

A COMPARATIVE STUDY OF VIDEO LARYNGOSCOPY VERSUS DIRECT LARYNGOSCOPY FOR ENDOTRACHEAL INTUBATION

A Systematic Review of Randomized Controlled Trials Evaluating First-Pass Success Rate and Intubation Time

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Abstract—Direct laryngoscopy (DL) using a Macintosh blade has long been the standard technique for achieving tracheal intubation, but it requires alignment of the oral, pharyngeal and laryngeal axes and remains technically demanding in patients with difficult airway anatomy. Video laryngoscopy (VL) provides an indirect, camera-assisted view of the glottis and has been increasingly adopted across operating rooms, emergency departments and intensive care units. **Objective:** to synthesize evidence from randomized controlled trials (RCTs) and RCT-based meta-analyses comparing VL and DL for endotracheal intubation, with emphasis on first-pass success rate and intubation time. **Methods:** a structured literature search of PubMed/MEDLINE, the Cochrane Library and Europe PMC (2016–2025) identified RCTs and systematic reviews/meta-analyses of RCTs reporting first-pass success and/or time to intubation for VL versus DL. Data were narratively synthesized because of clinical and methodological heterogeneity across settings; no new patient data were collected for this review. **Results:** VL was associated with higher first-pass success in most in-hospital settings—for example 85.1% vs 70.8% in a 1417-patient trial of critically ill adults, and 98.3% vs 92.4% in an 8429-patient operating-room trial—while a 25-trial meta-analysis of 5836 critically ill patients found no significant overall difference (RR 1.03) but a significant benefit confined to in-hospital use (RR 1.12) and an advantage that reversed when operators were more experienced with DL (RR 0.65). Findings on intubation time were mixed and setting-dependent. VL consistently reduced esophageal intubation (RR 0.36–0.44) and failed intubation (RR 0.06) across pooled analyses, without a significant difference in overall severe-complication rates or mortality. **Conclusion:** VL improves first-pass success and reduces esophageal and failed intubation in most in-hospital contexts, but its advantage is attenuated or reversed in pre-hospital settings and among clinicians already proficient with DL, underscoring the importance of setting- and operator-specific device selection and training.

Index Terms—Video laryngoscopy; direct laryngoscopy; endotracheal intubation; first-pass success; intubation time; airway management; randomized controlled trial; systematic review.

I. Introduction

Securing a patent airway through tracheal intubation is one of the most frequently performed and highest-stakes procedures in anesthesiology, emergency medicine, and critical care. Direct laryngoscopy, using a rigid Macintosh (or occasionally Miller) blade, has served as the conventional technique since the mid-twentieth century. It requires the operator to achieve a direct line of sight from the mouth to the glottis by aligning the oral, pharyngeal, and laryngeal axes—commonly the “sniffing” position—and glottic exposure is graded using the Cormack–Lehane classification, with grade III and IV views associated with a substantially higher risk of first-attempt failure and airway trauma. Video laryngoscopy was introduced in the early 2000s and has since diversified into numerous platforms, including the GlideScope, C-MAC, McGrath MAC, King Vision, and Airtraq, several of which offer hyperangulated (“D-blade”) variants. These devices incorporate a distal camera that projects a magnified glottic image onto a screen, allowing indirect visualization that does not strictly require alignment of the airway axes. Because the camera can often “see around the corner” of an anterior or difficult airway, VL has been proposed as a technique capable of improving glottic view and first-attempt success, particularly in patients with predictors of difficult intubation such as obesity, limited neck mobility, or trauma.

Despite broad adoption, questions remain regarding whether the improved glottic view afforded by VL reliably translates into faster, safer, or more successful intubation across all clinical settings. Device cost, screen soiling by blood or secretions, a distinct learning curve, and heterogeneous results across operating-room, emergency-department,

intensive-care, and pre-hospital trials have kept the comparative question open, prompting a large and rapidly growing body of randomized evidence since 2016.

This paper presents a structured, evidence-based narrative synthesis of existing randomized controlled trials and RCT-level meta-analyses rather than a newly conducted primary trial; it is intended as a comparative review for clinical, procurement, and airway-management training reference, consolidating first-pass success and intubation-time data that are otherwise scattered across individual publications.

II. Need of the Study

The period between 2016 and 2025 has produced a large volume of RCTs and meta-analyses comparing VL and DL, with headline results that can appear contradictory when read in isolation—for instance, a very large operating-room trial reporting a clear advantage for VL alongside a large intensive-care meta-analysis reporting no significant overall difference. Without synthesis, clinicians, procurement committees, and airway-management educators are left to reconcile seemingly conflicting findings on an ad hoc basis.

Airway-management training programs, including those for anesthesia technicians and Operation Theatre Technicians, must decide how much emphasis to place on VL versus DL skills in simulation-based curricula and how to justify equipment procurement to institutions. International airway-management guidelines increasingly recommend that VL be available for anticipated or unanticipated difficult airway, but the RCT evidence for its routine first-line use in normal airways is more nuanced and setting-dependent than a blanket recommendation would suggest.

This review therefore aims to consolidate recent RCT-level evidence specifically on the two most clinically actionable outcomes—first-pass success rate and intubation time—across diverse patient populations (intensive care, emergency department, elective operating room, and nasotracheal/maxillofacial surgery), so that the practical, setting-specific implications for practice and training can be made explicit rather than left implicit in individual trial reports.

III. Research Methodology

The methodology outlines how the underlying literature was identified, screened, and synthesized. This is not a de novo clinical trial; rather, it is a structured review of previously published, peer-reviewed randomized evidence.

3.1 Search Strategy

A structured search was conducted across PubMed/MEDLINE, the Cochrane Central Register of Controlled Trials (CENTRAL) and Europe PMC, covering the period January 2016 to September 2026. Search terms combined (“video laryngoscopy” OR “videolaryngoscopy”) AND (“direct laryngoscopy” OR “Macintosh laryngoscope”) AND (“intubation”) AND (“randomized controlled trial” OR “randomised controlled trial” OR “meta-analysis” OR “systematic review”). Reference lists of retrieved systematic reviews were also hand-searched for additional eligible primary trials.

3.2 Eligibility Criteria

Studies were eligible if they were randomized controlled trials, or systematic reviews/meta-analyses pooling randomized controlled trials, comparing video laryngoscopy with direct (Macintosh) laryngoscopy for tracheal intubation in human patients, and reporting first-pass (first-attempt) intubation success and/or time to successful intubation. Only English-language, peer-reviewed publications were included. Case reports, non-randomized observational studies, manikin- or simulation-only studies, and studies lacking a direct-laryngoscopy comparator arm were excluded.

3.3 Outcome Measures

The primary outcome of interest was first-pass (first-attempt) intubation success. Secondary outcomes included time to successful intubation, esophageal intubation, aspiration, hypoxemia, failed intubation, and dental or airway trauma, extracted as reported in the source publications (percentages, risk ratios [RR] or odds ratios with 95% confidence intervals, or mean/median differences, as available).

3.4 Data Extraction and Synthesis

For each included study, the design, clinical setting, sample size, operator experience where reported, device type, and effect estimates for the outcomes above were extracted directly from the published results or their abstracts. Because of substantial clinical heterogeneity across settings (pre-hospital, emergency department, intensive care unit, and elective operating room) and methodological heterogeneity in outcome definitions and operator skill-mix, a pooled random-effects re-analysis was not undertaken within this review; instead, findings are synthesized narratively and presented alongside the effect estimates as reported by the original authors, which is the appropriate and transparent approach when the source studies themselves already include peer-reviewed pooled estimates.

IV. Results and Discussion

4.1 Overview of Included Evidence

Seven key sources anchor this synthesis: two large, individual multicentre RCTs (a critically-ill-adult trial and a cardiac operating-room trial), three RCT-based meta-analyses (critically ill adults, mixed-setting critically ill adults, and nasotracheal/oromaxillofacial surgery), one elective-surgery RCT in patients with non-difficult airways, and one multicentre RCT evaluating device-to-device variability among six video laryngoscopes. Table 1 summarizes the design, population, and principal first-pass success findings of each.

Table 1. Summary of key randomized controlled trials and meta-analyses comparing video laryngoscopy (VL) and direct laryngoscopy (DL).

Study (Author, Year)	Design	N	Setting	VL first-pass success	DL first-pass success	Key additional finding
Prekker et al., 2023 [1] (DEVICE trial)	Multicentre RCT	1417	Emergency dept. & ICU, critically ill adults	85.1%	70.8%	No difference in severe complications between groups
Ruetzler et al., 2024 [2]	Cluster-randomized, multiple-crossover RCT	8429	Cardiac operating rooms	98.3%	92.4%	Failed intubation RR 0.06 (95% CI 0.03–0.14) favouring VL
Araújo et al., 2024 [3]	Meta-analysis (14 RCTs)	3981	ICU / operating room, critically ill adults	RR 1.12 (1.04–1.20)	reference	Esophageal intubation RR 0.44; no mortality difference
Yuan et al., 2025 [4]	Meta-analysis (25 RCTs)	5836	Critically ill adults, mixed settings	RR overall; RR 1.12 in-hospital	reference	Pre-hospital subgroup trended in favour of DL (RR 0.75)
Gupta et al., 2021 [5]	Meta-analysis (10 RCTs)	597	Nasotracheal intubation, oromaxillofacial surgery	94.8%	84.2%	VL ~9.0 s faster to intubate (MD -9.04 s, $p<0.001$)
Jamwal et al. [6]	RCT	90	Elective cholecystectomy, non-difficult airway	not reported (%)	not reported (%)	Shorter intubation time and better Cormack–Lehane view with VL
Kleine-Bruegggeny et al., 2016 [7]	Multicentre RCT, 6 VL devices	720	Simulated difficult airway	85–98% (device-dependent)	not included	Wide device-to-device variability in success rate and time

4.2 First-Pass Success Rate

Figure 1 presents first-pass success percentages from the three sources that reported them directly. In the DEVICE trial, a 1417-patient multicentre RCT conducted across 17 emergency departments and intensive care units, first-attempt success was 85.1% with VL versus 70.8% with DL [1]. In the largest available operating-room trial, an 8429-patient cluster-randomized, multiple-crossover study conducted in cardiac operating theatres, first-pass success was 98.3% with VL versus 92.4% with DL, and the trial was stopped early at roughly half its planned recruitment because the treatment effect so strongly favoured VL [2]. A meta-analysis of ten RCTs (597 patients) of nasotracheal intubation for oromaxillofacial surgery reported 94.8% first-pass success with VL versus 84.2% with DL [5].

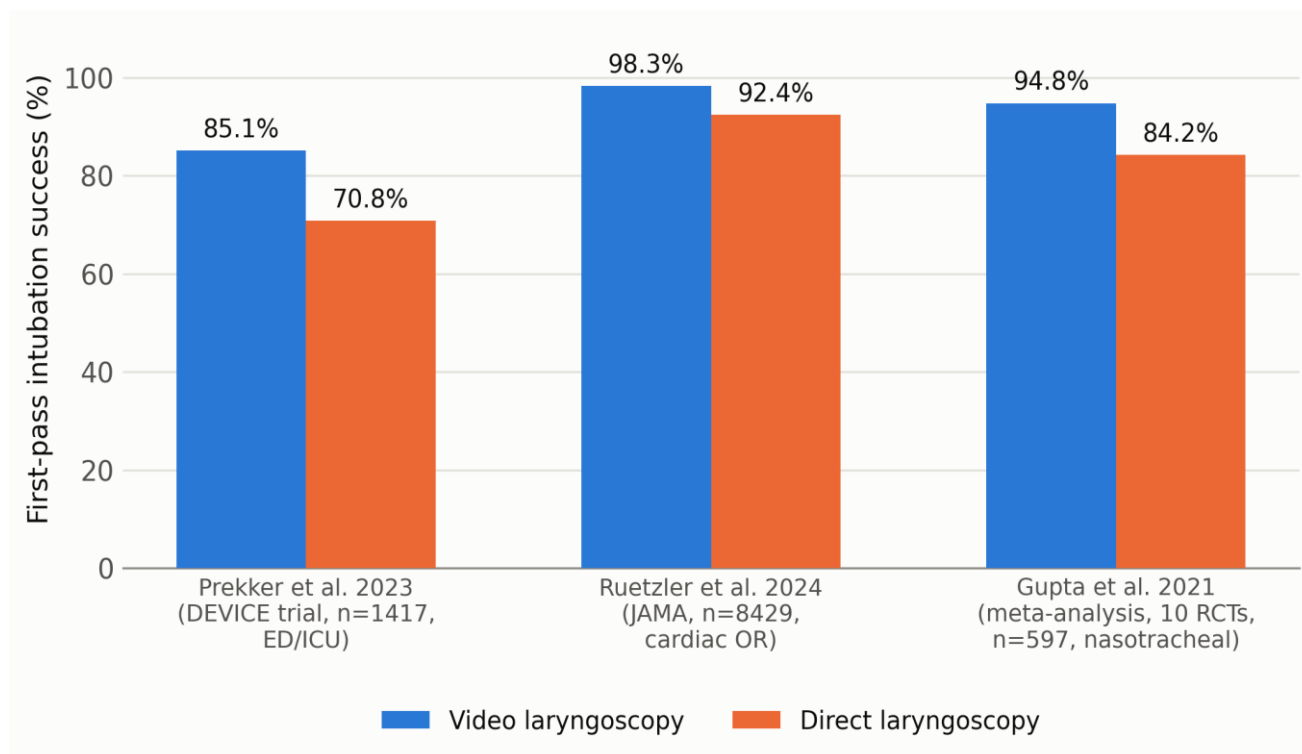


Fig. 1. first-pass intubation success (%) reported by three individual studies: an emergency department/ICU trial, a cardiac operating-room trial, and a nasotracheal-intubation meta-analysis. Data from [1], [2], [5].

Pooled risk-ratio estimates from meta-analyses (Figure 2) reinforce this pattern but also reveal important heterogeneity. A meta-analysis of 14 RCTs (3981 patients) of critically ill adults in ICU and operating-room settings found a significant first-pass-success advantage for VL (RR 1.12, 95% CI 1.04–1.20) [3]. A larger, more recent meta-analysis of 25 RCTs (5836 critically ill patients) found no significant overall difference (RR 1.03, 95% CI 0.96–1.11), but this null overall result concealed a significant benefit confined to in-hospital use (RR 1.12, 95% CI 1.04–1.22) and a non-significant trend toward inferiority of VL in pre-hospital settings (RR 0.75, 95% CI 0.56–1.00) [4]. The same meta-analysis found that when the operator was more experienced with DL than with VL, the VL success advantage reversed (RR 0.65, 95% CI 0.49–0.88), whereas when operators were equally proficient with both techniques, VL retained a clear advantage (RR 1.14, 95% CI 1.06–1.23) [4]. The nasotracheal-surgery meta-analysis also reported a modest but statistically significant advantage for VL (RR 1.10, $p = 0.001$) [5].

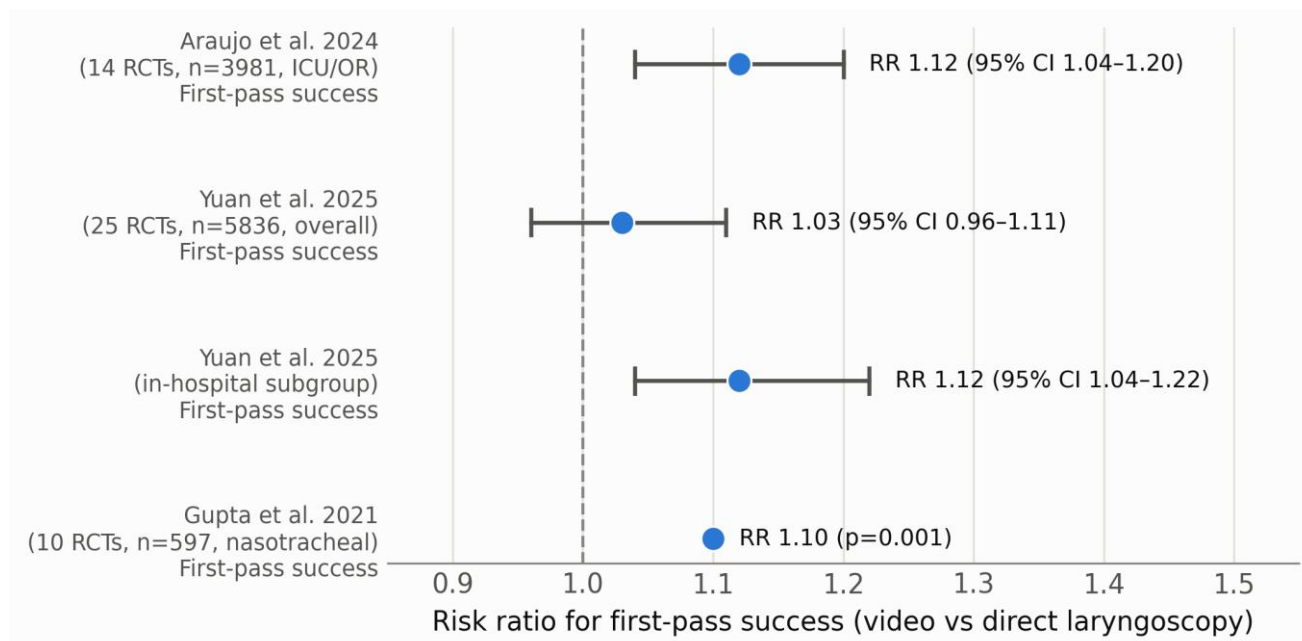


Fig. 2. pooled risk ratios (RR) for first-pass intubation success, video versus direct laryngoscopy (RR > 1 favours video laryngoscopy). Data from [3], [4], [5].

Taken together, these findings indicate that VL's first-pass-success advantage is real but not universal: it is most consistent and largest in supervised in-hospital settings (operating room, ICU, emergency department) and among operators without strong prior DL proficiency, and it attenuates or reverses in pre-hospital settings and among highly

DL-experienced clinicians—most plausibly reflecting factors such as screen glare, blood or secretion soiling of the camera lens, cramped working space, and the additional cognitive load of interpreting a screen image rather than a direct view under field conditions.

4.3 Intubation Time

Unlike first-pass success, findings on intubation time were mixed and did not uniformly favour VL. The 25-trial critically-ill-patient meta-analysis found no significant difference in intubation duration between VL and DL (standardized mean difference -0.05 , $p = 0.65$) [4]. By contrast, the nasotracheal/oromaxillofacial-surgery meta-analysis found VL to be approximately 9 seconds faster on average (mean difference -9.04 s, $p < 0.001$), a result the original authors noted ran counter to some earlier, smaller studies [5]. In the elective-cholecystectomy RCT of patients with non-difficult airways, VL was associated with a shorter mean intubation time and a more frequently Cormack–Lehane grade I glottic view, although exact time values were not reported in the available abstract [6]. Among video laryngoscopes evaluated head-to-head in a simulated difficult airway (without a DL comparator arm), median time to successful intubation ranged widely by device, from 47 seconds (Airtraq) to 93 seconds (A.P. Advance), illustrating that “video laryngoscopy” is not a single, homogeneous intervention but a family of devices with materially different performance characteristics [7].

This device heterogeneity is an important caveat for interpreting pooled “VL versus DL” comparisons: trials and meta-analyses often combine several different video-laryngoscope models under a single “VL” label, so a pooled time or success estimate represents an average across devices of varying design (Macintosh-shaped versus hyperangulated blades) rather than the performance of any one product.

4.4 Complications and Safety Outcomes

Beyond first-pass success and time, VL was associated with consistent reductions in oesophageal intubation and failed intubation across the pooled analyses (Figure 3). The 14-trial critically-ill-patient meta-analysis reported a reduced risk of oesophageal intubation with VL (RR 0.44, 95% CI 0.24–0.80) and of aspiration (RR 0.63, 95% CI 0.41–0.96), with no significant difference in severe hypoxemia (RR 0.98, 95% CI 0.74–1.29) or all-cause mortality (RR 1.00, 95% CI 0.87–1.16) [3]. The 25-trial meta-analysis similarly found a substantially lower risk of oesophageal intubation with VL (RR 0.36, 95% CI 0.21–0.61), though the evidence certainty across its analyses was rated very low owing to heterogeneity [4]. In the cardiac operating-room trial, failed intubation occurred in 0.27% of VL cases versus 4.0% of DL cases (RR 0.06, 95% CI 0.03–0.14), while dental or airway injury did not differ significantly between groups [2]. The DEVICE trial likewise found no significant difference in the rate of severe complications or safety events such as oesophageal intubation, dental injury, or aspiration between the two techniques, despite VL’s large first-pass-success advantage [1].

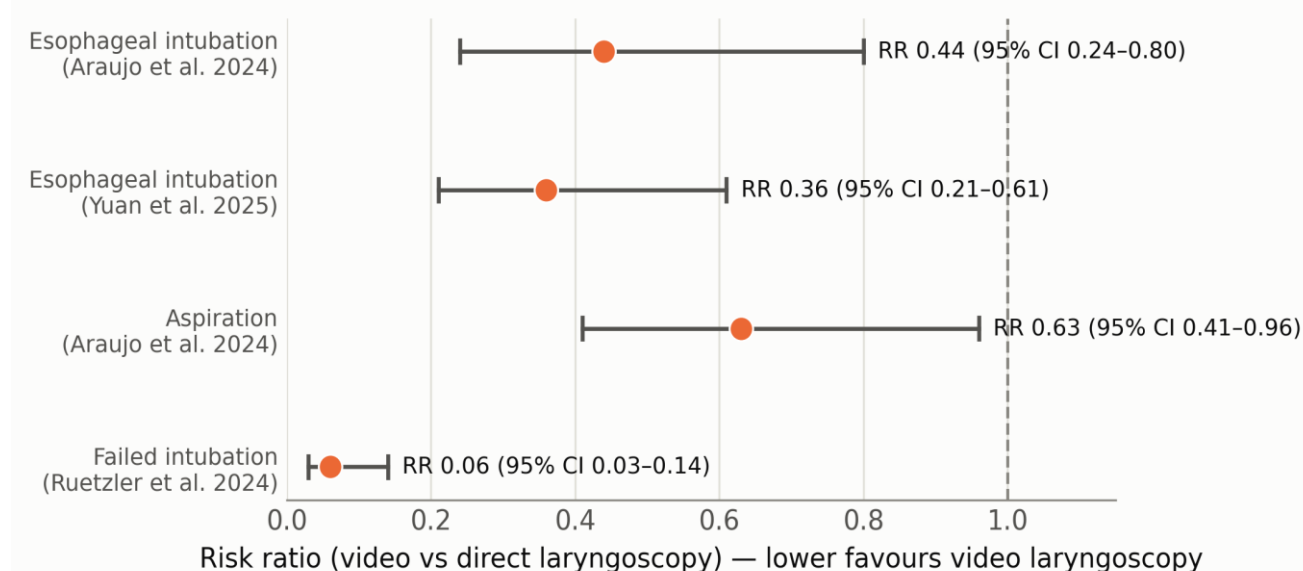


Fig. 3. pooled risk ratios (RR) for complication and failure outcomes, video versus direct laryngoscopy (RR < 1 favours video laryngoscopy). Data from [2], [3], [4].

4.5 Setting- and Operator-Dependent Heterogeneity

A recurring theme across the synthesized evidence is that the comparative performance of VL and DL is highly context-dependent. VL’s advantage was largest and most consistent in supervised, well-resourced in-hospital environments—operating rooms and ICUs with immediate backup and device familiarity—and was attenuated or reversed in pre-hospital/emergency medical services settings and among clinicians whose baseline proficiency lay with DL [4]. Device-level heterogeneity, illustrated by the six-device comparison in simulated difficult airways, further suggests that blade

geometry (standard Macintosh-shaped versus hyperangulated) materially affects both success rate and time to intubation, independent of the broader VL-versus-DL question [7]. Patient-level factors such as obesity, anticipated difficult airway, and the need for nasotracheal (rather than orotracheal) intubation also appear to modulate the magnitude of VL's benefit, as reflected in the population-specific meta-analyses reviewed here [5].

4.6 Implications for Practice and Training

For institutions and training programs, these findings suggest a nuanced rather than a uniform recommendation. Where video laryngoscopes are available and operators are trained on them, the evidence supports their use as a means of improving first-pass success and reducing oesophageal and failed intubation, particularly in operating-room and intensive-care settings and in patients with predictors of a difficult airway. However, the evidence does not support treating VL as categorically superior in all contexts: maintaining DL proficiency remains important, both because DL-experienced operators do not show the same VL advantage and because VL is not universally available, particularly in resource-limited or pre-hospital settings. Airway-management curricula, including for anesthesia and operation-theatre-technology trainees, may therefore benefit from structured, comparative simulation training in both techniques rather than an exclusive focus on either.

4.7 Strengths and Limitations of the Evidence Base

The principal strength of the reviewed evidence is the presence of several large, well-conducted, multicentre RCTs and meta-analyses published within the last decade, including two trials exceeding 1,000 and 8,000 patients respectively. Key limitations include: (i) substantial clinical and device heterogeneity within the broad "VL" category; (ii) variable operator experience and training across trials, which appears to interact meaningfully with outcome; (iii) very-low-to-moderate certainty of evidence in some pooled subgroup analyses owing to statistical heterogeneity; and (iv) the restriction of this review to English-language, indexed sources. As a narrative synthesis rather than a *de novo* meta-analysis, this review also does not generate new pooled statistical estimates but relies on those already reported by the original peer-reviewed sources; readers requiring a formal, updated quantitative synthesis are directed to the Cochrane systematic review and its periodic updates [8].

V. Conclusion

Across the randomized evidence reviewed, video laryngoscopy is associated with higher first-pass intubation success and lower rates of oesophageal and failed intubation compared with direct laryngoscopy in most in-hospital settings, without a corresponding increase in overall severe complications or mortality. Its advantage on intubation time is less consistent and appears setting- and device-dependent, and its first-pass-success benefit is attenuated or reversed in pre-hospital settings and among clinicians already proficient with direct laryngoscopy. These findings support selective, context-aware adoption of video laryngoscopy alongside continued direct-laryngoscopy training, rather than a one-size-fits-all substitution of one technique for the other.

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