

Effect of Bougie Use on First-Attempt Success in Tracheal Intubations: A Systematic Review and Meta-Analysis



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The use of a bougie, a flexible endotracheal tube introducer, has been proposed to optimize first-attempt success in emergency department intubations. We aimed to evaluate the available evidence on the association of bougie use in the first attempt and success in tracheal intubations. This was a systematic review and meta-analysis of studies that evaluated first-attempt success between adults intubated with a bougie versus without a bougie (usually with a stylet) in all settings. Manikin and cadaver studies were excluded. A medical librarian searched Ovid Cochrane Central, Ovid Embase, Ovid Medline, Scopus, and Web of Science for randomized controlled trials and comparative observational studies from inception to June 2023. Study selection and data extraction were done in duplicate by 2 independent reviewers. We conducted a meta-analysis with random-effects models, and we used GRADE to assess the certainty of evidence at the outcome level. We screened a total of 2,699 studies, and 133 were selected for full-text review. A total of 18 studies, including 12 randomized controlled trials, underwent quantitative analysis. In the meta-analysis of 18 studies (9,151 patients), bougie use was associated with increased first-attempt intubation success (pooled risk ratio [RR] 1.11, 95% confidence interval [CI] 1.06 to 1.17, low certainty evidence). Bougie use was associated with increased first-attempt success across all analyzed subgroups with similar effect estimates, including in emergency intubations (9 studies; 8,070 patients; RR 1.11, 95% CI 1.05 to 1.16, low certainty). The highest point estimate favoring the use of a bougie was in the subgroup of patients with Cormack-Lehane III or IV (5 studies, 585 patients, RR 1.60, 95% CI 1.40 to 1.84, moderate certainty). In this meta-analysis, the bougie as an aid in the first intubation attempt was associated with increased success. Despite the certainty of evidence being low, these data suggest that a bougie should probably be used first and not as a rescue device in emergency intubations. [Ann Emerg Med. 2024;83:132-144.]

Please see page 133 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

Endotracheal intubation is a critical procedure commonly performed in various health care settings, including out-of-hospital, emergency department (ED), intensive care unit (ICU), and operating rooms.¹ Successful intubation on the first pass, also known as first-attempt success, is associated with reduced risks of complications, such as hypoxemia, aspiration, and airway trauma.² This procedure is part of the core competencies of emergency medicine. Despite advancements in airway management techniques, achieving high first-attempt success proportions remains a challenge, particularly in settings with low frequency of intubations and in difficult airways.³

Importance

The use of a bougie, a flexible endotracheal tube introducer, has gained popularity as a potential strategy to improve first-attempt intubation success.⁴ The bougie serves as a guide to facilitate the placement of the endotracheal tube, particularly in cases of difficult airways or limited laryngeal visualization.⁵ Although the use of a bougie has been advocated by some clinicians, its overall influence on first-attempt success and clinical outcomes is still a topic of debate.⁶ Therefore, a comprehensive evaluation of the association between bougie use and first-attempt intubation success is of scientific importance and holds potential implications for clinical practice.

Goals of This Investigation

The objective of this systematic review and meta-analysis was to assess the association between the use of a bougie

Editor's Capsule Summary*What is already known on this topic*

Emergency physicians can intubate using either a bougie or endotracheal tube with a stylet in place.

What question this study addressed

Which of these intubation techniques has greater first-attempt success?

What this study adds to our knowledge

In this meta-analysis of 9,151 patients comparing bougie versus stylet, first-attempt success was higher with the bougie.

How this is relevant to clinical practice

Emergency physicians should consider bougie as the first-line approach for endotracheal intubation.

during endotracheal intubations and first-attempt success proportions. Through a comprehensive analysis of the existing evidence, we aimed to determine the effect size and clinical significance of using a bougie in the first attempt of intubation as opposed to a stylet or no-tube introducer aid. We sought to provide clinicians with evidence-based insights to enhance the success rates of endotracheal intubation and optimize patient outcomes.

MATERIALS AND METHODS**Study Design**

This was a systematic review and meta-analysis performed to evaluate the effect of using a bougie on first-attempt intubation success. A protocol was registered on the PROSPERO website (CRD42023403212). This manuscript adhered to the latest Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.⁷

Eligibility Criteria

Eligible studies included original research assessing adult intubation using a bougie as an intervention compared to usual care, where intubation was performed either with or without a standard stylet. Bougie was defined as a flexible endotracheal tube introducer with coude tip, and stylet was defined as a semirigid endotracheal tube introducer. When a study reported a control group both with a stylet and without, we used the cohort intubated with a stylet as controls to compare with the bougie (intervention), as this is commonly considered standard of care in many settings. Because we focused on

the use of a bougie and not on the specialty of the clinician managing the airway, the population encompassed all settings, including out-of-hospital, ED, ICU, and operating-room intubations. Nevertheless, subgroup analyses were done by study setting. Manikin and cadaver studies were excluded. We did initially include manikin and cadaver studies in our literature search, and relevant data from these studies were duly extracted. However, because of the inherent dissimilarity between simulation-based studies and actual patient studies, we exercised judgment in not incorporating these studies. Such an inclusion could potentially exacerbate heterogeneity issues. There was no restriction to the bougie type. Studies using only hyper-angulated video laryngoscopy or channeled laryngoscopic devices such as the airway scope were excluded. A standard-shaped bougie with a coude tip is often inadequate for tube delivery during hyper-angulated video laryngoscopy because it cannot closely follow the primary curve around the blade. To be included, studies had to report the outcome of first-attempt intubation success in both the bougie and the non-bougie group. Inclusion was limited to randomized controlled trials or comparative non-randomized observational studies. The latter required a clear distinction between a group of patients intubated with a bougie and another group intubated without a bougie. Secondary analyses of randomized controlled trials that did not randomly assign the use of the bougie were considered observational studies. Studies lacking a control group were excluded. Studies comparing different types of bougies were excluded. Studies published in languages other than English, Portuguese, or Spanish were excluded. Conference abstracts were not included. Publication year was not considered an exclusion criterion.

Information Sources and Search Strategy

A comprehensive literature search was conducted to explore the concept of intubation with an endotracheal tube introducer (ie, bougie). A medical librarian (D.J.G.) with expertise in systematic reviews performed the search by using a combination of keywords and standardized index terms. Various synonyms for bougie, such as "gum elastic bougie," "Frova guide," (Cook Medical, Bloomington, IN, USA) "endotracheal tube introducer," "Eschman introducer," and "bougie stylet," were included in the search strategies. The search was carried out on October 5, 2022, and updated on June 15, 2023, across multiple databases, including Ovid Cochrane Central Register of Controlled Trials (1991+), Ovid Embase

(1974+), Ovid Medline (1946+ including epub ahead of print, inprocess and other nonindexed citations), Scopus (1788+), and Web of Science Core Collection (Science Citation Index Expanded 1975+ and Emerging Sources Citation Index 2015+). Filters were applied to exclude most animal studies and case reports. The search results were exported to Covidence, where duplicates were removed. [Appendix E1](#) (available at <http://www.annemergmed.com>) provides detailed search strategies. Additionally, the reference lists of eligible studies were reviewed to ensure no important studies were missed. Gray literature was not systematically searched. A few days after the search update in June, a large randomized study (DirEct versus Video LaryngosCope [DEVICE] trial) was published comparing the use of video laryngoscopy versus direct laryngoscopy in critically ill adults, and unpublished data for those intubated with a bougie versus without a bougie were obtained directly from the authors through email.⁸

Selection Process

Pairs of reviewers (R.V.H., N.F., L.O.J.S.) independently evaluated the potential eligibility of each title and abstract identified by the search strategy. Any records deemed potentially eligible were then assessed in full-text format by 2 independent reviewers (R.V.H., L.O.J.S.) to determine their eligibility. In cases where disagreements arose, a consensus was reached after discussion and mutual agreement.

Data Collection and Outcomes

To ensure consistent data collection, a standardized form was created. One investigator initially extracted the data, and a second reviewer (R.V.H., L.O.J.S.) cross-checked it to ensure accuracy. Disagreements were resolved by consensus. The collected data encompassed various aspects, including study design, sample size, study setting, study population, specific details of interventions (including bougie type), and the outcomes of interest. The collection of outcome data was purposefully done to calculate risk ratios for each comparison.

Variables extracted included the setting in which the intubations took place (such as out-of-hospital, ED, ICU, or operating room), the utilization of rapid sequence intubation technique, the type of laryngoscopy employed (either direct or video), the specific laryngoscope blades used (conventional or hyper-angulated), the level of intubator experience, patient age and sex, indications for intubation, Cormack-Lehane grades, and the inclusion or exclusion of difficult airways.

The primary outcome of interest was the first-attempt intubation success, most commonly defined as the successful placement of the endotracheal tube on the first laryngoscope insertion. In addition to the primary outcome, several secondary outcomes were extracted. These outcomes included first-attempt success without clinically important complications (as defined by each study, usually including specific adverse events such as hypotension and hypoxemia after induction), occurrences of hypoxemia (defined as oxygen saturation <90%), postintubation arrest, duration of intubation, incidence of intubation-related injuries (such as airway trauma), cases of esophageal intubations, and the occurrence of postprocedural sore throat.

Risk of Bias Assessment

Risk of bias was evaluated at the outcome level for each eligible study after training and calibration exercises. For randomized controlled trials, the risk of bias was assessed by using version 2 of the Cochrane risk of bias tool.⁹ For observational studies, the modified Newcastle-Ottawa scale tool was used.¹⁰ The assessment of risk of bias was performed by one investigator (R.V.H.), and the results were subsequently cross-checked by a methodologist (L.O.J.S.). Disagreements were resolved by consensus.

Effect Measures and Analysis

For conducting meta-analyses, Review Manager (version 5.4.1.; The Nordic Cochrane Centre, The Cochrane Collaboration) software was used. The meta-analyses were performed using a random-effects model, as described by DerSimonian and Laird.¹¹ The pooled effect estimates of using a bougie during intubation compared with not using it were reported as risk ratios (RRs) with 95% confidence intervals (CIs). Statistical heterogeneity among the studies was assessed using the I^2 statistic proposed by Higgins and Thompson.¹² Visual evaluation was also employed to gauge between-study heterogeneity. To account for the clinical and statistical heterogeneity observed between studies, a random-effects model was employed. A funnel plot was depicted for the meta-analysis of the primary outcome in order to assess for potential publication bias.

Subgroup and Sensitivity Analyses

During the development of the protocol, we planned to conduct subgroup analyses based on study design (randomized versus nonrandomized studies), risk of bias (high risk versus some concerns versus low risk),

intubation setting (prehospital/ED/ICU versus operating room), training (resident versus nonresident), and intubation device (direct versus video laryngoscopy). The intubator training was not consistently reported, and we were not able to do such analysis. The analysis of studies that reported the subset of difficult airway patients was planned post hoc as we were not expecting to have such granular data. Difficult airway was defined as those patients with Cormack-Lehane grade III or IV, but a separate analysis including other definitions of difficult airway, such as the presence of cervical immobilization, was also performed. As for sensitivity analyses, during our attempt to explain the existing heterogeneity, we visually inspected forest plots and excluded outlier studies (eg, the BOUGIE trial) to understand their effect on the pooled effect estimate and on the overall statistical heterogeneity. These analyses were designed to provide further insights and explore potential sources of heterogeneity within and between the included studies.

Certainty Assessment

The certainty in the evidence for the effect of using a bougie on first-attempt intubation success was evaluated by using the GRADE approach.¹³

RESULTS

The search strategy identified 2,699 studies for review. After screening the titles and abstracts, we identified 134 potentially relevant studies (Figure 1). After a full-text review, a total of 18 studies met the inclusion criteria: 4 out-of-hospital studies,¹⁴⁻¹⁷ 5 ED-ICU studies,^{4,18-20} and 9 operating room studies.²¹⁻²⁹ Overall, 12 of these 18 (66.7%) studies were randomized controlled trials (Table 1, Appendix E2, available at <https://www.annemergmed.com>).

The studies included 9,151 participants, with 4,897 patients being intubated with a bougie and 4,254 controls being intubated without a bougie. Most of the control group patients were intubated with a standard stylet. The mean or median age ranged between 26.2 and 65 years in the bougie group and between 28.6 and 64 years in the controls. Rapid sequence intubation with the use of a rapidly acting paralytic agent occurred in all but one study,¹⁵ which included only intubations during cardiac arrest. Most studies (11/18, 61.1%) included intubations with direct laryngoscopy, whereas the rest used video laryngoscopy with conventional Macintosh blades. Two studies reported first-attempt success proportions separately for both direct and video laryngoscopy.^{8,19}

Certainty of Evidence

The certainty of evidence in the overall pooled estimate for the association between using a bougie and first-attempt intubation success was deemed to be low because of concerns about risk of bias and inconsistency. None of the included studies were considered as low risk of bias. All observational studies were deemed as high risk of bias (mostly because of imbalance between groups as a consequence of confounding by indication), and all randomized control trials had at least some concerns in one or more domains of the RoB 2 tool (Cochrane Collaboration) assessment (Appendix E3, available at <https://www.annemergmed.com>). Some asymmetry was found in the funnel plot in the evaluation of publication bias, but we did not decrease the certainty of evidence for this domain (Appendix E4, available at <https://www.annemergmed.com>). Despite multiple subgroup analyses, there was a relatively high I^2 for the meta-analyses, which led us to decrease the certainty of the evidence for inconsistency. Nevertheless, in the group of patients with Cormack-Lehane grades III or IV, results were consistent and, therefore, of moderate certainty.

Primary Outcome

In the meta-analysis of 18 studies including 9,151 patients, the use of a bougie during intubation was associated with increased first-attempt success (pooled RR 1.11, 95% CI 1.06 to 1.17, $I^2=83%$) (Figure 2).

Additional Analyses

The meta-analysis for studies that occurred in the out-of-hospital, ED, and ICU settings, including 8,070 emergency intubations, yielded similar results (RR 1.11, 95% CI 1.05 to 1.16, $I^2=74%$) (Figure 3).^{4,8,14-20} The high statistical heterogeneity in the subgroup of emergency intubations was partly explained by the BOUGIE trial,¹⁹ and its exclusion from the meta-analysis yielded similar results (RR 1.12, 95% CI 1.10 to 1.15) with decreased statistical heterogeneity ($I^2=6%$) (Appendix E5, available at <https://www.annemergmed.com>).

The use of a bougie was associated with increased first-attempt intubation success across all analyzed subgroups with similar effect estimates (Table 2, Appendix E5). Importantly, among the 12 randomized controlled trials, bougie was still associated with increased first-attempt success (RR 1.09, 95% CI 1.02 to 1.17). There were only 3 randomized controlled trials^{4,16,19} including emergency intubations, and its meta-analysis yielded a wide CI (RR 1.05, 95% CI 0.91 to 1.21, $I^2=90%$).

The highest risk ratio estimate favoring the use of a bougie was in the subgroup of patients with Cormack-Lehane III or

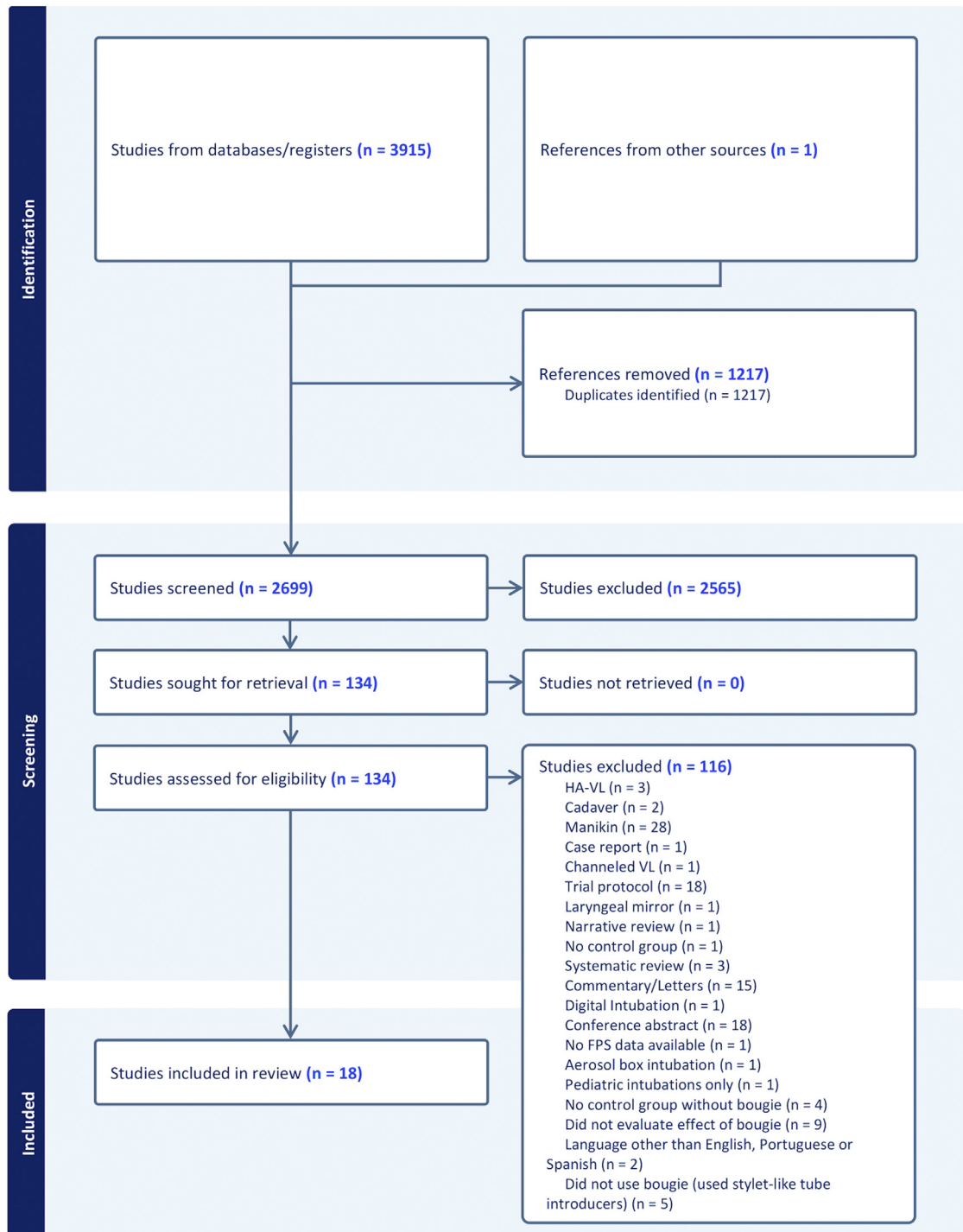


Figure 1. Systematic review flowchart. HA-VL, hyperangulated video laryngoscopy.

IV (5 studies, 585 patients, RR 1.60, 95% CI 1.40 to 1.84, $I^2=0\%$) (Figure 4).^{4,8,16,17,24}

Secondary Outcomes

Only 2 studies^{4,8} reported the outcome of first-attempt success without clinically important complications, and those being intubated with a bougie

had higher success than those intubated with a stylet (807/1003, 80.5% for bougie versus 759/1151, 65.9% for controls).

In the meta-analysis of 6 studies^{4,17-19,22,29} including 3,160 patients, the use of a bougie was not associated with an increased incidence of hypoxemia, but the CI was wide (RR 0.93, 95% CI 0.66 to 1.31, $I^2=59\%$) (Appendix E5). Only 2

Table 1. Main baseline characteristics of included studies.

Study	Design	Setting, Country	Population	Device	Intervention [N]	Control [N]
Angerman ¹⁴ 2018	Observ.	Out-of-hospital, Finland	Nonarrest adult intubations.	VL	Intubation with bougie [n=543]	No details on nonbougie devices [n=244]
Arasu ²¹ 2021	RCT	OR, India	Adult patients undergoing elective surgery.	VL	Intubation with bougie [n=70]	No stylet or bougie [n=70]
Bawa ²² 2022	RCT	OR, India	Adult patients undergoing elective or emergency surgery.	VL	Intubation with bougie [n=50]	Stylet [n=50]
Bonnette ¹⁵ 2020	Post hoc analysis of RCT (Observ.)	Out-of-hospital, USA	Adult patients with nontraumatic out-of-hospital cardiac arrest.	NR	Intubation with bougie [n=440]	No bougie, unclear about stylet [n=787]
Driver ¹⁸ 2017	Observ.	ED, USA	Adult patients undergoing intubation in the ED.	VL (38.1%)/DL (61.9%)	Intubation with bougie [n=435]	Most likely stylet but not described [n=108]
Driver ⁴ 2018	RCT	ED, USA	Adult patients undergoing intubation in the ED.	VL (46%) /DL (54%)	Intubation with bougie [n=381]	Stylet [n=376]
Driver ¹⁹ 2021	RCT	ED-ICU, USA	Adult patients undergoing intubation in the ED or ICU.	VL (75.1%)/DL (24.9%)	Intubation with bougie [n=556]	Stylet [n=546]
Dutta ²³ 2020	RCT	OR, India	Adult patients undergoing elective surgery.	DL	Intubation with bougie [n = 140]	Stylet [n = 138]
Gataure ²⁴ 1996	RCT	OR, UK	Adult patients undergoing elective surgery and with laryngoscopy simulating a Cormack-Lehane III.	DL	Intubation with bougie [n=50]	Stylet [n=50]
Grant ²⁰ 2021	Observ.	ED, Australia	Patients undergoing rapid sequence intubation in the ED.	VL/DL*	Intubation with bougie [n=578]	Stylet [n=14]
Gupta ²⁵ 2020	RCT	OR, India	Adult patients undergoing elective surgery.	VL	Intubation with bougie [n=20]	Stylet [n=20]
Heegaard ¹⁶ 2003	RCT	Out-of-hospital, USA	Out-of-hospital intubations in patients aged ≥ 12 years.	NR [†]	Intubation with bougie [n=20]	No details on nonbougie devices [n=31]
Khan ²⁶ 2014	RCT	OR, Pakistan	Adult patients' elective surgery. Patients were put a cervical collar after sedation to simulate a difficult airway.	NR ¹	Intubation with bougie [n=28]	Stylet [n=28]

Table 1. Continued.

Study	Design	Setting, Country	Population	Device	Intervention [N]	Control [N]
Latimer ¹⁷ 2021	Observ.	Out-of-hospital, USA	Out-of-hospital intubations in adult patients (age ≥ 16 years).	DL	Intubation with bougie [n=771]	No details on nonbougie devices [n=823]
Nolan ²⁷ 1993	RCT	OR, UK	Adult patients (age ≥ 16 years) undergoing elective surgery. A difficult airway was simulated with manual cervical stabilization and cricoid pressure.	DL	Intubation with bougie [n=78]	No details on nonbougie devices [n=79]
Ponnusamy ²⁸ 2018	RCT	OR, India	Adult male patients undergoing elective surgery.	DL	Intubation with bougie [n=60]	Stylet [n=60]
Prekker ⁸ 2023	Post-hoc analysis of RCT (Observ.)	ED-ICU, USA	Critically ill adults (age ≥ 18 years) undergoing orotracheal intubation with the use of a laryngoscope.	VL (49.8%)/DL (50.2%)	Intubation with bougie [n=632]	Stylet [n=785]
Sut ²⁹ 2017	RCT	OR, Turkey	Adult patients undergoing elective intubations in whom a cervical collar was put to simulate difficult intubation.	DL	Intubation with bougie [n=45]	No details on non-bougie devices [n=45]

Observ., observational study; RCT, randomized controlled trial; OR, operation room; ED, emergency department; ED-ICU, emergency department, and intensive care unit; VL, video laryngoscopy; DL, direct laryngoscopy; NR, nonreported; USA, United States of America.
 *Did not report the % of DL vs VL.
 †Specific device not reported but most likely direct laryngoscopy.

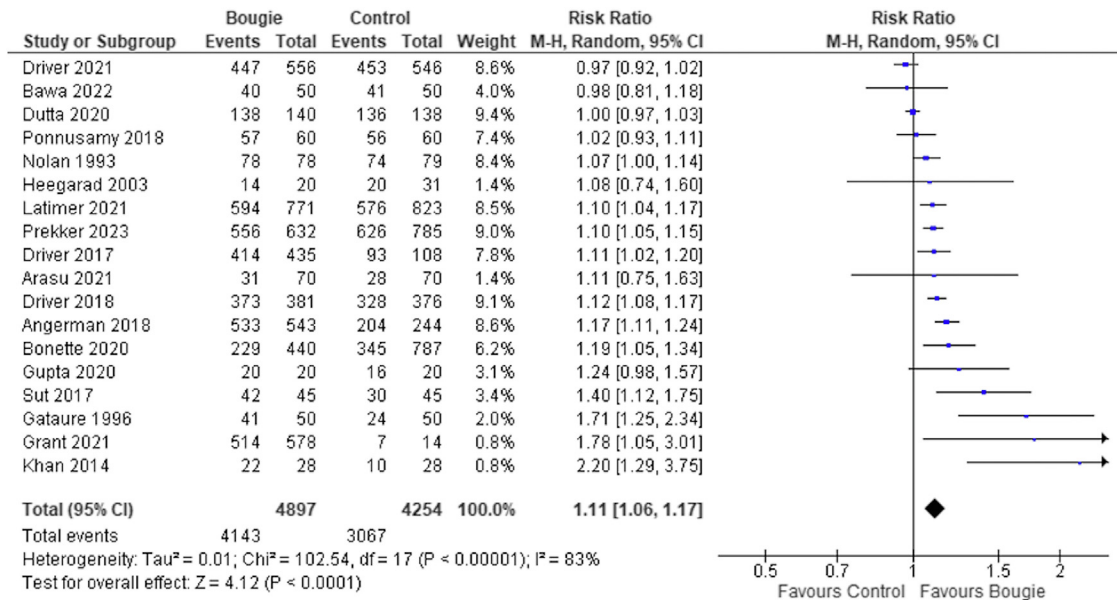


Figure 2. Forest plot of the meta-analysis for first-attempt intubation success, including all studies.

studies reported the outcome of postintubation arrest, and in both, rates were similar between groups (1.8% versus 1.8% in one study,¹⁹ and 1.1% versus 0.9% in the other¹⁷).

Intubation times had slightly different definitions across studies but were overall similar between groups being intubated with a bougie versus controls (means and

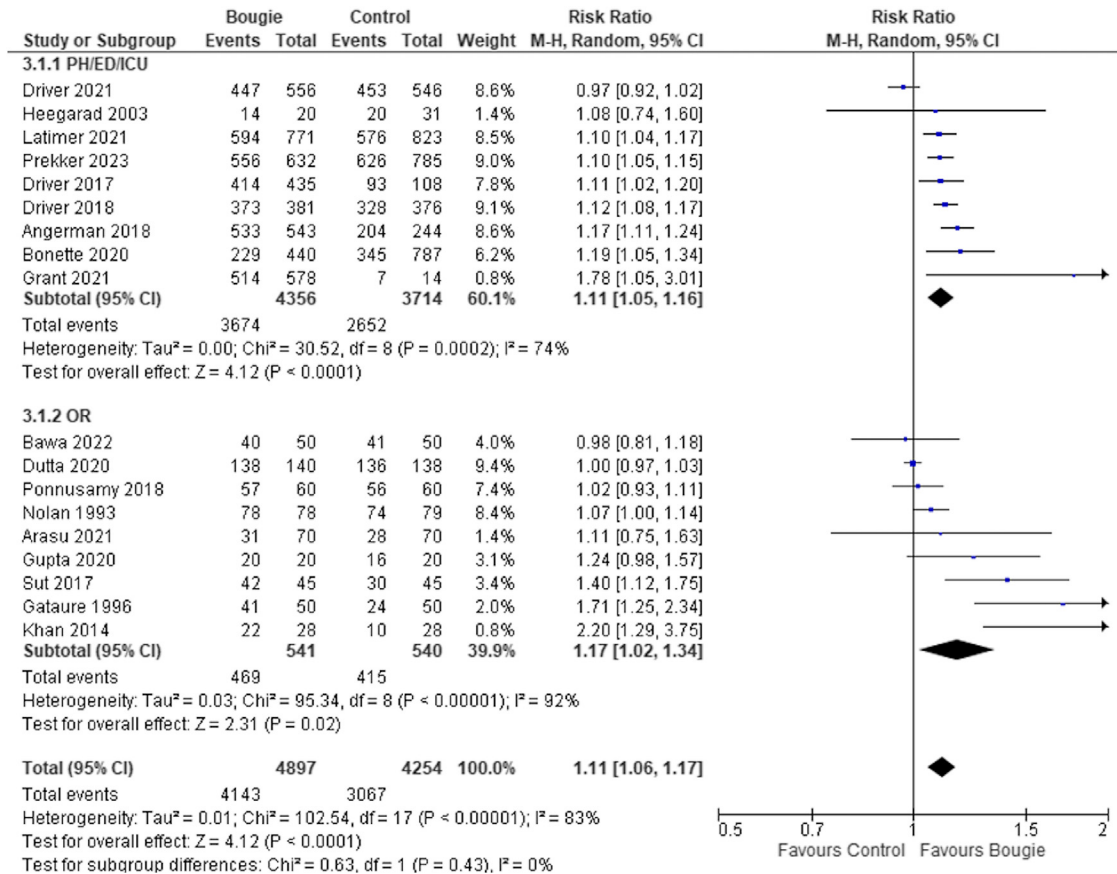


Figure 3. Forest plot of the meta-analysis for first-attempt intubation success stratified by study setting. ED, emergency department; ICU, intensive care unit; OR, operating room; PH, prehospital.

Table 2. Pooled effect estimates among subgroups.

	N of Studies	N of Patients	Risk ratio (RR)	95% CI	I ² %
Overall	18	9,151	1.11	1.06-1.17	83
Randomized trials	12	2,991	1.09	1.02-1.17	82
Observational	6	6,160	1.13	1.09-1.17	33
PH/ED/ICU	9	8,070	1.11	1.05-1.16	74
Operating room	9	1,081	1.17	1.02-1.34	92
High risk of bias	8	6,311	1.14	1.09-1.20	51
Some concerns/lower risk of bias	10	2,840	1.07	1.01-1.14	81
Direct laryngoscopy	10*	3,947	1.13	1.02-1.24	89
Video laryngoscopy	8*	3,807	1.10	1.04-1.17	73
Difficult airway [†]	9	1,540	1.34	1.15-1.55	86
Cormack-Lehane III-IV	5	585	1.60	1.40-1.84	0

PH, prehospital.

*The studies Driver 2021 and Prakker 2023 reported first-attempt intubation success proportions by those intubated with direct vs video laryngoscopy.^{8,19}

[†]This meta-analysis includes both studies that defined difficult airways as Cormack-Lehane III or IV and studies that defined difficult airways based on other criteria such as limited cervical mobilization.

medians ranged between 14.4 and 124 seconds in bougie groups and 15.1 and 112 seconds in the nonbougie groups). However, 9^{4,15,18,19,21-23,25,27} of 13 (69.2%) studies that reported this outcome had numerically longer intubation times in those intubated with a bougie. For ED-

based studies, the average maximum increase was 13 seconds (Table 3).

Although uncommon (1.8%), intubation-related injuries such as oral and airway trauma were more frequent among patients intubated with a bougie

Table 3. Intubation times in bougie and control groups across studies.

Study	Intubation Time (s)		Mean or Median Differences (95% CI*)(s)
	Bougie	Control	
	Mean (or Median) and Variance (SD, IQR or CI)	Mean (or Median) and Variance (SD, IQR or CI)	
Angerman 2018	NR	NR	-
Arasu 2021, median (IQR)	35.5 (30.2, 38.7)	30.4 (25.3, 37.8)	+5.1
Bawa 2022, mean (SD)	33.8 (20.5)	22.2 (6.7)	+11.6 (5.5, 17.6)
Bonnette 2020	NR	NR	-
Driver 2017, median (IQR)	40 (39, 42)	27 (25, 29)	+13
Driver 2018, median (IQR)	38 (29, 51)	36 (25, 54)	+2
Driver 2021, median (IQR)	124 (97, 180)	112 (85, 157)	+12
Dutta 2020, mean (SD)	26.6 (7.5)	27.7 (4.6)	-1.1 (-2.6, -0.4)
Gataure 1996, mean (SD)	14.4 (0.3)	15.1 (0.6)	-0.7 (-0.9, -0.5)
Grant 2021	NR	NR	-
Gupta 2020, mean (SD)	73.5 (7.3)	40.5 (12.8)	+33 (26.3, 39.7)
Heegaard 2003, mean (95% CI)	62 (16, 108)	62 (36, 86)	0
Khan 2014	NR	NR	-
Latimer 2021	NR	NR	-
Nolan 1993, median (range)	26 (15, 45)	20 (13, 95)	+6
Ponnusamy 2018	NR	NR	-
Prekker, 2023	NR	NR	-
Sut 2017, mean (SD)	36 (0.6)	41.0 (1.1)	-5 (-5.4, -4.6)

CI, confidence interval; IQR, interquartile range; NR, not reported; SD, standard deviation.

*95% CIs were only calculated for mean differences in studies with the necessary and available data (both means and standard deviations).

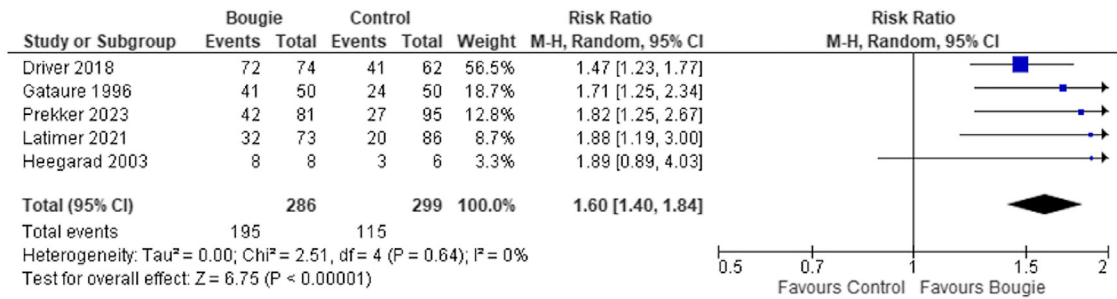


Figure 4. Forest plot of the meta-analysis for first-attempt intubation success for patients with Cormack-Lehane III or IV.

(6 studies, 3,576 patients, RR 1.55, 95% CI 1.00 to 2.39, I² = 0%). Only 2 ED-based studies reported this outcome, and there were relatively similar proportions between those intubated with a bougie and those without (Driver 2021¹⁹ [0/556, 0% in the bougie group versus 3/546, 0.5% in controls]; Driver 2018⁴ [10/381, 2.6% versus 6/376, 1.6%]). Among the 10 events in the bougie group, these included 7 lip lacerations, 2 iatrogenic bleeding from the oropharynx or perilaryngeal structures, and 1 dental trauma. There were no direct airway injuries related to bougie use. Finally, the incidence of esophageal intubations was not statistically different between groups (6 studies, 3,376 patients, RR 0.59, 95% CI 0.25 to 1.36, I² = 0%) (Appendix E5).

LIMITATIONS

The present study has several limitations. The major limitation relates to the quality of included studies. Although most included studies were randomized controlled trials, concerns for risk of bias were identified in all of them, leading to decreased certainty in the estimated effect. Secondly, a high level of statistical heterogeneity was observed in the meta-analysis, partly attributable to the BOUGIE trial. However, despite this heterogeneity, subgroup analyses consistently demonstrated a relative increase of approximately 10% in first-attempt intubation success when a bougie was used. Also, within the subgroup of patients with difficult airways, inconsistency was low. Thirdly, there was a lack of reporting on the level of experience of the intubator in using a bougie. Although some studies provided this information, most did not, preventing us from conducting a subgroup analysis to assess the effect of intubator experience on the efficacy of the bougie. Fourthly, most studies reported only first-attempt success proportions alone and not first-attempt success without clinically significant complications, so we cannot assume that because significant complications are not reported, these did not happen. Lastly, not all studies

provided first-attempt success proportions for each Cormack-Lehane grade in both the bougie and control groups. Nevertheless, by pooling data from those studies that reported it, we were able to generate meaningful insights into the relationship between bougie use and first-attempt success in patients with difficult airways.

DISCUSSION

This systematic review and meta-analysis demonstrated that using a bougie as an aid for intubation probably increases first-attempt success. There was no difference in the incidence of hypoxemia, postintubation arrest, and esophageal intubations. We found that intubation-related injuries may be more common in those intubated with a bougie, but there were no airway injuries related to its use in ED-based studies.

Our findings are somewhat different from previous systematic reviews that have evaluated this intervention. The systematic review by Sheu et al did not find an association between bougie use and increased first-attempt intubation success.³⁰ There are many reasons why their results are different. First, our literature search was more comprehensive, with more than 2,500 titles being screened in ours as compared to 370 in their review. Second, there were only 5 randomized controlled trials in their meta-analysis, including one study³¹ that used a hyper-angulated video laryngoscopy not compatible with a standard-shaped bougie, and it is likely the reason why their results were neutral in regards to the effect of the bougie use.³² The systematic review by Tollman et al did find an association between using a bougie and increased first-attempt intubation success, but only in the subgroup of patients being intubated with video laryngoscopy.³³ This meta-analysis did not perform a comprehensive literature search and included only out-of-hospital-based studies. Also, most included studies in their review were simulation-based, using manikins. Compared with these previous meta-analyses,^{30,33} our study has a more comprehensive literature search, uses GRADE for evaluating the certainty

of evidence, provides precise effect estimates across different subgroups, and includes mostly intubations outside of the operating room (8,070 of 9,151 [88.2%] analyzed patients across studies were intubated in the out-of-hospital, ED or ICU setting).

Although our study shows a consistent effect of bougie use in increasing first-attempt success, this outcome is not a patient-centered outcome and should be interpreted in the context of other outcomes like the incidence of severe complications, including hypoxemia, hemodynamic instability, and cardiac arrest. Only 2 studies^{4,8} reported the composite outcome of first-attempt success without severe complications, and those being intubated with a bougie had higher safe success than those intubated with a stylet. This finding is reassuring, and future studies may focus on first-attempt success without severe complications rather than first-attempt success alone. Although limited by relatively wide CIs for the pooled estimates, we did not observe a difference in the incidence of hypoxemia between those intubated with a bougie versus those without, even with most studies reporting prolonged intubation times with the bougie. The prolonged intubation time (maximum of 13 seconds more on average in ED-based studies) could be attributed to many factors, including lack of familiarity with the instrument and handling techniques (eg, rail-roaded versus preloaded).

There is much debate about using a bougie in the first attempt versus saving it for use when a difficult airway is identified during laryngoscopy (eg, Cormack-Lehane III or IV). Although there are no existing clinical trials comparing such strategies, evidence from our meta-analysis suggests that using a bougie in the first attempt likely increases success, and this effect seems to be larger among those with difficult airways. Given our limited ability to predict who will have a difficult airway beforehand,³⁴ it is reasonable to assume that a bougie-first strategy could optimize patient safety, especially in emergency intubations where there is limited preprocedural information and higher physiologic derangements.

Finally, although we did encounter a relatively high level of statistical heterogeneity, most studies had point estimates and CIs compatible with the use of a bougie being associated with higher first-attempt intubation success. One study, specifically the BOUGIE trial, partly explains the existing heterogeneity.¹⁹ This was a large multicenter randomized controlled trial that did not find a statistically significant difference in first-attempt success between critically ill adults being intubated with a bougie compared with those being intubated with a stylet. This study was very similar to the BEAM trial except for the fact that the

latter was done at a single center where intubators were highly trained at using the bougie.⁴ Even in patients with difficult airway characteristics, the BEAM trial achieved a very high first-attempt success (96%) using video laryngoscopy with a conventional Macintosh blade along with the bougie in the first attempt. Moreover, the BOUGIE trial was limited by the fact that bougie experience was limited in the following ways: 9/15 of the centers that participated in the trial rarely used a bougie on the first attempt before the trial; the median number of prior bougie uses for operators in the trial was just 10; and operators enrolled a median of one patient each during the trial (which means that if they did not use a bougie outside of the trial, the median operator just had one opportunity to either use the bougie or not use the bougie before they went back to their normal practice). This limitation in bougie experience could explain the difference in the effect estimate between the BOUGIE trial and our meta-analysis. Unfortunately, most included studies in our systematic review provided little to no data regarding bougie-specific expertise, which precluded our ability to perform subgroup analysis by proceduralist level of training in using the bougie. It is important to consider that an operator's training and experience in performing tracheal intubation, either overall or with a specific device, may significantly influence the likelihood of achieving first-attempt success. The use of the bougie may provide less benefit for patients who show no signs of a difficult airway. However, if the instrument is only used in difficult cases, the associated learning curve may be steeper.

In summary, the bougie as an aid in the first intubation attempt was associated with increased success. These data suggest that bougie should probably be used first and not as a rescue device. Despite the certainty of evidence being low, the bougie seems to be an important adjunct for emergency airway management.

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