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Hemodynamic Effects of Prophylactic Vasopressors During Anesthetic Induction and Emergency Tracheal Intubation in Adults: A Systematic Review

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Abstract

Hemodynamic instability is the most frequent serious complication of tracheal intubation in critically ill adults, and prophylactic vasopressors are increasingly used to prevent it. This systematic review assessed comparative evidence on adrenergic vasopressors given before or during anesthetic induction in adults, with emergency tracheal intubation analyzed as a clinically distinct subgroup. Applicability was examined according to clinical determinants of hemodynamic risk, with procedural location, including urgent radiology, considered as one contextual factor. No protocol was registered. Eligibility was broadened from a radiology-specific population to adult induction and emergency intubation in any setting after preliminary searching found no direct comparative studies. PubMed/MEDLINE, Embase, CENTRAL, and Scopus were searched for studies published from August 2021 to 15 August 2026, with supplementary searching to 26 September 2026. Risk of bias was assessed with risk-of-bias tool for randomized trials (RoB 2) and Risk of Bias in Non-randomised Studies of Interventions (ROBINS-I), and the narrative synthesis followed the Synthesis Without Meta-analysis (SWiM) guideline. Of 341 database records, 205 were screened, and 67 full texts were assessed; 13 studies were included (eight randomized, five nonrandomized), one of which was published after the primary database search date. Two studies addressed emergency intubation and 11 addressed planned induction. In planned induction, point estimates mostly favored prophylaxis, but effect sizes ranged from large reductions in moderate hypotension to no difference in severe hypotension (mean arterial pressure below 55 mmHg) in the cardiac surgery trial. The two emergency intubation cohorts were observational and gave discordant results, and no study evaluated intubation for urgent radiology. Benefits for kidney injury and mortality were not shown, and pressure benefits were accompanied in some trials by hypertension or dose-related bradycardia. Prophylactic vasopressors can reduce induction-related hypotension in selected planned-induction populations, but evidence for emergency intubation is limited and conflicting. Emergency status, baseline shock and vasopressor requirement, cardiovascular reserve, and induction technique are more plausible determinants of benefit than procedural location. No universal agent, dose, or regimen can be recommended.

Categories: Radiology, Emergency Medicine, Internal Medicine
Keywords: critically ill adults, emergency tracheal intubation, interventional radiology, peri-intubation hemodynamic instability, prophylactic vasopressors, systematic review

Introduction And Background

Cardiovascular instability is the most common major adverse event during tracheal intubation of critically ill adults [1]. Induction drugs, loss of sympathetic tone, and the start of positive-pressure ventilation can expose limited cardiovascular reserve, particularly in patients with sepsis, hypovolemia, or ventricular dysfunction. The clinical aim is to maintain adequate circulation during this short transition, not only to correct an isolated blood pressure value.

Preventive hemodynamic management can involve fluid administration, adjustment of induction drugs, and pharmacological support of vascular tone. An intubation bundle reduced complications in intensive care units, but the contribution of its individual components could not be separated [2], and a randomized trial found that routine fluid boluses did not prevent cardiovascular collapse [3]. Vasopressors may counteract induction-related vasodilation, but their effect depends on the drug, dose, timing, and mode of delivery. A prophylactic infusion started before induction is not equivalent to a bolus given after hypotension develops, and fewer episodes of moderate hypotension do not necessarily mean fewer episodes of collapse or organ injury.

Two recent systematic reviews have examined prophylactic vasopressors at intubation. Saunders et al. identified 13 randomized trials, mostly of phenylephrine or ephedrine with propofol induction in the operating room [4], and da Silveira et al. pooled 24 randomized trials of push-dose vasopressors in normotensive adults, most of whom were elective surgical patients [5]. Both reviews concentrated on bolus dosing in low-risk elective patients. Studies of continuous norepinephrine (NE) strategies, high-risk and septic surgical patients, and emergency intubation in critically ill adults have accumulated more recently and were largely outside the scope of these reviews.

The clinical context of airway management also varies. Critically ill adults may require intubation in the emergency department, intensive care unit, or operating room, or before urgent computed tomography, angiography, embolization, mechanical thrombectomy, or endoscopy. Where a given procedure is performed depends substantially on institutional infrastructure, staffing, urgency, and local practice; the same procedure may take place in an operating room, a hybrid theater, an interventional suite, or at the bedside, and the anesthetic and resuscitative resources in each vary between hospitals. Procedural location is therefore an unstable surrogate for hemodynamic risk. Factors more plausibly related to the effect of prophylaxis include emergency versus planned airway management, baseline blood pressure and shock state, existing vasopressor requirement, ventricular function and cardiovascular reserve, induction agent, dose, and technique, the transition to positive-pressure ventilation, and the availability of monitoring and immediate rescue treatment. Randomized trials of anesthesia strategy during endovascular stroke treatment illustrate that procedural context influences hemodynamic management, but they did not isolate a prophylactic vasopressor effect [6,7]. In this review, urgent radiology, which motivated the original question, is therefore treated as one example of procedural context rather than as a distinct clinical category.

The objective was to summarize comparative evidence on the hemodynamic and clinical effects of prophylactic vasopressors during anesthetic induction in adults, to examine emergency tracheal intubation as a clinically distinct subgroup, and to consider applicability according to clinical determinants of hemodynamic risk, with procedural location treated as a contextual factor.

Review

Methodology

Study Design and Aim

Reporting follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework [8], and eligibility is structured by population, intervention, comparator, outcomes, and study design (PICOS) [9]. Because meta-analysis was not appropriate, the narrative synthesis is reported according to the Synthesis Without Meta-analysis (SWiM) guideline [10]. No review protocol was prospectively registered in PROSPERO or elsewhere.

Eligibility Criteria

The review was first designed around critically ill adults undergoing emergency tracheal intubation for urgent diagnostic or interventional radiology. Preliminary searching identified no comparative study in this population. During review development, eligibility was therefore broadened to adults undergoing general-anesthesia induction or emergency intubation in any clinical setting, and the original radiology question was retained as a contextual consideration in the assessment of applicability. This change was not prespecified and is reported as a deviation from the original review plan. Eligible interventions were adrenergic vasopressors deliberately administered before or during induction to prevent hemodynamic deterioration. Comparators included placebo, no prophylaxis, reactive usual care, fluid preloading, or another preventive regimen. Randomized and nonrandomized comparative primary studies were eligible; reviews, protocols, editorials, letters, conference abstracts, preprints, noncomparative reports, animal studies, and neuraxial-only anesthesia studies were excluded. The broader synthesis included induction with a supraglottic airway as indirect physiological evidence.

Studies published from August 2021 onward were eligible, and the supplementary update extended the evidence cutoff to 26 September 2026. This five-year window was chosen for three reasons. First, earlier randomized evidence, largely consisting of bolus phenylephrine or ephedrine in elective operating room patients, has already been synthesized in two systematic reviews, the more recent of which searched databases from inception to September 2024 [4,5]. Second, the review aimed to examine strategies that have been evaluated mainly in recent years, including continuous NE infusions started at induction, high-risk, cardiac, and septic surgical populations, and emergency intubation in critically ill adults. Third, current practice in induction drugs, airway devices, and hypotension definitions differs from that in many older trials. Because the date limit was applied as a database filter, studies published before August 2021 were not retrieved, and the number of otherwise eligible older studies cannot be enumerated; this is acknowledged as a limitation. The operational eligibility criteria are summarized in Table *1*.

Component	Eligibility
Population	Original question: critically ill adults undergoing emergency intubation for urgent radiology (no eligible comparative studies identified). Broadened eligibility: adults undergoing general-anesthesia induction in any setting, with emergency intubation analyzed as a clinically distinct subgroup; procedural location considered as a contextual factor.
Intervention	Adrenergic vasopressor started before or during induction/intubation to prevent instability.
Comparator	Placebo, no prophylaxis, reactive care, fluid preload, or another preventive regimen.
Outcomes	Hemodynamic effects; rescue treatment, adverse effects, organ injury, or mortality.
Study design	Peer-reviewed comparative randomized or nonrandomized primary research.
Publication period	August 2021 to 15 August 2026 (database search); supplementary update to 26 September 2026.
Exclusions	Rescue-only exposure; pediatric, animal, neuraxial-only, noncomparative, or non-original reports.

TABLE 1: Eligibility criteria based on population, intervention, comparator, outcomes, and study design

Information Sources

The database search covered PubMed/Medical Literature Analysis and Retrieval System Online (MEDLINE), Embase, the Cochrane Central Register of Controlled Trials, and Scopus, with a last database-search date of 15 August 2026. Supplementary searching and source verification through Europe PMC, PubMed, and publisher records continued through 26 September 2026. Reference lists and linked corrections were examined. Publication dates, article identities, and digital object identifiers were checked against bibliographic and publisher records. The primary database-search date and supplementary-update date are distinguished because a retained report was first published after 15th August.

Search Strategy

The search combined four concept blocks: (1) vasopressor terms, including vasopressor, push-dose, NE, noradrenaline, phenylephrine, ephedrine, metaraminol, epinephrine, and adrenaline; (2) tracheal intubation or anesthesia induction; (3) hemodynamic outcomes, including hypotension and blood pressure; and (4) preventive administration, including prophylaxis, prevention, preemptive treatment, and pre-intubation administration. Subject headings and free-text terms were adapted to each database, and results were limited to publications from August 2021 onward. Radiology-related terms were used only in focused supplementary searches and were not applied as filters. A supplementary search combining vasopressor terms with induction or intubation terms in titles was used to identify induction studies, including supraglottic airway trials, whose preventive intent appeared only in the abstract or full text. The complete strategies for all four databases are provided in the Appendix.

Selection Process

Screening was performed by one reviewer. Duplicate records were removed before relevance screening, and potentially eligible reports were assessed against the population, intervention timing, comparator, and publication criteria. Preventive treatment was distinguished from rescue treatment after established hypotension. Anesthesia strategy studies were not treated as vasopressor trials unless an eligible pharmacological comparison could be isolated. Multiple reports of a single study were linked rather than counted as independent studies. Screening was not independently duplicated.

Data Collection Process

Study information was extracted from available full texts and published journal records and checked against article tables where accessible. Extraction distinguished screened, randomized, and analyzed sample sizes. Numerical discrepancies between abstracts, main text, tables, and reported effect measures were retained as interpretation issues rather than silently reconciled. Original analyses nested within randomized trials were classified according to whether vasopressor exposure itself was randomized. Published corrections were applied to dosing information. Data extraction was not independently duplicated.

Data Items

Extracted items included author, publication year, country, study design, clinical setting, sample size, drug and dose, initiation time, treatment duration, comparator, and hemodynamic and clinical outcomes. Outcomes included hypotension incidence, blood pressure nadir or change, duration or burden of instability, cardiac index, rescue treatment, hypertension, bradycardia, acute kidney injury, and mortality. Study-specific thresholds and observation windows were retained. Clinical determinants of hemodynamic risk were extracted where reported: emergency or planned airway management, baseline shock state and vasopressor requirement, ventricular function, induction agent and technique (including rapid-sequence induction), and monitoring. The procedural setting was recorded as a contextual variable.

Study Risk-of-Bias Assessment

The reviewer assessed randomized studies using the revised Cochrane risk-of-bias tool for randomized trials (RoB 2) [11] and nonrandomized comparisons using Risk of Bias in Non-randomised Studies of Interventions (ROBINS-I) [12]. Assessments were visualized with the Risk-of-bias VISualization (robvis) tool [13]. RoB 2 covered randomization, deviations from intended interventions, missing outcomes, outcome measurement, and selective reporting. ROBINS-I additionally addressed confounding, participant selection, and intervention classification. Limitations of the underlying designs were considered alongside domain and overall judgments when interpreting causal effects.

Effect Measures

Binary outcomes were reported as event counts, proportions, risk ratios, or odds ratios, with confidence intervals when available. Continuous outcomes were reported using the source study's means, medians, changes, or adjusted between-group estimates. Adjusted and unadjusted estimates were not interchanged. Where a published effect label conflicted with event counts, a crude risk ratio was calculated from those counts and explicitly distinguished from the reported estimate. No participant-level observations were imputed.

Synthesis Methods

The synthesis followed the SWiM items [10]. Studies were grouped according to a clinical risk framework rather than procedural location: group A, emergency intubation in critically ill adults; group B, planned induction in older, high-risk, cardiac, or septic surgical patients; and group C, planned induction in low-risk elective or neurosurgical patients. Emergency intubation was treated as a clinically distinct subgroup because baseline instability, urgency, opportunity for optimization, induction technique, and existing vasopressor requirement differ from planned induction; findings from groups B and C were therefore not used to conclude group A. Because hypotension definitions, observation windows, and comparators differed, no common effect metric could be calculated, and pooling was not appropriate. For each study, the direction of effect on the study's own primary hemodynamic outcome was classified from the point estimate (favoring prophylaxis, favoring the comparator, or no clear direction), independently of statistical significance. Statistical significance, effect magnitude, sample size, and overall risk of bias were tabulated separately. Results were not summarized by counting statistically significant studies, because such counts do not account for effect size, precision, or study quality. When findings conflicted, priority was given, in order, to directness to emergency intubation, randomized design and overall risk of bias, sample size, and clinically important outcomes (severe hypotension, organ injury, and mortality) over changes in pressure alone. Heterogeneity was examined descriptively by synthesis group, drug, dose, delivery method (bolus or infusion), and hypotension threshold; no subgroup meta-analysis, meta-regression, or sensitivity meta-analysis was performed. Results are presented in tables of study characteristics, per-study direction of effect and significance, and clinically important qualifications, and in an unpooled figure of selected randomized comparisons with extractable hypotension incidences.

Reporting Bias Assessment

Selective reporting was considered within the design-specific risk-of-bias tools. Publication bias was not quantified because no homogeneous meta-analysis was conducted and the relevant comparisons generally involved few studies. Small studies with large effects, incompletely reported safety outcomes, and discrepancies between abstracts and detailed results were interpreted cautiously. Funnel-plot asymmetry or statistical significance was not used as a substitute for assessing these limitations.

Certainty Assessment

The domains of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework (risk of bias, inconsistency, indirectness, imprecision, and publication bias) guided interpretation [14]. Formal outcome-specific GRADE ratings were not assigned because the synthesis combined distinct interventions, populations, and endpoints rather than a single estimable treatment contrast. The absence of randomized evidence in emergency intubation, and of any study of intubation for urgent radiology, was treated as a directness limitation, not as evidence of no treatment effect.

Results

Study Selection

The database search identified 341 records: 109 from PubMed/MEDLINE, 87 from Embase, 83 from the Cochrane Central Register of Controlled Trials, and 62 from Scopus. After removal of 136 duplicates, 205 records were screened; 138 were excluded for irrelevant titles. All 67 reports sought were retrieved, with none unavailable because of a paywall, and 67 full texts were assessed. Fifty-four reports were excluded: 13 for not being related to tracheal intubation, seven for not involving adults, 27 because they were reviews, commentaries, or editorial letters, and seven because they were conference abstracts or preprints. Thirteen studies were retained. The study selection process is shown in Figure *1*. The retained set includes a September 2026 publication identified during the later supplementary work; that route is not separately enumerated in the flow diagram. Because the publication date limit was applied in the database searches, no report was excluded for publication date at screening.

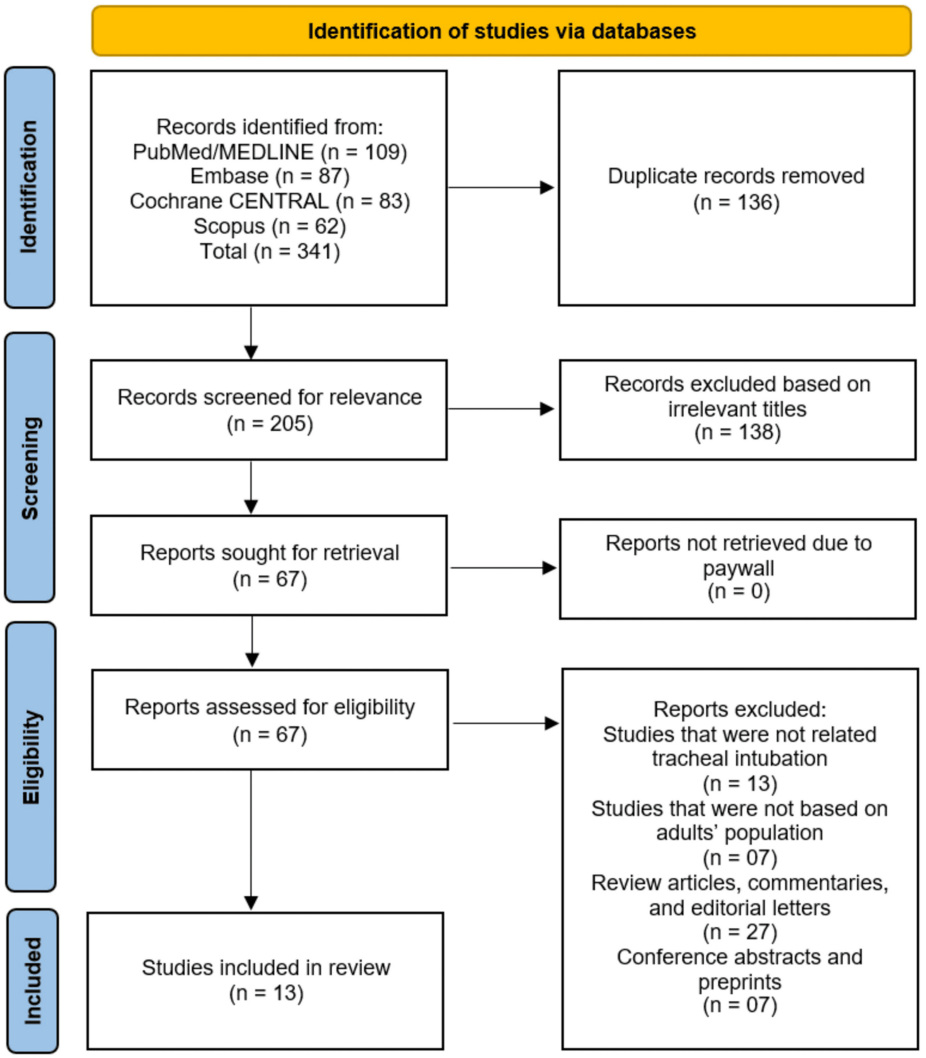


FIGURE 1: Study selection according to the PRISMA

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework [8]; MEDLINE: Medical Literature Analysis and Retrieval System Online; CENTRAL: Central Register of Controlled Trials.

Counts and exclusion categories follow the screening record. The later supplementary-search route is not separately represented.

Study Characteristics

The synthesis comprised eight randomized trials and five nonrandomized comparative studies. Two studies addressed emergency intubation and 11 addressed planned induction. No study enrolled patients intubated for urgent radiology.

Wu et al. compared preventive NE doses in older spinal surgery patients [15]. Fuchita et al. evaluated clinician-selected prophylaxis during emergency intubation [16]. Onishi et al. studied elective transcatheter aortic valve replacement [17], whereas Maimaitiming et al. studied prostatectomy induction [18] and Megha et al. compared ephedrine with crystalloid preloading in low-risk surgical patients [19]. Trocheris-Fumery et al. examined preventive NE during major abdominal surgery [20]. Sjøen et al. compared three preventive boluses with placebo during general anesthesia with a laryngeal mask [21]. Gaillard et al. enrolled cardiac surgery patients [22], Helmy et al. studied surgical sepsis [23], and da Silveira et al. examined metaraminol during septic intensive care intubation [24]. Min et al., Peng et al., and Thotungal et al. studied craniotomy, older abdominal surgery patients, and glioma surgery, respectively [25-27]. Table *2* summarizes the comparative study characteristics. The work by Thotungal et al. was published online on 20 September 2026, and therefore falls outside the primary 15 August database cutoff [27].

Study/country (group)	Design/sample	Population	Preventive regimen	Comparator	Principal findings
Wu, 2021 [15]/China (B)	Randomized; 90	Older adults; spinal fusion	NE 0.03/0.06/0.09 μg/kg/min before induction	Alternative NE doses	Hypotension 33.3% at the lowest dose; bradycardia 3.3%, 6.7%, 26.7% with increasing dose
Fuchita, 2023 [16]/United States (A)	Observational; 1,798; 374 matched	Emergency intubation	Clinician-selected prophylaxis	No prophylaxis	Matched hypotension 41% versus 32%
Onishi, 2024 [17]/Japan (B)	Retrospective; 181	Elective aortic valve intervention	NE 0.1 μg/kg/min from induction	Reactive treatment	Lowest mean pressure before surgery 63 versus 47 mmHg
Maimaitiming, 2025 [18]/China (B)	Prospective cohort; 63	Older adults; prostatectomy	NE 2-5 μg/kg/h at induction	Usual care	Better pressure stability and recovery scores
Megha, 2025 [19]/India (C)	Nonrandomized; 40	Low-risk elective surgery	Ephedrine 0.1 mg/kg before induction	Ringer's lactate 10 mL/kg	No significant mean pressure difference
Trocheris-Fumery, 2025 [20]/France (B)	Randomized; 473 analyzed	Major abdominal surgery	NE 0.48 mg/h, then titration	Reactive ephedrine	Hypotension 35/235 versus 176/238
Sjøen, 2026 [21]/Norway (C)	Randomized; 122 analyzed	Healthy women; laryngeal mask	Ephedrine 0.1 mg/kg; phenylephrine 1 μg/kg; NE 0.1 μg/kg	Saline	Smaller maximum systolic decrease with each vasopressor than with saline
Gaillard, 2026 [22]/France (B)	Randomized; 210	Cardiac surgery	NE 0.06 μg/kg/min from preoxygenation	Reactive ephedrine	Severe hypotension 43.8% versus 44.8%
Helmy, 2026 [23]/Egypt (B)	Randomized; 80	Stable surgical sepsis	NE base 0.2 μg/kg/min before induction	Saline	Early hypotension 4/40 versus 18/40
da Silveira, 2026 [24]/Brazil (A)	Retrospective; 349	Septic emergency intubation	Metaraminol immediately before/during intubation	No push-dose metaraminol	Hypotension 21.1% versus 49.4%
Min, 2026 [25]/South Korea (C)	Randomized; 63 analyzed	Elective craniotomy	NE 0.02 to <0.05 μg/kg/min from induction	Reactive treatment	Moderate instability 7.4% versus 12.2%
Peng, 2026 [26]/China (B)	Randomized; 60	Older adults; abdominal surgery	NE 3 μg/min from induction, then titration	Saline	Adjusted cardiac index change difference + 0.63 L/min/m²
Thotungal, 2026 [27]/India (C)	Randomized; 90	Glioma surgery	Propofol–phenylephrine admixture	Propofol-saline	Overall hypotension 6.7% versus 84.4%

TABLE 2: Characteristics and principal findings of the included studies

NE: norepinephrine (noradrenaline).

Samples are analyzed participants unless otherwise indicated; the matched cohort is not an additional sample. Trial-specific thresholds and observation windows differ. Wu analyzed 90 participants despite conflicting counts elsewhere in the report [15]. Sjøen and Gaillard were first published online in 2025 and assigned to 2026 journal issues [21,22]. Thotungal was published after the primary database-search cutoff [27]. Synthesis groups: A, emergency intubation; B, planned induction in older, high-risk, cardiac, or septic surgical patients; C, planned induction in low-risk elective or neurosurgical patients.

For the synthesis, two studies formed group A (emergency intubation in critically ill adults) [16,24], seven formed group B (planned induction in older, high-risk, cardiac, or septic surgical patients) [15,17,18,20,22,23,26], and four formed group C (planned induction in low-risk elective or neurosurgical patients) [19,21,25,27]. The only image-guided procedure represented was elective transcatheter aortic valve replacement [17].

Risk of Bias in Studies

The RoB 2 assessments classified four randomized trials as low risk, one as having some concerns, and three as high risk overall. Wu et al. [15], Min et al. [25], and Thotungal et al. [27] received high-risk judgments; Trocheris-Fumery et al. [20] received a judgment of some concerns. Sjøen et al. [21], Gaillard et al. [22], Helmy et al. [23], and Peng et al. [26] were rated low risk. The domain-level assessments are displayed in Figure *2*.

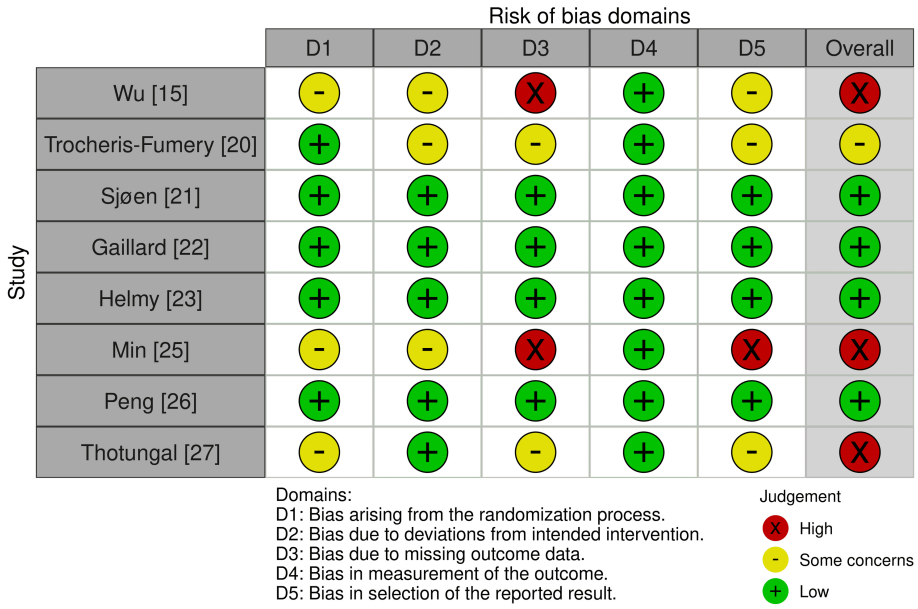


FIGURE 2: Risk-of-bias assessments for randomized trials using the revised Cochrane RoB 2

RoB 2: risk-of-bias tool for randomized trials [11], displayed in robvis format [13]. Green: low risk; yellow: some concerns; red: high risk. D1-D5 denote the five domains defined within the figure.

Study citations correspond to the reference list[15,20-23,25-27].

The ROBINS-I assessments rated Fuchita et al. [16], Megha et al. [19], and da Silveira et al. [24] as low risk and Onishi et al. [17] and Maimaitiming et al. [18] as serious risk overall (Figure *3*). These ratings should be distinguished from the causal limitations of nonrandomized treatment selection. Fuchita et al. [16] lacked detailed drug/dose information and could not eliminate residual confounding, while Megha et al. [19] allocated treatment according to anesthesiologist discretion. Low-risk labels in the assessment do not make these comparisons randomized or remove those documented limitations.

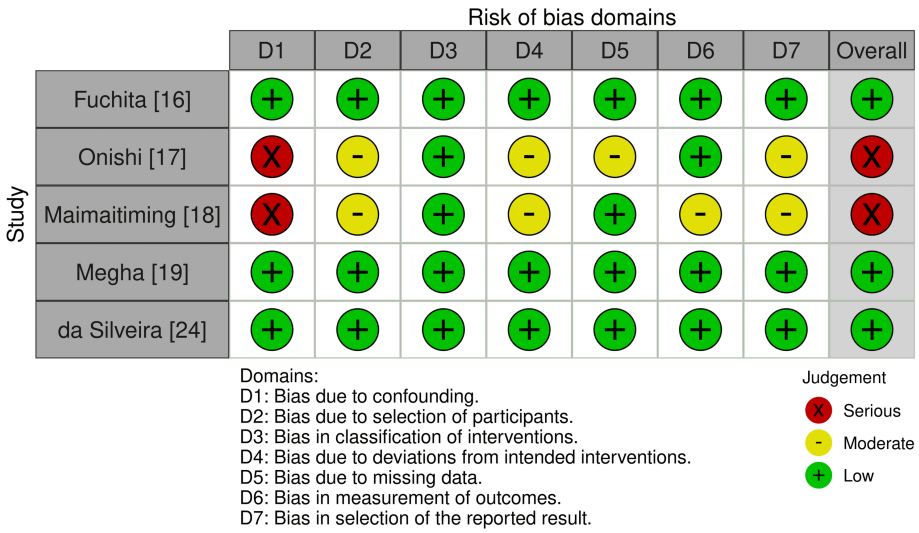


FIGURE 3: Assessments using ROBINS-I

ROBINS-I: Risk of Bias in Non-randomized Studies of Interventions [12], displayed in robvis format [13]. Green: low risk; yellow: moderate risk; red: serious risk. D1-D7 denote the seven domains defined within the figure.

Study citations correspond to the reference list[16-19,24].

Results of Individual Studies and Syntheses

Group A: emergency intubation. The emergency-intubation findings were discordant. In Fuchita et al., hypotension occurred in 41% of prophylaxis recipients and 32% of matched controls, without a statistically significant difference [16]. In da Silveira et al., prophylactic metaraminol was associated with less hypotension at completion of intubation (21.1% versus 49.4%) but no significant difference in seven- or 28-day mortality [24]. Both findings arose from observational exposure comparisons.

Group B: planned induction in older, high-risk, cardiac, or septic surgical patients. Randomized surgical studies showed endpoint-dependent effects. Trocheris-Fumery et al. reported fewer induction-period hypotensive events with NE, accompanied by more hypertension [20]. Gaillard et al. found no reduction in severe hypotension defined by mean arterial pressure (MAP) below 55 mmHg, although hypotension below 65 mmHg was less frequent [22]. Helmy et al. reported fewer early hypotensive events in stable surgical sepsis, but excluded rapid-sequence induction [23]. Peng et al. reported an attenuated fall in cardiac index after adjustment [26]. Among the nonrandomized studies in this group, Onishi et al. [17] and Maimaitiming et al. [18] reported better pressure stability with NE, and Wu et al. [15] compared doses without an untreated control.

Group C: planned induction in low-risk elective or neurosurgical patients. Sjøen et al. found smaller pressure decreases with each vasopressor bolus than with saline [21], whereas Megha et al. found no significant difference in mean pressure between ephedrine and crystalloid preloading [19]. Min et al. reported a reduced burden of moderate instability during craniotomy [25]. Thotungal et al. found a smaller induction MAP decrease and fewer hypotensive events across the operative period [27]. Figure *4* displays selected randomized comparisons without pooling them.

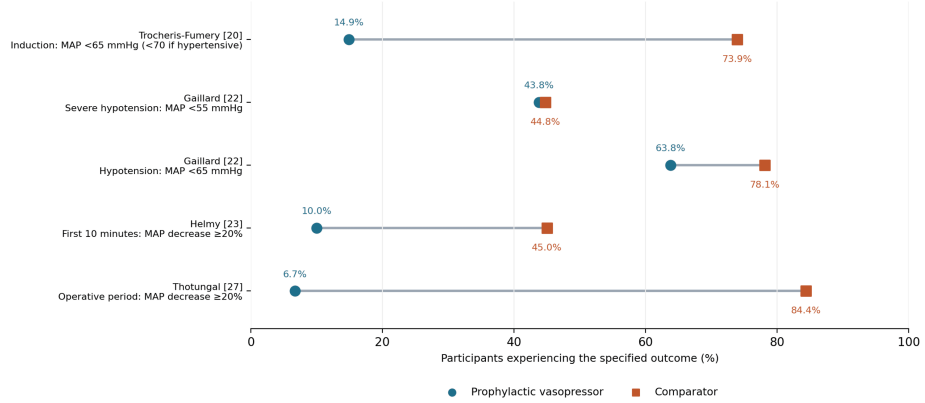


FIGURE 4: Trial-specific hypotension incidences in selected randomized comparisons

Studies: [20,22,23,27]. Pressure denotes mean arterial pressure. Blue circles indicate prophylactic treatment and orange squares the comparator. Connecting lines display within-trial differences, not pooled effects or confidence intervals. The two Gaillard rows represent different thresholds in the same participants [22]. Trocheris-Fumery percentages were calculated from 35/235 and 176/238 events [20]; other percentages are as reported. Different thresholds, windows, and comparators preclude cross-trial ranking.

Table *3* reports, for each study, the direction of effect separately from statistical significance, together with effect magnitude, sample size, and overall risk of bias. In group A, the two observational cohorts pointed in opposite directions [16,24]. In group B, point estimates favored prophylaxis in five of six controlled comparisons, but magnitude varied widely: the largest trial showed a large reduction in induction hypotension (14.9% versus 73.9%) with some concerns about bias [20], whereas the cardiac surgery trial, at low risk of bias, showed no clear difference in severe hypotension (43.8% versus 44.8%) [22]. In group C, point estimates favored prophylaxis in three of four comparisons; the largest effect (6.7% versus 84.4%) came from a trial at high risk of bias in which phenylephrine was given throughout anesthesia [27], and the ephedrine-preload comparison showed no clear difference [19]. Across groups, larger effects tended to come from smaller or higher-risk studies, and the effects were not consistent enough to be summarized as a single overall direction.

Group	Study; design; n	Primary hemodynamic outcome (prophylaxis versus comparator)	Direction of effect	Statistical significance	Overall risk of bias
A	Fuchita [16]; observational; 374 matched	Hypotension 41% versus 32%	Favors comparator	Not significant	Low (ROBINS-I)
A	da Silveira [24]; retrospective; 349	Hypotension at the end of intubation 21.1% versus 49.4%	Favors prophylaxis	Significant	Low (ROBINS-I)
B	Wu [15]; RCT; 90	Dose comparison; bradycardia 3.3%, 6.7%, 26.7%	Not applicable (no untreated control)	Not applicable	High
B	Onishi [17]; retrospective; 181	Lowest MAP before surgery 63 versus 47 mmHg	Favors prophylaxis	Significant	Serious (ROBINS-I)
B	Maimaitiming [18]; prospective cohort; 63	Blood pressure stability	Favors prophylaxis	Significant	Serious (ROBINS-I)
B	Trocheris-Fumery [20]; RCT; 473	Induction hypotension 14.9% versus 73.9%	Favors prophylaxis	Significant	Some concerns
B	Gaillard [22]; RCT; 210	MAP <55 mmHg 43.8% versus 44.8%; OR 0.96 (95% CI 0.56–1.66)	No clear direction	Not significant	Low
B	Helmy [23]; RCT; 80	Early hypotension 10.0% versus 45.0%	Favors prophylaxis	Significant	Low
B	Peng [26]; RCT; 60	Adjusted cardiac-index difference +0.63 L/min/m² (95% CI 0.18–1.07)	Favors prophylaxis	Significant	Low
C	Megha [19]; nonrandomized; 40	Mean arterial pressure after induction	No clear direction	Not significant	Low (ROBINS-I)
C	Sjøen [21]; RCT; 122	Maximum systolic pressure decrease	Favors prophylaxis	Significant	Low
C	Min [25]; RCT; 63	Moderate instability 7.4% versus 12.2%	Favors prophylaxis	Significant	High
C	Thotungal [27]; RCT; 90	Overall hypotension 6.7% versus 84.4%	Favors prophylaxis	Significant	High

TABLE 3: Direction of effect, statistical significance, and risk of bias by study and synthesis group

MAP: mean arterial pressure; RCT: randomized controlled trial; OR: odds ratio; CI: confidence interval.

Direction of effect is classified from the point estimate of each study's primary hemodynamic outcome, independently of statistical significance. Risk of bias: RoB 2 for randomized and ROBINS-I for nonrandomized studies.

Additional findings and clinically important qualifications are summarized in Table *4*. In Helmy et al., acute kidney injury occurred in two of 40 versus nine of 40 patients, but the multiplicity-adjusted P-value was 0.288 [23]. For the postoperative complication counts of 103/235 versus 137/238 in Trocheris-Fumery et al., the crude risk ratio is approximately 0.76, not the published value labeled as 0.58 [20]. Peng et al.'s favorable adjusted change in cardiac index should be distinguished from similar unadjusted MAP values at 10 minutes [26]. The corrected doses in Sjøen et al. were NE 0.1 μg/kg and phenylephrine 1 μg/kg [21].

Synthesis group	Studies	Direction of effect (primary hemodynamic outcome)	Applicability to emergency intubation
A: Emergency intubation in critically ill adults	Fuchita [16]; da Silveira [24]	1 of 2 favored prophylaxis: less hypotension with metaraminol (21.1% versus 49.4%); no significant difference, numerically more hypotension with prophylaxis, in Fuchita (41% versus 32%)	Closest to target; both observational, with confounding by indication
B: Older, high-risk, cardiac, or septic surgical patients	Wu [15]; Onishi [17]; Maimaitiming [18]; Trocheris-Fumery [20]; Gaillard [22]; Helmy [23]; Peng [26]	5 of 6 controlled comparisons favored prophylaxis; Gaillard primary outcome (MAP <55 mmHg) not reduced, although MAP <65 mmHg was; Wu compared doses only	Intermediate; planned induction in higher-risk patients, sepsis cohort hemodynamically stable
C: Low-risk elective or neurosurgical patients	Megha [19]; Sjøen [21]; Min [25]; Thotungal [27]	3 of 4 favored prophylaxis; no significant difference between ephedrine and crystalloid preload in Megha	Least direct; healthy or elective patients, whole-anesthesia endpoints in neurosurgical trials

TABLE 4: Direction of effect on the primary hemodynamic outcome by synthesis group

Additional findings and clinically important qualifications are summarized in Table *5*. In Helmy et al., acute kidney injury occurred in two of 40 versus nine of 40 patients, but the multiplicity-adjusted P-value was 0.288 [23]. For the postoperative complication counts of 103/235 versus 137/238 in Trocheris-Fumery et al., the crude risk ratio is approximately 0.76, not the published value labeled as 0.58 [20]. Peng et al.'s favorable adjusted change in cardiac index should be distinguished from similar unadjusted MAP values at 10 minutes [26]. The corrected doses in Sjøen et al. were NE 0.1 μg/kg and phenylephrine 1 μg/kg [21].

Study/outcome	Finding	Interpretation
Wu [15]; bradycardia	3.3%, 6.7%, 26.7% across increasing doses	Dose-related safety signal; small study
Trocheris-Fumery [20]; complications	103/235 versus 137/238 at 30 days	Crude risk ratio ≈ 0.76; published label differs
Trocheris-Fumery [20]; hypertension	42/235 versus 0/238	Pressure benefit accompanied by more hypertension
Gaillard [22]; severe hypotension	43.8% versus 44.8%; odds ratio 0.96 (95% confidence interval 0.56-1.66)	No demonstrated reduction below 55 mmHg
Helmy [23]; kidney injury	2/40 versus 9/40; adjusted P = 0.288	No confirmatory renal benefit
da Silveira [24]; mortality	No significant seven-/28-day difference	Hypotension association did not establish survival benefit
Min [25]; instability	Moderate instability burden reduced	Whole-anesthesia endpoint includes high and low pressure
Peng [26]; cardiac index	Adjusted difference + 0.63 L/min/m² (95% confidence interval 0.18-1.07)	Adjusted change is not an unadjusted pressure difference

TABLE 5: Clinical outcomes and qualifications relevant to interpretation

Reporting Biases and Certainty of Evidence

No formal estimate of publication bias or pooled certainty rating was produced. The combination of heterogeneous outcome definitions, small trials, observational confounding, and several reporting inconsistencies restricts confidence in a generalized vasopressor effect. Randomized evidence for emergency intubation was absent, and no study addressed intubation for urgent radiology. Evidence from planned surgical induction therefore cannot establish a regimen, a mortality benefit, or a neurological benefit for critically ill adults requiring emergency airway management.

Discussion

In planned induction, prophylactic vasopressors reduced the incidence or depth of induction-related hypotension in most comparisons, but the size of the effect depended on the drug, dose, comparator, hypotension threshold, and baseline risk. Emergency intubation in critically ill adults, treated here as a clinically distinct question, was represented only by two observational cohorts with discordant results, and no study addressed intubation for urgent radiology. These findings agree with earlier reviews that reported less hypotension with prophylactic phenylephrine or ephedrine and modest increases in arterial pressure with push-dose vasopressors, mainly in elective operating room patients [4,5]. The present review adds recent trials of continuous NE in high-risk, cardiac, and septic surgical patients and recent emergency-intubation cohorts. It also shows that the pressure effect has not yet been accompanied by a demonstrated reduction in severe hypotension, organ injury, or mortality.

The emergency-intubation evidence is the most relevant to critically ill patients but the weakest for causal inference. In the secondary analysis by Fuchita et al., clinicians chose whether to give prophylaxis within randomized parent trials, so it may have been given preferentially to patients judged likely to deteriorate [16]. Propensity matching cannot correct for unrecorded judgments about ventricular function, fluid responsiveness, or anticipated intolerance of induction, and drug and dose details were incomplete. The higher hypotension rate in that cohort does not show harm, and the absence of a significant difference does not show ineffectiveness. In the ARAMAN cohort, push-dose metaraminol was associated with less hypotension in septic intensive care patients without a mortality difference, but the study was retrospective, and preventive dosing is difficult to separate from dosing triggered by an early pressure fall when drugs are given "before or during" intubation [24]. Neither study supports ranking one agent above another.

In surgical patients, the apparent benefit depended on the endpoint. NE started at induction reduced hypotension in high-risk abdominal surgery but caused more hypertension, and the trial tested an ongoing management strategy rather than an induction dose alone [20]. Its reported complication risk ratio (0.58) also differs from the crude ratio calculated from the published counts (approximately 0.76) and should not be cited without clarification. In cardiac surgery, prophylactic NE reduced hypotension below 65 mmHg but not the primary outcome of hypotension below 55 mmHg [22]. In surgical sepsis, preemptive NE reduced early hypotension, but participants were hemodynamically stable, rapid-sequence induction was excluded, and the difference in acute kidney injury was not significant after adjustment for multiple comparisons [23]. Preventing moderate pressure falls appears easier than preventing profound cardiovascular depression, and organ protection has not been shown.

Dose and delivery varied widely. Sjøen et al. tested single boluses in healthy women managed with a laryngeal mask, and the three drugs differed in duration of effect and in heart rate and cardiac output responses [21]. Peng et al. found an attenuated fall in cardiac index with NE after adjustment for propofol exposure, although unadjusted pressures at 10 minutes were similar [26], and Wu et al. observed more bradycardia at higher NE infusion rates [15]. No included study compared weight-based with fixed dosing, single with repeated boluses, or bolus with infusion delivery, and none tested an individualized dosing algorithm. NE doses were also reported inconsistently as base or salt. The optimal agent, dose, and regimen therefore remain undefined, and a higher pressure should not be assumed to mean better flow.

The smaller and nonrandomized studies generate hypotheses rather than firm estimates. The transcatheter aortic valve replacement cohort is relevant to an image-guided procedure, but it involved elective patients with severe aortic stenosis [17]. The prostatectomy and ephedrine-preload comparisons were small, and treatment followed anesthesiologist preference [18,19]. The neurosurgical trials used whole-anesthesia endpoints or a phenylephrine-propofol admixture given throughout anesthesia, so their effects cannot be attributed to the intubation period [25,27].

Procedural location is a weak basis for judging applicability. The same procedure may be performed in an operating room, a hybrid theater, an interventional suite, or at the bedside depending on institutional resources, staffing, urgency, and local practice, and operating-room-level anesthetic support is available in some procedural suites but not in others. Two patients with similar physiology may therefore be managed in different locations, whereas two procedures outside the operating room may differ greatly in urgency, baseline instability, and anesthetic exposure. The synthesis groups in this review were accordingly defined by clinical characteristics rather than location. For an individual patient, the more relevant considerations are whether airway management is emergency or planned, baseline blood pressure and shock state, existing vasopressor requirement, ventricular function and cardiovascular reserve, the induction agent and dose, the use of rapid-sequence induction, the transition to positive-pressure ventilation, and the availability of monitoring and immediate rescue treatment. Location influences management mainly through these system-level factors, for example, whether an infusion can be started before transfer or whether invasive arterial monitoring is available. Trials comparing anesthesia strategies during stroke thrombectomy show that hemodynamic management forms part of the whole procedural pathway, but they did not isolate a vasopressor effect [6,7,28].

Plausible preventive measures can fail when tested: routine fluid loading did not reduce cardiovascular collapse [3], and the benefit of a multicomponent bundle could not be attributed to any single element [2]. A

useful next step would be a multicenter randomized comparison of an explicitly timed preventive strategy against protocolized rescue care during emergency intubation, stratified by baseline vasopressor dependence, with standardized recording of induction doses, airway attempts, ventilation settings, and fluid administration. The primary endpoint should capture the severity and duration of hypotension within a defined peri-intubation window, and cardiac arrest, hypertension, arrhythmia, organ injury, and patient-centered outcomes should be prespecified. Prespecified subgroups should be defined by clinical determinants such as shock state, ventricular function, and induction technique, with procedural location recorded as a contextual covariate rather than as a defining category.

In practice, the evidence supports readiness to treat cardiovascular instability rather than routine administration of a fixed preventive dose to every patient. It provides little information about patients already receiving escalating vasopressor support, those with severe ventricular dysfunction, or those undergoing time-critical procedures without invasive monitoring. Decisions about hemodynamic preparation should therefore be based on the individual patient's physiology, the urgency of airway management, and the monitoring and rescue resources available, wherever the procedure takes place.

Limitations

The evidence is derived predominantly from planned surgical induction and is indirect for emergency intubation; no study addressed urgent radiology. Elective surgical participants, including patients managed with a laryngeal mask, differ from critically ill adults undergoing emergency tracheal intubation. Interventions, comparators, monitoring methods, and outcome windows varied substantially. Several studies were small, observational, or affected by reporting inconsistencies, and safety and long-term outcomes were incompletely characterized. No protocol was registered, and the broadening of eligibility from a radiology-specific population was made during review development rather than prospectively. The five-year publication window may have excluded older eligible trials; although much of this earlier randomized evidence has been synthesized in previous reviews [4,5], the number of excluded older studies cannot be enumerated. The primary database strategy required an intubation or induction term, and induction-only studies were also sought through a supplementary title search; some eligible induction studies may nevertheless have been missed. Screening and extraction were not independently duplicated. The screening flow does not separately enumerate later supplementary identification, although the retained set contains a report published after 15 August 2026 [27]. This limits reproducibility of the search chronology. The risk-of-bias judgments do not eliminate residual confounding or indirectness, and formal outcome-specific certainty ratings were not assigned. No included study evaluated patient-specific dosing or compared single- with multiple-dose regimens. Clinical determinants of hemodynamic risk, such as ventricular function and baseline vasopressor requirement, were inconsistently reported, which prevented their examination as effect modifiers.

Conclusions

In planned anesthetic induction, prophylactic vasopressors can reduce induction-related hypotension in selected adult surgical populations, although effects vary with drug, dose, hypotension threshold, and baseline risk. Evidence for emergency intubation, a clinically distinct setting, is limited to two observational cohorts with discordant results. A universal preventive regimen and benefits for survival or major organ injury remain unproven. Decisions should be guided by the urgency of airway management, the patient's hemodynamic status and cardiovascular reserve, and the induction technique, with procedural location considered as one contextual factor. Randomized trials of explicitly timed preventive strategies during emergency intubation are needed before firm recommendations can be made.

Appendices

Database	Search strategy
PubMed/MEDLINE	("Vasoconstrictor Agents"[Mesh] OR vasopressor*[tiab] OR "push-dose"[tiab] OR norepinephrine[tiab] OR noradrenaline[tiab] OR phenylephrine[tiab] OR ephedrine[tiab] OR metaraminol[tiab] OR epinephrine[tiab] OR adrenaline[tiab]) AND ("Intubation, Intratracheal"[Mesh] OR intubation[tiab] OR "tracheal intubation"[tiab] OR "endotracheal intubation"[tiab] OR "rapid sequence intubation"[tiab] OR "Anesthesia, General"[Mesh] OR "anesthesia induction"[tiab] OR "anaesthesia induction"[tiab] OR "induction of anesthesia"[tiab] OR "induction of anaesthesia"[tiab] OR "post-induction"[tiab]) AND ("Hemodynamics"[Mesh] OR "Hypotension"[Mesh] OR hemodynamic*[tiab] OR haemodynamic*[tiab] OR hypotension[tiab] OR "blood pressure"[tiab]) AND (prophyla*[tiab] OR prevent*[tiab] OR preemptive[tiab] OR "pre-emptive"[tiab] OR "pre-intubation"[tiab] OR "peri-intubation"[tiab] OR "before induction"[tiab]) AND ("2021/08/01"[dp] : "2026/08/15"[dp])
Embase (Embase.com)	#1 'vasoconstrictor agent'/exp OR 'noradrenalin'/exp OR 'phenylephrine'/exp OR 'ephedrine'/exp OR 'metaraminol'/exp OR 'adrenalin'/exp OR (vasopressor* OR 'push dose' OR norepinephrine OR noradrenaline OR phenylephrine OR ephedrine OR metaraminol OR epinephrine OR adrenaline):ti,ab #2 'endotracheal intubation'/exp OR 'induction of anesthesia'/exp OR (intubat* OR 'anesthesia induction' OR 'anaesthesia induction' OR 'induction of anesthesia' OR 'induction of anaesthesia' OR 'post-induction'):ti,ab #3 'hypotension'/exp OR 'hemodynamics'/exp OR (hemodynamic* OR haemodynamic* OR hypotension OR 'blood pressure'):ti,ab #4 (prophyla* OR prevent* OR preemptive OR 'pre-emptive' OR 'pre-intubation' OR 'peri-intubation' OR 'before induction'):ti,ab #5 #1 AND #2 AND #3 AND #4 AND (2021-2026)/py
Cochrane CENTRAL	#1 [mh "Vasoconstrictor Agents"] OR (vasopressor* OR "push dose" OR norepinephrine OR noradrenaline OR phenylephrine OR ephedrine OR metaraminol OR epinephrine OR adrenaline):ti,ab,kw #2 [mh "Intubation, Intratracheal"] OR [mh "Anesthesia, General"] OR (intubat* OR "anesthesia induction" OR "anaesthesia induction" OR "induction of anesthesia" OR "induction of anaesthesia" OR "post-induction"):ti,ab,kw #3 [mh Hypotension] OR [mh Hemodynamics] OR (hemodynamic* OR haemodynamic* OR hypotension OR "blood pressure"):ti,ab,kw #4 (prophyla* OR prevent* OR preemptive OR "pre-emptive" OR "pre-intubation" OR "peri-intubation" OR "before induction"):ti,ab,kw #5 #1 AND #2 AND #3 AND #4, publication date August 2021 to August 2026
Scopus	TITLE-ABS-KEY((vasopressor* OR "push dose" OR norepinephrine OR noradrenaline OR phenylephrine OR ephedrine OR metaraminol OR epinephrine OR adrenaline) AND (intubat* OR "anesthesia induction" OR "anaesthesia induction" OR "induction of anesthesia" OR "induction of anaesthesia" OR "post-induction") AND (hemodynamic* OR haemodynamic* OR hypotension OR "blood pressure") AND (prophyla* OR prevent* OR preemptive OR "pre-emptive" OR "pre-intubation" OR "peri-intubation" OR "before induction")) AND PUBYEAR > 2020
Supplementary title search (PubMed, Europe PMC)	(vasopressor* OR norepinephrine OR noradrenaline OR phenylephrine OR ephedrine OR metaraminol OR epinephrine OR adrenaline)[ti] AND (induction OR intubation OR anesthesia OR anaesthesia)[ti], August 2021 to 26 September 2026; radiology terms (radiology OR "computed tomography" OR angiography OR embolization OR thrombectomy OR "interventional") added in focused runs

TABLE 6: Complete search strategies

Additional Information

Author Contributions

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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Sarra Kamil Abbas Mohamed Ahmed equally contributed to this work and should be considered joint first author of this work. All authors have made substantial and equal contributions to this work and meet the ICMJE criteria for authorship. Although affiliated with different institutions, we maintain a frequent and productive research collaboration that made this joint effort possible. All authors have approved the final manuscript and agree to be accountable for all aspects of this work.

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