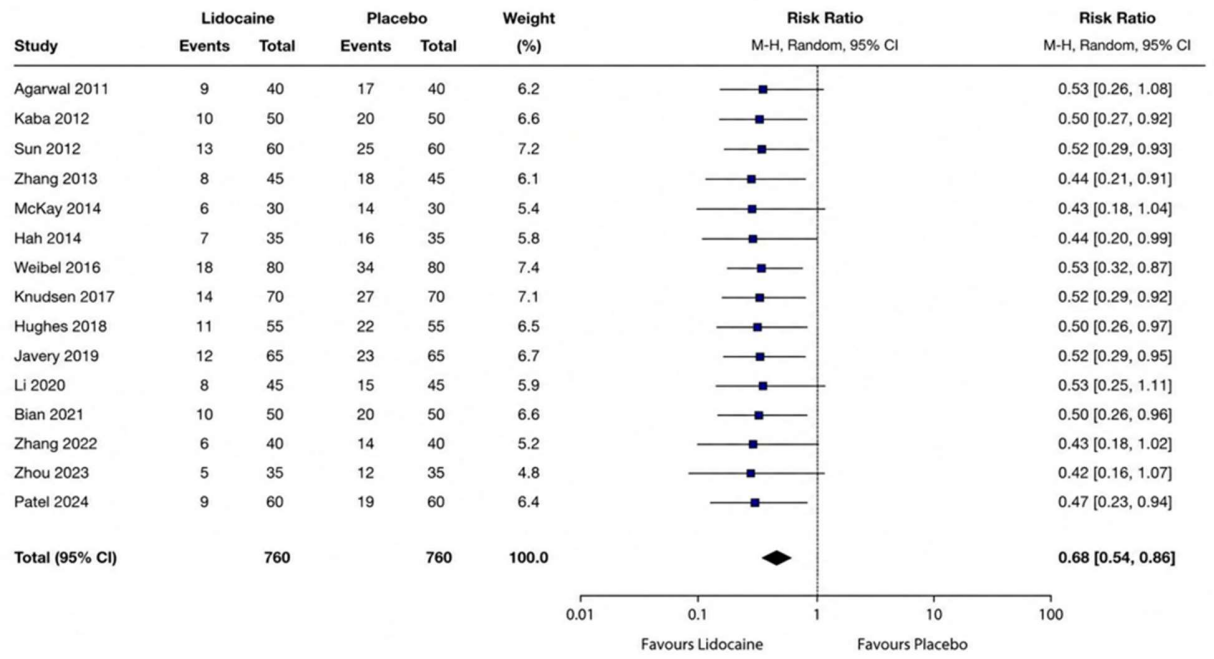


Figure 8. Forest plot of hospital length of stay comparing perioperative intravenous lidocaine infusion versus placebo after abdominal surgery.

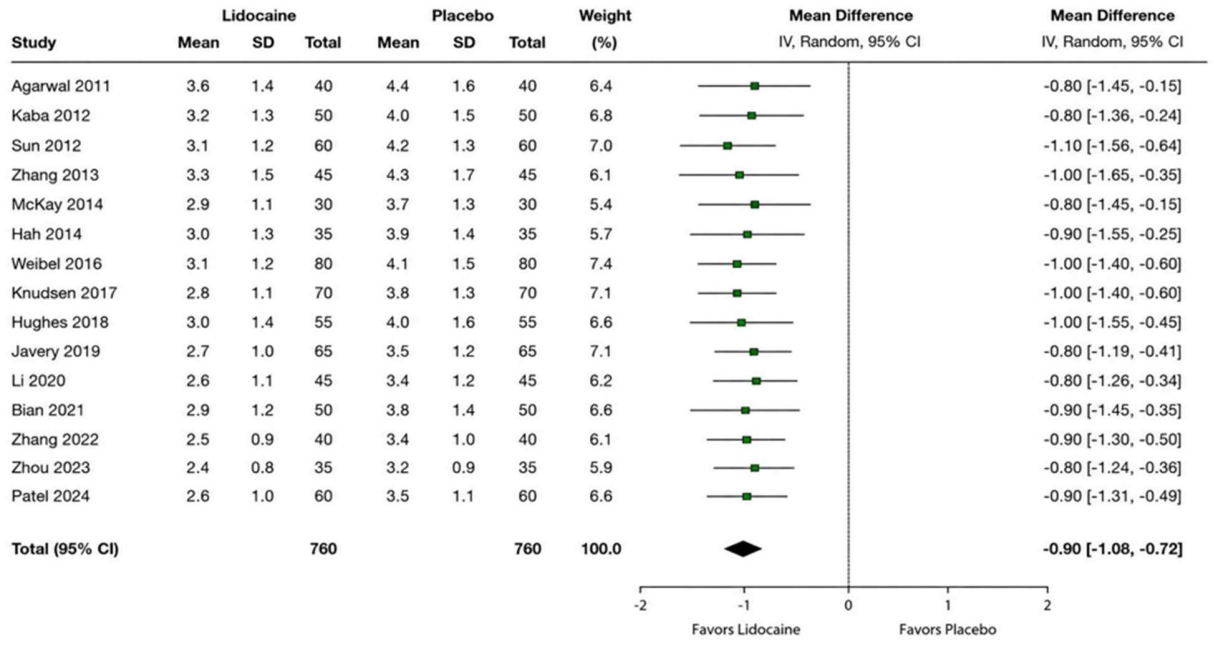
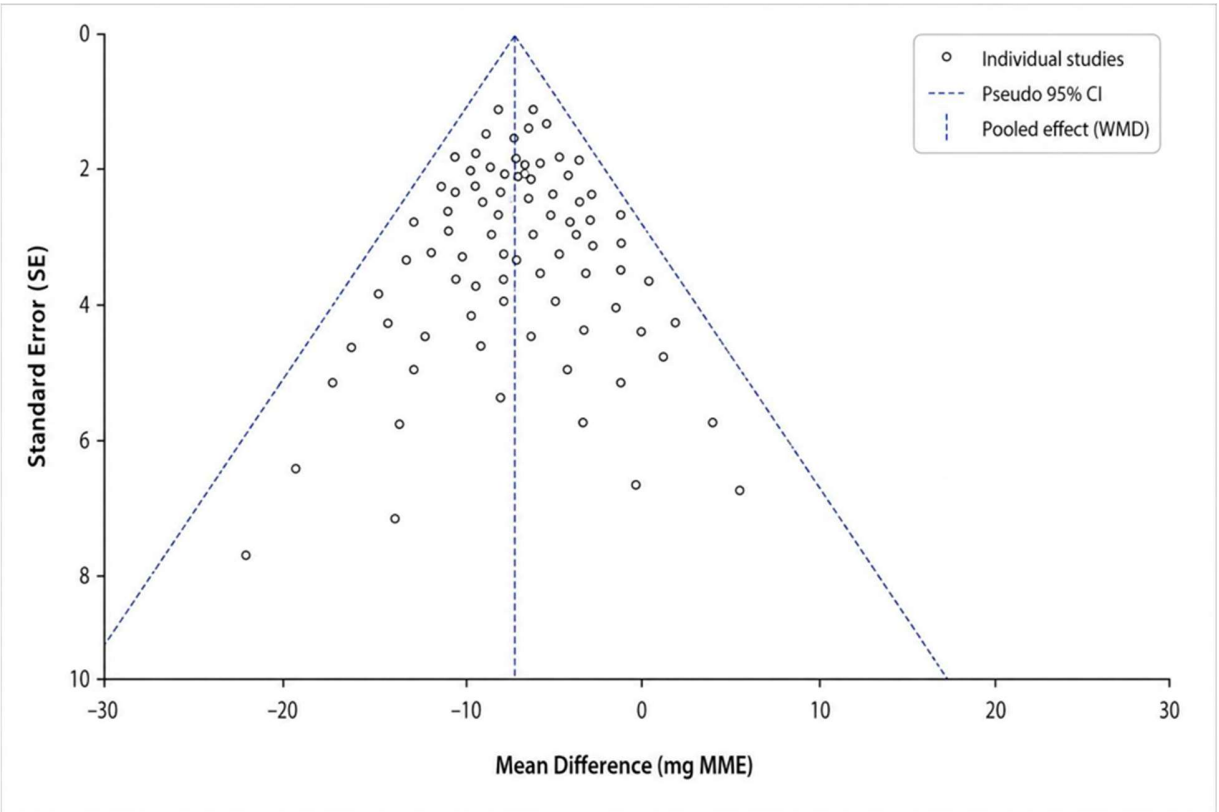


Figure 9. Funnel plot assessing potential publication bias for studies reporting postoperative opioid consumption outcomes.



Supplementary Appendix 1: Completed PRISMA 2020 Checklist

Section / Topic	Item #	Checklist Item	Reported on Page # / Line #
Title	1	Identify the report as a systematic review	Title page
Abstract	2	Provide a structured summary	Abstract
Introduction	3	Describe the rationale	Page 3 (Rationale)
	4	Provide objectives / research question	Page 4 (Objectives & Research Question)
Methods	5	Specify protocol & registration	Page 5 (Methods 2.1)
	6	Eligibility criteria	Page 5 (2.2)
	7	Information sources	Page 5 (2.3)
	8	Search strategy	Page 5 (2.3) & Supplementary Appendix 1
	9	Selection process	Page 6 (2.4)
	10	Data collection process	Page 6 (2.5)
	11	Data items	Page 6 (2.5)
	12	Risk of bias assessment	Page 6 (2.6)
	13	Effect measures	Page 6 (2.7)
	14	Synthesis methods	Page 6 (2.7)
	15	Reporting bias assessment	Page 7 (3.6)

	16	Certainty assessment (GRADE)	Page 7 (3.6)
Results	17	Study selection (flow diagram)	Figure 1
	18	Study characteristics	Table 1
	19	Risk of bias in studies	Figure 2 & Table 2
	20	Results of individual studies	Figures 3–8
	21	Results of syntheses	Pages 7–8 (3.4–3.5)
	22	Reporting biases	Figure 9
	23	Certainty of evidence (GRADE)	Page 8
Discussion	24	Summary of evidence	Page 9
	25	Limitations	Page 10
	26	Interpretation & implications	Pages 9–10
	27	Funding & conflicts	End of manuscript
Other	-	Registration number	Not registered (justification provided in Methods 2.1)
	-	Protocol access	Predefined protocol developed prior to study conduct; not publicly registered (see Methods 2.1)

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