



Review

The Evolution of Laryngoscopy in Airway Management and Tracheal Intubation

Daniele Salvatore Paternò ¹, Luigi La Via ^{2,*}, Emilia Concetta Lo Giudice ³ and Massimiliano Sorbello ^{1,3}

¹ Department of Anesthesia and Intensive Care, “Giovanni Paolo II” Hospital, 97100 Ragusa, Italy; danielesalvatore.paterno@asp.rg.it (D.S.P.); massimiliano.sorbello@unikore.it (M.S.)

² Department of General Surgery and Medical Surgical Specialties, University of Catania, 95100 Catania, Italy

³ School of Anesthesia and Intensive Care, “Kore” University, 94100 Enna, Italy; emilia.logiudice@unikore.it

* Correspondence: luigilavia7@gmail.com

Abstract

The work of anesthesiologists–intensivists, critical care specialists, and medical emergency teams is multifaceted and complex, with airway management representing a cornerstone and a common denominator of many procedures and interventions. Tracheal intubation has represented and still represents today the gold standard for airway control. This narrative review, conducted through a comprehensive search of PubMed/MEDLINE, EMBASE, and the Cochrane Library from database inception to December 2025 and supplemented by manual reference searches and retrieval of key historical sources, aims to trace the evolution of laryngoscopy for airway management and tracheal intubation—from its nineteenth-century origins to the current state of the art—while simultaneously addressing the clinical, educational, and safety implications of this evolution. Laryngoscopy evolution progressed in parallel with technological development and innovation, resulting in the expansion of clinical possibilities and in the improvement of patient safety. The evolution of laryngoscopy essentially took place between the late 1800s and the first half of the 1900s, culminating in the widespread adoption of the Macintosh laryngoscope. Almost 50 years later, a pivotal turning point occurred around the 2000s with the introduction of videolaryngoscopes. Along this path, the devices that succeeded one another introduced new problems, driving the search for new solutions. At present, tracheal intubation with videolaryngoscopy has achieved success and safety standards substantially superior to those of the early days of the technique. In this review we retrace the historical milestones of laryngoscopy, analyze the problems that emerged over time with various devices and the solutions adopted, examine the evolution of videolaryngoscopes and the impact of these devices on both technical and non-technical skills, discuss the ongoing debate surrounding their routine use (universal videolaryngoscopy) and the selection of optimal adjunct devices, and outline the emerging role of artificial intelligence in improving success rates and facilitating the learning curve. This journey, after 150 years of evolution, has reached a high level of maturity in terms of safety and efficacy.

Keywords: laryngoscopy; videolaryngoscopy; tracheal intubation; airway management; difficult airway; artificial intelligence; non-technical skills



Academic Editor: Agnieszka
Szczepiek

Received: 29 March 2026

Revised: 30 June 2026

Accepted: 1 July 2026

Published: 6 July 2026

Copyright: © 2026 by the authors.

Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the [Creative Commons Attribution \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) license.

1. Introduction

Airway management, and tracheal intubation in particular, represents one of the most critical competencies in anesthesiology, intensive care medicine, and emergency medicine.

Securing a patent and protected airway is the cornerstone of perioperative and critical care practice, and failure to do so in a timely and safe manner is associated with potentially catastrophic consequences, including hypoxic brain injury, cardiac arrest, and death. Over the past century and a half, the tools and techniques employed to achieve tracheal intubation have undergone a remarkable transformation, driven by parallel advances in optics, materials science, electronics, and digital technology.

From the rudimentary mirror-based instruments of the mid-nineteenth century to battery-powered direct laryngoscopes in the early twentieth century, and ultimately to modern high-definition videolaryngoscopes capable of projecting real-time glottic images onto integrated or remote screens, each technological generation has redefined what is possible at the bedside. The Macintosh curved laryngoscope, introduced in the early 1940s, defined the standard of care for nearly six decades. The advent of the first commercial videolaryngoscope in the early 2000s initiated a paradigm shift that is still unfolding, fundamentally altering not only the mechanics of intubation but also the conceptual framework within which difficulty is defined, predicted, and managed. The COVID-19 pandemic further accelerated the worldwide adoption of videolaryngoscopy, and the subsequent accumulation of high-quality evidence has prompted growing consensus around the concept of universal videolaryngoscopy.

Despite the existence of several systematic reviews and meta-analyses comparing videolaryngoscopy with direct laryngoscopy in specific clinical settings, no single synthesis has traced the evolution of laryngoscopy for airway management and tracheal intubation—from its historical roots through the conceptual and technical revolution introduced by videolaryngoscopes—while simultaneously addressing the associated changes in learning curves, non-technical skills, adjunct device selection, human factors, and the emerging application of artificial intelligence. Most existing reviews address comparative effectiveness in narrowly defined populations or clinical environments and as a result do not engage with the broader conceptual, educational, and systemic safety implications that have accompanied technological progress. Furthermore, several pivotal randomized trials, systematic reviews, and international guidelines have been published since the most recent comprehensive overviews, warranting an updated and integrated synthesis.

The present narrative review is therefore intended to fill this gap. Specifically, this review aims to: (i) retrace the key historical milestones in laryngoscopic technique and device development; (ii) analyze the conceptual and technical transition from direct to videolaryngoscopy and its implications for clinical practice and teaching; (iii) examine the evidence and ongoing debate regarding the optimal adjunct device for use with videolaryngoscopes; (iv) discuss the role of non-technical skills and human factors within the framework of modern airway management; and (v) outline the emerging potential of artificial intelligence as a future direction in this field. In doing so, this review offers an integrated perspective on laryngoscopy for airway management and tracheal intubation that encompasses historical, technical, clinical, and educational dimensions—a synthesis that, to our knowledge, has not previously been provided in this form and that is particularly timely given the current transition toward universal videolaryngoscopy and the accelerating pace of innovation in airway technology.

2. Materials and Methods

2.1. Study Design

This is a narrative review conducted and reported in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA). The narrative review format was selected as the most appropriate methodology for the broad historical, conceptual, and tech-

nical scope of the present work, which spans both historical scholarship and contemporary clinical evidence across multiple domains of airway management.

2.2. Literature Search Strategy

A comprehensive literature search was conducted across three major electronic databases—PubMed/MEDLINE, EMBASE, and the Cochrane Library—from database inception to December 2025. The following search terms were employed individually and in combination using Boolean operators (AND, OR, NOT): laryngoscopy, direct laryngoscopy, videolaryngoscopy, video laryngoscopy, tracheal intubation, endotracheal intubation, airway management, difficult airway, videolaryngoscope, GlideScope, C-MAC, McGrath, hyperangulated blade, Macintosh laryngoscope, Miller blade, gum elastic bougie, tracheal introducer, stylet, fiberoptic bronchoscope, flexible bronchoscope, awake intubation, awake tracheal intubation, learning curve, non-technical skills, human factors, simulation, artificial intelligence, machine learning, deep learning, universal videolaryngoscopy, first-pass success, intubation success rate, history of laryngoscopy, physiologically difficult airway, neuromuscular blockade intubation. In addition, the reference lists of all included articles and of relevant systematic reviews, meta-analyses, and international guidelines were manually screened to identify additional eligible sources not captured by the electronic search. Given the historical scope of the review, key primary historical sources and monographs not indexed in contemporary electronic databases were retrieved through library archives and cited secondary sources.

2.3. Inclusion and Exclusion Criteria

Publications were considered eligible for inclusion if they: (i) were written in English or had a published English translation; (ii) reported on any aspect relevant to the scope of this review, including laryngoscope design and historical development, technique, comparative clinical effectiveness, learning curve, non-technical skills, human factors, simulation training, adjunct devices, or artificial intelligence applications in airway management; (iii) belonged to any of the following publication types: randomized controlled trials, observational studies, case series with generalizable findings, systematic reviews, meta-analyses, narrative reviews, consensus statements, international guidelines, or historical accounts. Publications were excluded if they were: (i) conference abstracts without an associated full-text publication; (ii) individual case reports with no generalizable data; (iii) publications not pertaining to laryngoscopy, videolaryngoscopy, or airway management. No restriction was applied to study population, clinical setting, or study design, given the broad and inclusive scope of this narrative review.

2.4. Study Selection and Data Synthesis

Two authors (D.S.P. and L.L.V.) independently screened titles and abstracts of all retrieved records for relevance to the review objectives. Full texts of potentially eligible publications were subsequently reviewed by the same authors, with discrepancies resolved by discussion and consensus involving the senior author (M.S.). Given the narrative format of this review, a formal quantitative data synthesis was not performed. Findings are instead presented thematically, organized according to the chronological and conceptual evolution of the field. Priority was given to the highest available level of evidence—randomized controlled trials, systematic reviews, and meta-analyses—for topics in which such evidence exists; historical sources, expert opinion, and lower levels of evidence were incorporated where higher-level evidence is unavailable, inappropriate, or insufficient to address the question.

3. The Evolution of Techniques to Visualize the Larynx

In 1743, André Levret, a pioneer in Medicine and a French obstetrician, used a reflecting spatula (essentially a vaginal speculum) illuminating the nasal cavities with a candle to remove intracavitary polyps [1]. In 1807, Philip von Bozzini developed a speculum consisting of two metal tubes equipped with mirrors (the *Lichtleiter*), used to reflect light (from the sun or a candle) to visualize the internal cavities of the body, including the upper airway [2]. Benjamin Guy Babbington presented his “Glottiscope” in 1829, once again using a speculum as a tongue depressor illuminated by sunlight or candlelight. Babbington never formally published a scientific paper on his device [3], and it appears that the term “laryngoscope” was used for the first time not by Dr. Babbington himself but by a colleague, Dr. Hodgkin, better known for the description of the lymphoma that bears his name [4]. Years later, in 1855, Manuel Garcia (a singer and also an anatomy teacher) used a double-mirror system, which reflected sunlight or candlelight, to perform the first indirect laryngoscopy in history, describing the vocal cords, the mechanism of breathing, and the genesis of the voice [5]. The first clinical uses of laryngoscopes are attributed to physicians Ludwig Türck (Vienna) and Johann Nepomuk Czermak—a Bohemian-born (Prague) physiologist who held the chair of physiology at Pest (Budapest), within the Habsburg later Austro-Hungarian realm. Both doctors described the first clinical applications of laryngoscopy in 1857, both receiving recognition from the French Academy of Sciences, in an academic *ex aequo* that was anything but peaceful and was fought out through a flurry of scientific articles [6,7]. Sir William Macewen, a Scottish surgeon, has been credited with performing the first elective and prolonged intubation (36 h) on 5 July 1878 [8,9], thus defining the so-called “endotracheal anesthesia” [10]. A few years later, in 1895, Alfred Kirstein codified the use of laryngoscopy in Germany, inventing his “autoscope” (an esophagoscope combined with an electroscope) [11] consisting of a spatula reflecting external light (later replaced by an independent external light source) and combining its use for tracheal intubation [12]. Building on Kirstein’s direct technique, the German laryngologist Gustav Killian—widely regarded as the father of bronchoscopy—introduced suspension laryngoscopy and an inverted-V (anterior-commissure) blade, advances aimed primarily at diagnostic and operative endolaryngeal practice that remain foundational to contemporary laryngology [10,12]. Chevalier Jackson, an otolaryngology surgeon and Professor of Laryngology at Jefferson Medical College in Philadelphia, in 1913 modified a suspension laryngoscope (creating a tubular “U”-shaped instrument with a blade and handle) [13] using it first with a light source on the operator’s head and then distal to the instrument, which featured a sliding system at the base, thus creating space for an endotracheal tube [14] or a rigid bronchoscopic optic [15]. In the same year, the American anesthetist Henry Janeway at Bellevue Hospital in New York created a laryngoscope equipped with a battery-powered light source located inside the instrument handle. Additionally, he created an anchoring system on the blade, which he designed slightly curved to facilitate laryngoscopy, defining, without proper credit, the foundations of modern laryngoscopy and general anesthesia with endotracheal intubation with the first landmark article [16]. After Janeway’s laryngoscope, numerous modifications followed until 1941, when Robert Miller, an American physician, designed a blade with a semicircular flange and straight blade, whose use facilitated visualization of the aditus ad laryngem during the laryngoscopic maneuver, but with two important limitations. The first was represented by potential trauma to the dental arch, and the second was the laryngeal view being obscured by the passage of the tube inside the semicircular channel of the flange. The second problem was partially solved in collaboration with Sir Robert Macintosh, an English physician who modified a urethral dilator (bougie) into a guide that passed inside the Miller blade flange without obscuring the glottic view, over which the tube could subsequently slide (under partial vision) [17]. Sir Ivan Whiteside

Magill developed an evolution of Jackson's laryngoscope in 1931, incorporating batteries into the handle and articulating a folding blade [18], in a (new) dispute with Rowbotham for primacy of invention, not only of the laryngoscope but also of Magill forceps, which apparently were originally developed by Rowbotham himself [19]. The true innovation proposed by Sir Macintosh was to redesign a blade with continuous curvature, from articulation with the handle to the distal end, which allowed maintaining excellent approach to laryngeal visualization in a more protective manner for dentition [20] and above all to define and codify the technique of use [21]. Miller's blade ("straight") [22] is still used today, especially in the neonatal population, while Macintosh's curved blade accompanied generations of anesthetists until the early twenty-first century. In the 60 years of Macintosh blade use, apart from variously successful "variations on the theme", such as the articulated segmented blade ("flexiblade"), the Macintosh blade with articulated tip ("McCoy") [23], the only significant innovation was probably represented by the development, by Dr. Paul Venn, of the first tracheal introducer with "coudé" tip, launched on the market in 1973 and since then universally defined as "gum elastic bougie" (in honor of the first "straight" bougie developed by Macintosh) [24–26]. Parallel to the evolution of the laryngoscope, the introduction of new batteries and especially optical fibers allowed improvement of the laryngoscopes' illumination systems, and in 1967, Shigeto Ikeda of Asahi Pentax Corporation developed a prototype fiberoptic bronchoscope [27,28], which allowed bringing the human eye to the bronchial branches, opening new perspectives for tracheal intubation with a fiberoptic bronchoscope (described by Calder and Murphy in 1967) [29,30], even in the "awake" patient in spontaneous breathing [31]. The last true innovations in laryngoscopy came in the 1990s, with "hybrids" between rigid and articulated laryngoscopes (Bullard scope [32], Wu-scope [33], and UpsherScope [34]) and with Berci's intuition (in 1988 Berci coupled a video system to a Macintosh laryngoscope [35]) that formally initiated the videolaryngoscope "revolution" at the turn of 2000. Weiss in 1998 [36] coupled optical fibers to a standard laryngoscope, while Berci and Kaplan, in the same year, published a report of a Macintosh laryngoscope mounting a CCD video camera system. In 2001, American surgeon John Pacey, together with Canadian anesthetist Richard Cooper, developed the Glidescope[®], the first true videolaryngoscope in history, with a hyperangulated blade and video system at the blade tip [37]. From 2000 onwards, a large number of videolaryngoscopes have appeared with the most diverse characteristics: from single-use to reusable models, devices with reusable handle/screen and disposable blade/blade cover, Macintosh-like blades and models with hyperangulated blade with proprietary curvature, devices with the possibility of oxygen supplementation and videolaryngoscopes equipped with a channel or semi-guide for tube direction, models dedicated to nasal intubation and models for use with double-lumen tubes. Regardless of specific characteristics, however, the videolaryngoscope revolution has implied a series of technical and non-technical changes, summarized in Table 1.

The recent COVID-19 pandemic then represented an important push in the evolution and diffusion of videolaryngoscopes: the observation that a videolaryngoscope allowed for the doubling of the distance from the patient's airway, a source of viral infection, from about 17 to about 35 cm [38] and the awareness that the external video allowed for better vision through personal protective equipment, as well as its sharing with the team [39], meant that the pandemic indirectly promoted the diffusion of videolaryngoscopes, whose number strongly increased, comparing pre- and post-pandemic censuses [40].

What is certain is that within two decades, with a pandemic that favored and promoted the diffusion of these instruments, the approach to laryngoscopy and intubation has radically changed. After almost one hundred years of searching for line of sight, the new millennium has seen us return to Manuel Garcia's indirect laryngoscopy, replacing mirrors

and candles with video cameras and LEDs, leading us to “see (better) around the corner” (look around the corner) and shifting the center of gravity of difficulty to the passage of the tube between the vocal cords of a very well-visualized larynx.

Table 1. Comparison of traditional laryngoscopy and videolaryngoscopy.

Traditional Laryngoscopy	Videolaryngoscopy
Alignment of axes—line of sight	Non-alignment of axes—look around the corner
Laryngoscopic vision limited by line of sight	Better laryngoscopic vision
Vision = intubation	Vision does not necessarily = intubation
Mechanical articulation of the blade	No articulated mechanical parts
Different types of blades and sizes	Different types of blades and sizes
Less illumination	Better illumination
Tunneled vision	Vision on incorporated and/or separate screen
Individual operator–patient relationship	Shared patient–team vision
Need for double tube position check	Better/immediate tube position check
Indirect teaching (operator feedback)	Direct teaching (shared vision)
Eye–hand–tube coordination	Eye–screen–hand–tube coordination
3D vision	2D vision
Obligatory position	Better intubation ergonomics
Defined learning curve	Learning curve under definition

4. The Airway Around the Corner

Videolaryngoscopy has represented not only a technological but also a cultural evolution: by redefining airway visualization and facilitating it, it has determined the following:

- Reassessment of the concept and predictive parameters of difficulty: While maintaining mouth opening (interincisor distance [41]), macroglossia, rigidity of neck structures post-radiation or post-surgery, classical predictive parameters of difficulty such as atlo-occipital extension, thyromental distance or mento-hyoid distance have taken on a different meaning with videolaryngoscopes, since the alignment of oral, pharyngeal, and tracheal axes is no longer the mechanism underlying visualization. There are not many studies that have analyzed predictive parameters of “pure” videolaryngoscopic difficulty, but certainly several have identified the institution and experience in use as an important predictive factor for intubation success with videolaryngoscope [42–44].
- Definition of two learning curves, that of the naïve user (who starts from videolaryngoscopy) and that of the Macintosh user, who has to “forget” the direct laryngoscopy technique to learn the new videolaryngoscopy technique. The classic work by Mulcaster [45] identified 47 as the number of laryngoscopy attempts with a Macintosh laryngoscope as a cutoff for the optimal learning of the technique. Similarly, another work by the Italian group of Cortellazzi [46] identified 76 as the number of attempts with videolaryngoscope to achieve the same objective. This difference certainly reflected the era in which the study was carried out (early phases of videolaryngoscope diffusion), thus less background and the need for a shift from the concept of line of sight to that of look around the corner. More recent studies, in an era where universal videolaryngoscopy is now discussed [47], indicate that the number of attempts to acquire skills with the hyperangulated blade videolaryngoscope in subjects already familiar with airway management drops to 12 [48].
- Facilitation of teaching: Classical laryngoscopy required direct feedback from the user, who in the early phases of the learning curve certainly might not be able to

correctly report the difficulty, often determining the need for the trainer to intervene directly, sometimes intervening directly on laryngoscopy and intubation. Certainly videolaryngoscopy, considering the possibility of sharing vision (or limiting it to only the teacher, who observes the screen while the student uses the Macintosh blade in direct vision) represents an enormous possibility in teaching terms, so much so that recent meta-analyses indicate videolaryngoscopes as the preferential teaching instrument [49]. The topic is not exempt from debate, with supporters of classical laryngoscopy focused on the need, imposed by the “old technique,” to better know anatomy, structures, and the physiology of intubation [50]. Probably the combined approach (user on laryngoscope and teacher on screen) also fills this teaching gap.

- Facilitation of evolution toward teamwork and valorization of non-technical skills: The possibility of transforming laryngoscopy from a 1:1 relationship between the operator and the patient to team visualization implies an important series of advantages that reverberate both on airway control success and on patient safety [51]. Shared vision of the moment of laryngoscopy and intubation allows for targeted help from the assistant, sharing observation of anatomy and any pathological findings, choice of tube size, and shared verification (or doubt) of correct endotracheal tube positioning (so much so that recent PUMA guidelines indicate the videolaryngoscope as the second instrument after capnography for verification of correct tracheal intubation) [52]. In a sense, the videolaryngoscope acts as a nudge, a gentle push toward sharing and teamwork, coordinating team actions and, ultimately, improving patient safety.

The true revolution associated with videolaryngoscope use, however, was realizing, accepting, and consequently finding a new technique that allowed one to direct the tube between the vocal cords moving along a line no longer straight but characterized by at least two curves (Figure 1).

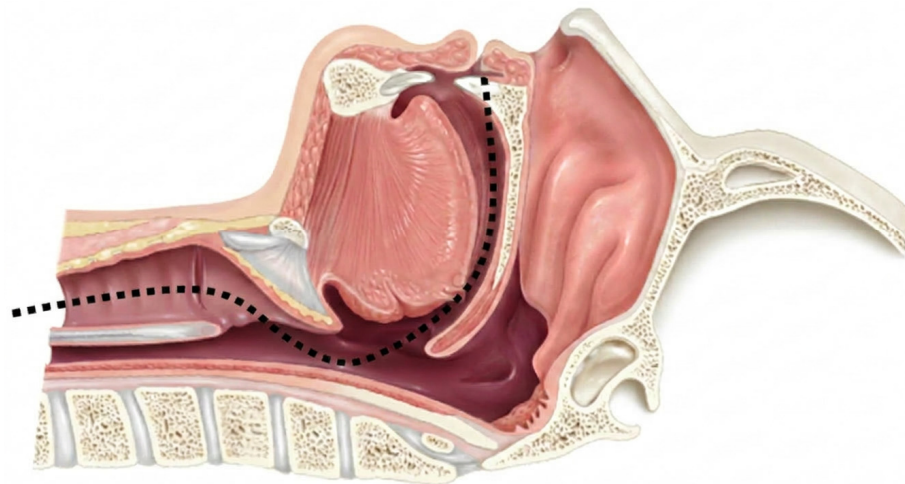


Figure 1. The curvature of oral, pharyngeal, and tracheal axes during videolaryngoscopy. Original schematic created by the authors.

The result of this situation, especially in the initial phases of videolaryngoscope use, was the materialization of a paradoxical situation in which, faced with excellent (and superior to Macintosh) laryngoscopic vision, intubation could be difficult or unsuccessful due to impossibility of directing the tube between the vocal cords, especially when using a hyperangulated blade. Although not intuitive, the explanation was very simple: in the transition from Macintosh, which by aligning the axes defined a linear and straight path for the tube (whose movement was further directly coordinated by the operator’s gaze), the intubating world had to move to a situation in which the tube had to undergo a series of curves, with the further complexity related to the fact that this passage occurred by

coordinating the movement of the tube and the operator's hands through the screen. This may explain the initial increase in the steepness of the learning curve, a series of failures, and above all why the use of the hyperangulated blade videolaryngoscope requires the use of an adjunct, such as a malleable preformable stylet, a preformed rigid one (choice of various production companies), a tracheal introducer, or a stylet or introducer with articulated tip. Alongside these devices, further technical elements consist of choosing a smaller blade size, so as to move the fulcrum point back and gain space and depth of field in the hypopharynx [53]; again using smaller diameter tubes (possibly to be changed subsequently on a tube exchanger guide); and reducing (video) laryngoscopic traction at the moment of passing the tube between the vocal cords, so as to reduce the angle that forms between the hypopharynx and the tracheal axis (Figure 1). Interestingly, the existence of these difficulties during the Macintosh–videolaryngoscopy transition phase, together with the fact that many studies were case series or manikin studies, determined an interesting phenomenon from a scientific point of view. A first systematic review on the use of videolaryngoscopes published by the English group of Lewis in 2017 discouraged, in some way, the use of videolaryngoscopes. The results, especially on first-pass success, intubation time, desaturation episodes, and esophageal intubation, were not as positive [54] as one might have expected based on the laryngoscopic visions that videolaryngoscopes had by then accustomed anesthetists to. Similarly, a large study published in JAMA by the French group from Montpellier on intensive care patients [55] presented really poor results for videolaryngoscopes, with greatly lengthened intubation times that, intuitively, resulted in a greater number of complications in fragile ICU patients (the so-called “physiologically difficult airway”) [56]. However, the French study can give us the right reading key for what we know today. The physicians enrolled in the study were in large part physicians in training, half of which were not even anesthesiologist–intensivists: once again, experience and videolaryngoscopes travel closely side by side and explain the limited results. When in fact in 2022, Hansel's group (which included Lewis himself) published a second systematic/Cochrane review [57], after years of routine use and experience with videolaryngoscopes, and especially after a pandemic that had favored their widespread diffusion, the results were reversed, with consistent superiority of videolaryngoscopes across all endpoints, from intubation success to the time to obtain it to desaturation episodes and complications, including unrecognized esophageal intubation. After Hansel's study, the results were further confirmed by other important publications. In intensive care, where we find the most fragile patients with physiologically difficult airway (that is, where the anatomical factor may be normal, or that, even if altered, becomes secondary to reduced apnea tolerance, hemodynamic instability, absence of reflexes, and the many problems of the critical patient) [58], the INTUBE study [59] and in particular the sub-analysis on videolaryngoscopy [60] highlighted the superiority of these devices. And again, Prekker's study in the *New England Journal of Medicine* [61], reversing Lascarroux's results, established the use of videolaryngoscopes in intensive care. Further systematic reviews have definitively sanctioned the superiority of videolaryngoscopy both in the operating room [62] and outside it [63], determining the maturity of the airway manager community for the switch toward universal videolaryngoscopy [64].

5. The Best Adjunct

Having clarified the differences in technique and approach and consolidated the learning and training path for videolaryngoscope use, the literature debate today is focused on the search for the best adjunct device for videolaryngoscopy. Originally, various manufacturers supplied the videolaryngoscope with a dedicated rigid stylet, with curvature that generally reflected the shape of the videolaryngoscope's blade. Alongside this technique,

various users resorted to using a soft, malleable stylet, which they shaped according to the laryngoscopic view or again with 90-degree hockey-stick type distal curvature. Some manufacturers also presented stylets with articulated distal tip, hypothesizing that this function could contribute to an increase in intubation success [65]. More recently, the bougie, or tracheal introducer, has experienced renewed interest. Born in 1973 with the idea that the coudé tip could facilitate intubation by approaching difficult laryngoscopic views (Cormack–Lehane 2, 2e, and 3), the original introducer has undergone various evolutions, especially in the transition from reusable to disposable. Today there are many introducers on the market, but the ones better performing with a videolaryngoscope seem to be those made out of polyethylene (with different density variables), as this material allows for a certain shape memory, unlike Teflon, PVC, and other material blends. The main advantage of the introducer, in itself, is represented by greater length and smaller diameter when compared with an endotracheal tube [66], which allows for the separation of the negotiation of the passage of the introducer (small diameter) between the vocal cords from the tube (larger diameter), as shown in Figure 2.

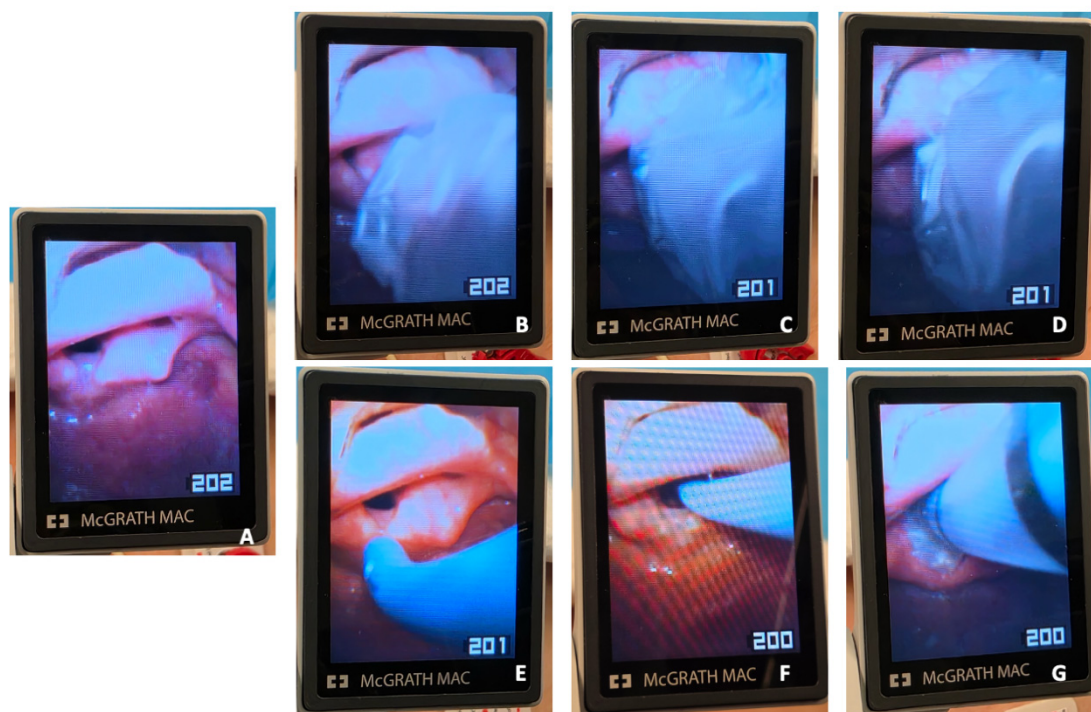


Figure 2. Videolaryngoscopy without (B–D) and with (E–G) tracheal introducer. Starting from the same videolaryngoscopic exposure (A), use of a styletted tracheal tube results in partial/complete obscuration of laryngeal view inlet (B,C), including the moment of tube passage between vocal cords (D). When a tracheal introducer is used, better laryngeal exposure may be obtained (the introducer in correct position lifts the epiglottis (E,F)), and tube passage between vocal cords results clearer (G). Intraoperative laryngoscopic images obtained by the authors; written informed consent for publication was obtained from the patient(s), and the images contain no identifiable features.

Various studies have analyzed the comparison between the two techniques, with two meaningful and paradigmatic papers by the American group of Brian Driver. The first paper, designed as a single-center study, compared stylet vs. introducer on first-pass success with (video-)laryngoscope in the emergency department [67], whereas the second one, designed as multicentric, explored the same endpoint but in an intensive care unit [68]. While the emergency department study demonstrated clear superiority of the introducer over the stylet (96% vs. 82%), the results of the multicentric intensive care study failed to

reach the same figures (80.4% vs. 83%). Excluding any difference between resuscitation and emergency department patients in anatomical terms, the only explanation lies, once again, in users' expertise. The first study, single-center, was conducted by a group of users experienced with videolaryngoscope and introducer, unlike the second, multicenter, where various degrees of competence and expertise probably produced greater result variability. In expert hands, and according to logic criteria, the introducer should be superior to the stylet, as, not by chance, today the videolaryngoscope–introducer association is recommended from the first attempt on a patient with anatomically and/or physiologically predicted difficult airway [69,70]. The question, however, is far from finding definitive solutions. The real problem remains that the introducer, like the Macintosh laryngoscope, was designed to operate and favor the linear approach of the search for a line of sight, while hyperangulated blade videolaryngoscopes kept in place anatomical curves and angles. Tout court, application of a bougie to a videolaryngoscope means applying a linear solution to a curved problem, which is probably the reason behind the active debate including dynamic bougies, articulated introducers, and studies on different forms and approaches to maximize intubation success [71–74].

6. Videolaryngoscopes, Strategy, and Human Factor

Analyses of the Danish Anesthesia Database [75], data from the National Audit Project 4 (an extensive one-year audit conducted in England by RCOA and AAGBI) [76], medico-legal UK sources [77], and American Closed Claims Projects [78] unanimously suggest that the so-called human factor plays a pivotal role in airway-related accident occurrence. The absence of strategy and planning, lack of adequate and assertive communication, and stress-associated physiological effect of cognitive biases, especially in emergency, represent in fact the common denominator of all documented incidents [79]. Recent guidelines for airway management [80], the PUMA project (Project for Universal Management of Airways—www.universalairway.org) [81] and human factor-oriented research emphasize the importance of non-technical skills, simulation, checklists, cognitive aids and teamwork as the key for a successful approach to improving airway management safety and success [82,83].

Videolaryngoscopes in this context may be a double-edged sword. On one hand they exhibit a manifold role as the best tool to maximize intubation first-pass success, an effective and powerful teaching method [84] and last but not least a natural facilitator of team interaction during airway management. These features clearly allow for a significant potential to reduce airway-related accidents. On the other hand, videolaryngoscopes, making intubation somehow easier and within reach of less experienced personnel, may induce evaluation errors and lead to no-way-back choices (such as neuromuscular blocking agent administration), where the preponderant patient's difficulty is ventilation and oxygenation. Prediction, to be performed in a context-sensitive manner [85], remains of cornerstone importance as a tool to establish choices and strategies. When correctly located in the frame of a strategy, videolaryngoscopes are natural providers of team intubation, improving success and reducing cognitive biases; they are not a panacea, given that they cannot provide oxygen in an anesthetized patient [86,87]. There are conditions and patients in which choices for airway control may be different from tracheal intubation, even with a videolaryngoscope. The old question “will my patient be difficult to intubate?” should be modernly turned into awareness (“I must define the strategy to manage this patient's airway”) carrying a new question: “can I suppress the patient's spontaneous breathing?”. Any guideline proposing an a priori harsh separation between predicted and unpredicted difficulty [88] probably remains outdated, and oxygenation and oxygenability should remain the only priorities [89]. Should the decision be for anesthetized intubation, administration of neuromuscular blockers becomes a consequential and unavoidable step

of the strategy [90]. Conversely, if the only available plan B is maintaining spontaneous breathing, the choice of device (laryngoscopy, videolaryngoscopy, flexible bronchoscope, tracheotomy/cricothyrotomy under local anesthesia, or ECMO cannulation) [91] becomes secondary to the choice of maintaining the patient's spontaneous respiratory activity and airway muscular tone. Awake intubation with a videolaryngoscope, where possible and indicated, is equally performing in terms of success if compared with the gold standard of flexible bronchoscopy, with greater executor compliance and less patient discomfort, with overlapping times and success percentages [92–94]. Probably, awake videolaryngoscopy represents a more familiar technique when compared with the flexible bronchoscope intubation for most anesthetists, and it may have contributed to the growing diffusion of the awake tracheal intubation idea, with the indirect result of improving patient safety [95].

7. Conclusions

Although this review is written primarily from an anesthesia and critical care standpoint, laryngoscopy is a domain shared with otorhinolaryngology, and its history is in large part a laryngological one: Garcia, Czermak, Türck, Kirstein, Killian and Chevalier Jackson were singers, physiologists and laryngologists before the discipline of anesthesia matured, and the suspension and anterior-commissure techniques they devised remain foundational to operative endolaryngeal surgery. Several of the developments discussed here also bear directly on contemporary ENT practice. The conceptual shift from “line of sight” to “looking around the corner” parallels the routine use of flexible transnasal laryngoscopy in the office and operating room, and the same camera-and-screen ergonomics that transformed tracheal intubation now underpin shared visualization during microlaryngoscopy and head-and-neck procedures. The shared airway of head-and-neck and laryngeal surgery makes the anesthetist–otorhinolaryngologist team a paradigm of the non-technical skills emphasized above, while awake videolaryngoscopy and oxygenation strategies developed for the physiologically difficult airway are increasingly relevant to airway management in patients with laryngeal and pharyngeal pathology [87,91–95]. We therefore hope this synthesis is read not only as an anesthetic narrative but as an account of a technology and a culture that the laryngological and airway communities continue to shape together.

Difficult laryngoscopy is now probably rarer, and certainly many of those “classically” predictive factors for laryngoscopic difficulty have consequently been downsized. At same time, we have no evidence of specific predictive factors of videolaryngoscopic difficulty, except for reduced interincisal distance and the evidence of new cutoffs for the values we were accustomed to measuring. However, it is indisputable that videolaryngoscopes have changed the pattern of intubation difficulty [96]. The use of these devices can in itself be a trigger for cognitive biases and decision errors, insofar as awareness of a more effective instrument can raise the prudence threshold and lower that of “weight” of prediction faced with particularly challenging but not predictably extremely difficult cases. Conversely, their correct and prudent use and placement in the context of a decision-making algorithm results in valorizing non-technical aspects and team potentials, facilitating interaction, communication, evidence of error, and targeted help. New and interesting promises and prospects come from the growing development and exponential interest toward artificial intelligence [97], which could have an important role from difficulty prediction, real-time intubation assistance and teaching facilitation [98]. At present, the key research nodes concern identification of the best technical approach and definition of the best adjunct instruments, to overcome the difficulty of passing the tracheal tube even faced with brilliant laryngoscopic vision, the price to pay in the transition from Macintosh linearity to the curvilinear world of videolaryngoscopes. In the near future we can expect an improvement in optical performance, a thinning of blades, an implementation of sensors, monitoring, and

probably real-time cognitive support, but the objective of (video-)laryngoscopy remains the same as MacEwen, Jackson, and Macintosh laryngoscopy: see the vocal cords, intubate the trachea, and guarantee our patient's oxygenation.

Author Contributions: Conceptualization, D.S.P., L.L.V., E.C.L.G. and M.S.; writing—original draft preparation, D.S.P., L.L.V. and E.C.L.G.; writing—review and editing, M.S.; supervision, M.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research study received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: All data generated during this study are included in this published article.

Conflicts of Interest: M.S. received paid consultancy from DEAS Italia; he is a patent co-owner (no royalties) of DNA[®] and a patent co-owner (royalties) of Cricospeed[®] of DEAS Italia. M.S. has a paid consultancy agreement with Flexicare, UK. M.S. and L.L.V. have NDA agreements with Flexicare Italy and AI Endoscopic, Zurich. D.S.P. and E.C.L.G. declare no conflicts of interest. The commercial relationships disclosed above had no role in the conception, writing, interpretation, or conclusions of this narrative review, nor in the decision to submit it for publication. No company provided funding, materials, or editorial input for this work.

References

1. Levret, A. *Observations Sur La Cure Radicale de Plusieurs Polypes de La Matrice, de La Gorge et Du Nez*; Delaguet: Paris, France, 1749.
2. Bush, R.B.; Leonhardt, H.; Bush, I.V.; Landes, R.R. Dr. Bozzini's Lichtleiter: A translation of his original article (1806). *Urology* **1974**, *3*, 119–123. [CrossRef] [PubMed]
3. Bailey, B. Laryngoscopy and laryngoscopes—Who's first?: The forefathers/four fathers of laryngology. *Laryngoscope* **1996**, *106*, 939–943. [CrossRef] [PubMed]
4. Pieters, B.M.; Eindhoven, G.B.; Acott, C.; van Zundert, A.A. Pioneers of laryngoscopy: Indirect, direct and video laryngoscopy. *Anaesth. Intensive Care* **2015**, *43*, 4–11. [CrossRef] [PubMed]
5. Available online: <https://singerspace.com/articles/chapter-ii-manuel-garcia-ii-the-columbus-of-the-larynx/> (accessed on 1 March 2026).
6. Czermak, J.N. On the laryngoscope and its employment in physiology and medicine. *N. Am. Medchir. Rev.* **1861**, *5*, 262–265.
7. Turck, L. *Atlas Zur Klinik der Kehlkopfkrankheiten*; Wilhelm Braumuller: Vienna, Austria, 1866.
8. Macewen, W. Clinical Observations on the Introduction of Tracheal Tubes by the Mouth, Instead of Performing Tracheotomy or Laryngotomy. *Br. Med. J.* **1880**, *2*, 163–165. [CrossRef] [PubMed]
9. Brandt, L.; Pokar, H.; Schütte, H. 100 years of intubation anesthesia. William Macewen, a pioneer of endotracheal intubation. *Anaesthesist* **1983**, *32*, 200–204. [PubMed]
10. King, D.; Blair, A. The Evolution of Equipment and Technology for Visualising the Larynx and Airway. *Adv. Exp. Med. Biol.* **2023**, *1406*, 61–78. [CrossRef] [PubMed]
11. Kirstein, A. Autoskopie des Larynx und der Trachea (Laryngoscopia directa, Euthyskopie, Besichtigung ohne Spiegel). *Arch. Laryngol. Rhinol.* **1895**, *3*, 156–164.
12. Zeitels, S.M. Universal modular glottiscope system: The evolution of a century of design and technique for direct laryngoscopy. *Ann. Otol. Rhinol. Laryngol. Suppl.* **1999**, *179*, 2–24. [CrossRef] [PubMed]
13. Jackson, C. *Tracheo-Bronchoscopy, Esophagoscopy and Gastroscopy*; The Laryngoscope Co.: St Louis, MO, USA, 1907; pp. 39–43.
14. Jackson, C. The technique of insertion of intratracheal insufflation tubes. *Surg. Gynecol. Obstet.* **1913**, *17*, 507–509.
15. Asai, T. History of Tracheal Intubation: 1. First Application of Tracheal Intubation during General Anesthesia. *Masui* **2017**, *66*, 99–104. [PubMed]
16. Janeway, H.H. Intra-tracheal anaesthesia from the standpoint of the nose, throat and oral surgeon with a description of a new instrument for catheterizing the trachea. *Laryngoscope* **1913**, *23*, 1082–1090. [CrossRef]
17. Macintosh, R.R. An aid to oral intubation. *Br. Med. J.* **1949**, *1*, 28.
18. Magill, I. An improved laryngoscope for anaesthetists. *Lancet* **1926**, *207*, 500. [CrossRef]
19. Rowbotham, S. Intratracheal anaesthesia by the nasal route for operations on the mouth and lips. *Br. Med. J.* **1920**, *2*, 590–591. [CrossRef] [PubMed]

20. Unzueta, M.C.; Casas, J.I.; Merten, A. Macintosh's laryngoscope. *Anesthesiology* **2005**, *102*, 242. [[CrossRef](#)] [[PubMed](#)]
21. Macintosh, R.R. New Inventions: A New Laryngoscope. *Lancet* **1943**, *241*, 205. [[CrossRef](#)]
22. Miller, R.A. A new laryngoscope. *Anesthesiology* **1941**, *2*, 317–320. [[CrossRef](#)]
23. Henderson, J. Airway Management in the Adult. In *Miller's Anaesthesia*, 7th ed.; Miller, R.D., Ed.; Churchill Livingstone Elsevier: Philadelphia, PA, USA, 2010; pp. 1573–1610.
24. Venn, P.H. The gum elastic bougie. *Anaesthesia* **1993**, *48*, 274–275. [[CrossRef](#)]
25. Henderson, J.J. Development of the 'gum-elastic bougie'. *Anaesthesia* **2003**, *58*, 103–104. [[CrossRef](#)] [[PubMed](#)]
26. Viswanathan, S.; Campbell, C.; Wood, D.G.; Riopelle, J.M.; Naraghi, M. The Eschmann Tracheal Tube Introducer. (Gum elastic bougie). *Anesthesiol. Rev.* **1992**, *19*, 29–34. [[PubMed](#)]
27. Ikeda, S. Flexible bronchofiberscope. *Ann. Otol. Rhinol. Laryngol.* **1970**, *79*, 916–923. [[CrossRef](#)] [[PubMed](#)]
28. Ikeda, S.; Tsuboi, E.; Ono, R.; Ishikawa, S. Flexible bronchofiberscope. *Jpn. J. Clin. Oncol.* **2010**, *40*, e55–e64. [[CrossRef](#)] [[PubMed](#)]
29. Calder, I.; Pearce, A.; Towey, R. Classic paper: A fibreoptic endoscope used for tracheal intubation. *Anaesthesia* **1996**, *51*, 602. [[CrossRef](#)] [[PubMed](#)]
30. Calder, I.; Murphy, P. A fibre-optic endoscope used for nasal intubation. *Anaesthesia* **1967**; *22*: 489–91. *Anaesthesia* **2010**, *65*, 1133–1136. [[CrossRef](#)] [[PubMed](#)]
31. Raj, P.P.; Forestner, J.; Watson, T.D.; Morris, R.E.; Jenkins, M.T. Technics for fiberoptic laryngoscopy in anesthesia. *Anesth. Analg.* **1974**, *53*, 708–714. [[CrossRef](#)] [[PubMed](#)]
32. Borland, L.M.; Casselbrant, M. The Bullard laryngoscope. A new indirect oral laryngoscope (pediatric version). *Anesth. Analg.* **1990**, *70*, 105–108. [[CrossRef](#)] [[PubMed](#)]
33. Wu, T.L.; Chou, H.C. A new laryngoscope: The combination intubating device. *Anesthesiology* **1994**, *81*, 1085–1087. [[CrossRef](#)] [[PubMed](#)]
34. Pearce, A.C.; Shaw, S.; Macklin, S. Evaluation of the Upsherscope. A new rigid fibrescope. *Anaesthesia* **1996**, *51*, 561–564. [[CrossRef](#)] [[PubMed](#)]
35. Ball, C.M.; Featherstone, P.J. Videos in laryngoscopy. *Anaesth. Intensive Care* **2015**, *43*, 677–678. [[CrossRef](#)] [[PubMed](#)]
36. Weiss, M. Video-intuboscopy: A new aid to routine and difficult tracheal intubation. *Br. J. Anaesth.* **1998**, *80*, 525–527. [[CrossRef](#)] [[PubMed](#)]
37. Cooper, R.M.; Pacey, J.A.; Bishop, M.J.; McCluskey, S.A. A new video laryngoscope—An aid to intubation and teaching. *J. Clin. Anesth.* **2002**, *14*, 620–626. [[CrossRef](#)]
38. Hall, D.; Steel, A.; Heij, R.; Eley, A.; Young, P. Videolaryngoscopy increases 'mouth-to-mouth' distance compared with direct laryngoscopy. *Anaesthesia* **2020**, *75*, 822–823. [[CrossRef](#)] [[PubMed](#)]
39. Wylie, N.W.; Durrant, E.L.; Phillips, E.C.; De Jong, A.; Schoettker, P.; Kawagoe, I.; de Pinho Martins, M.; Zapatero, J.; Graham, C.; McNarry, A.F. The VL-iCUE Group. Videolaryngoscopy use before and after the initial phases of the COVID-19 pandemic: The report of the VL-iCUE survey with responses from 96 countries. *Eur. J. Anaesthesiol.* **2024**, *41*, 296–304. [[CrossRef](#)] [[PubMed](#)]
40. Saracoglu, A.; Saracoglu, K.; Sorbello, M.; Çakmak, G.; Greif, R. The influence of the COVID-19 pandemic on videolaryngoscopy: A cross-sectional before-and-after survey. *Anaesthesiol. Intensive Ther.* **2023**, *55*, 93–102. [[CrossRef](#)] [[PubMed](#)]
41. Peters, T.; Wunsch, V.A.; Siebert, H.; Köhl, V.; Breitfeld, P.; Dankert, A.; Sasu, P.B.; Dohrmann, T.; Krause, L.; Zöllner, C.; et al. What Is a Critical Mouth Opening for Macintosh Videolaryngoscopy? Results From a Prospective Observational Study. *Anesth. Analg.* **2025**, 10–1213. [[CrossRef](#)] [[PubMed](#)]
42. Amalric, M.; Larcher, R.; Brunot, V.; Garnier, F.; De Jong, A.; Moulaire Rigollet, V.; Corne, P.; Klouche, K.; Jung, B. Impact of Videolaryngoscopy Expertise on First-Attempt Intubation Success in Critically Ill Patients. *Crit. Care Med.* **2020**, *48*, e889–e896. [[CrossRef](#)] [[PubMed](#)]
43. Aziz, M.F.; Brambrink, A.M.; Healy, D.W.; Willett, A.W.; Shanks, A.; Tremper, T.; Jameson, L.; Ragheb, J.; Biggs, D.A.; Paganelli, W.C.; et al. Success of Intubation Rescue Techniques after Failed Direct Laryngoscopy in Adults: A Retrospective Comparative Analysis from the Multicenter Perioperative Outcomes Group. *Anesthesiology* **2016**, *125*, 656–666. [[CrossRef](#)] [[PubMed](#)]
44. Aziz, M.F.; Bayman, E.O.; Van Tienderen, M.M.; Todd, M.M.; StAGE Investigator Group; Brambrink, A.M. Predictors of difficult videolaryngoscopy with GlideScope® or C-MAC® with D-blade: Secondary analysis from a large comparative videolaryngoscopy trial. *Br. J. Anaesth.* **2016**, *117*, 118–123. [[CrossRef](#)] [[PubMed](#)]
45. Mulcaster, J.T.; Mills, J.; Hung, O.R.; MacQuarrie, K.; Law, J.A.; Pytka, S.; Imrie, D.; Field, C. Laryngoscopic intubation: Learning and performance. *Anesthesiology* **2003**, *98*, 23–27. [[CrossRef](#)] [[PubMed](#)]
46. Cortellazzi, P.; Caldiroli, D.; Byrne, A.; Sommariva, A.; Orena, E.F.; Tramacere, I. Defining and developing expertise in tracheal intubation using a GlideScope® for anaesthetists with expertise in Macintosh direct laryngoscopy: An in-vivo longitudinal study. *Anaesthesia* **2015**, *70*, 290–295. [[PubMed](#)]
47. Cook, T.M.; Aziz, M.F. Has the time really come for universal videolaryngoscopy? *Br. J. Anaesth.* **2022**, *129*, 474–477. [[CrossRef](#)] [[PubMed](#)]

48. Ott, S.; Müller-Wirtz, L.M.; Bustamante, S.; Rössler, J.; Skubas, N.J.; Shah, K.; Sessler, D.I.; Turan, A.; Ruetzler, K. VLS trial group. Learning tracheal intubation with a hyperangulated videolaryngoscopy blade: Sub-analysis of a randomised controlled trial. *Anaesthesia* **2025**, *80*, 395–403. [[CrossRef](#)] [[PubMed](#)]
49. Gunning, S.G.S.; Urwin, D.; Cook, T.M.; Hansel, J. Videolaryngoscopy versus direct laryngoscopy for teaching direct laryngoscopy skills: A systematic review and meta-analysis. *Br. J. Anaesth.* **2025**, *135*, 1397–1409. [[CrossRef](#)] [[PubMed](#)]
50. Ho, A.M.; Mizubuti, G.B.; Camiré, D.; Leitch, J.; Cupido, T.; Azargive, S.; Hurley, C. Do not stop teaching anaesthesia trainees direct laryngoscopy. *Anaesth. Intensive Care* **2026**, *54*, 7–10. [[CrossRef](#)] [[PubMed](#)]
51. Gómez-Ríos, M.Á.; Michalek, P.; Gaszyński, T.; Van Zundert, A.A.J. Human Factors in Airway Management: Designing Systems for Safer, Team-Based Care. *J. Clin. Med.* **2025**, *14*, 8850. [[CrossRef](#)] [[PubMed](#)]
52. Chrimes, N.; Higgs, A.; Hagberg, C.A.; Baker, P.A.; Cooper, R.M.; Greif, R.; Kovacs, G.; Law, J.A.; Marshall, S.D.; Myatra, S.N.; et al. Preventing unrecognised oesophageal intubation: A consensus guideline from the Project for Universal Management of Airways and international airway societies. *Anaesthesia* **2022**, *77*, 1395–1415. [[CrossRef](#)] [[PubMed](#)]
53. Sorbello, M.; Hodzovic, I. Optimising Glidescope performance. *Anaesthesia* **2017**, *72*, 1039–1040. [[CrossRef](#)] [[PubMed](#)]
54. Lewis, S.R.; Butler, A.R.; Parker, J.; Cook, T.M.; Schofield-Robinson, O.J.; Smith, A.F. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation: A Cochrane Systematic Review. *Br. J. Anaesth.* **2017**, *119*, 369–383. [[CrossRef](#)] [[PubMed](#)]
55. Lascarrou, J.B.; Boissrame-Helms, J.; Bailly, A.; Le Thuaut, A.; Kamel, T.; Mercier, E.; Ricard, J.D.; Lemiale, V.; Colin, G.; Mira, J.P.; et al. Video Laryngoscopy vs Direct Laryngoscopy on Successful First-Pass Orotracheal Intubation Among ICU Patients: A Randomized Clinical Trial. *JAMA* **2017**, *317*, 483–493. [[CrossRef](#)] [[PubMed](#)]
56. Myatra, S.N.; Divatia, J.V.; Brewster, D.J. The physiologically difficult airway: An emerging concept. *Curr. Opin. Anaesthesiol.* **2022**, *35*, 115–121. [[CrossRef](#)] [[PubMed](#)]
57. Hansel, J.; Rogers, A.M.; Lewis, S.R.; Cook, T.M.; Smith, A.F. Videolaryngoscopy versus direct laryngoscopy for adults undergoing tracheal intubation: A Cochrane systematic review and meta-analysis update. *Br. J. Anaesth.* **2022**, *129*, 612–623. [[CrossRef](#)] [[PubMed](#)]
58. Karamchandani, K.; Nasa, P.; Jarzebowski, M.; Brewster, D.J.; De Jong, A.; Bauer, P.R.; Berkow, L.; Brown, C.A.; Cabrini, L.; Casey, J.; et al. Society of Critical Care Anesthesiologists (SOCCA) Physiologically Difficult Airway Task Force. Tracheal intubation in critically ill adults with a physiologically difficult airway. An international Delphi study. *Intensive Care Med.* **2024**, *50*, 1563–1579. [[CrossRef](#)] [[PubMed](#)]
59. Russotto, V.; Myatra, S.N.; Laffey, J.G.; Tassistro, E.; Antolini, L.; Bauer, P.; Lascarrou, J.B.; Szuldrzynski, K.; Camporota, L.; Pelosi, P.; et al. INTUBE Study Investigators. Intubation Practices and Adverse Peri-intubation Events in Critically Ill Patients From 29 Countries. *JAMA* **2021**, *325*, 1164–1172. [[CrossRef](#)] [[PubMed](#)]
60. Russotto, V.; Lascarrou, J.B.; Tassistro, E.; Parotto, M.; Antolini, L.; Bauer, P.; Szuldrzyński, K.; Camporota, L.; Putensen, C.; Pelosi, P.; et al. INTUBE Study Investigators. Efficacy and adverse events profile of videolaryngoscopy in critically ill patients: Subanalysis of the INTUBE study. *Br. J. Anaesth.* **2023**, *131*, 607–616. [[CrossRef](#)] [[PubMed](#)]
61. Prekker, M.E.; Driver, B.E.; Trent, S.A.; Resnick-Ault, D.; Seitz, K.P.; Russell, D.W. Video versus Direct Laryngoscopy for Tracheal Intubation of Critically Ill Adults. *N. Engl. J. Med.* **2023**, *389*, 418–429. [[CrossRef](#)] [[PubMed](#)]
62. Ruetzler, K.; Bustamante, S.; Schmidt, M.T.; Almonacid-Cardenas, F.; Duncan, A.; Bauer, A.; Turan, A.; Skubas, N.J.; Sessler, D.I.; for the Collaborative VLS Trial Group. Video Laryngoscopy vs Direct Laryngoscopy for Endotracheal Intubation in the Operating Room: A Cluster Randomized Clinical Trial. *JAMA* **2024**, *331*, 1279–1286. [[CrossRef](#)] [[PubMed](#)]
63. Perkins, E.J.; Begley, J.L.; Brewster, F.M.; Hanegbi, N.D.; Ilancheran, A.A.; Brewster, D.J. The use of video laryngoscopy outside the operating room: A systematic review. *PLoS ONE* **2022**, *17*, e0276420. [[CrossRef](#)] [[PubMed](#)]
64. Taboada, M.; VIDEOLAR-SURGERY Investigators. Universal videolaryngoscopy: Supporting evidence from real-world data and recent trials. *Anaesthesia* **2025**, *80*, 1278. [[CrossRef](#)] [[PubMed](#)]
65. Gaszyński, T.; Gómez-Ríos, M.Á.; Serrano-Moraza, A.; Sastre, J.A.; López, T.; Ratajczyk, P. New Devices, Innovative Technologies, and Non-Standard Techniques for Airway Management: A Narrative Review. *Healthcare* **2023**, *11*, 2468. [[CrossRef](#)] [[PubMed](#)]
66. Sorbello, M. Lines, curves and diameters: The geometry of videolaryngoscopy adjuncts. *Anaesthesia* **2025**, *80*, 1279–1280. [[CrossRef](#)] [[PubMed](#)]
67. Driver, B.E.; Prekker, M.E.; Klein, L.R.; Reardon, R.F.; Miner, J.R.; Fagerstrom, E.T.; Cleghorn, M.R.; McGill, J.W.; Cole, J.B. Effect of Use of a Bougie vs Endotracheal Tube and Stylet on First-Attempt Intubation Success Among Patients with Difficult Airways Undergoing Emergency Intubation: A Randomized Clinical Trial. *JAMA* **2018**, *319*, 2179–2189. [[CrossRef](#)] [[PubMed](#)]
68. Driver, B.E.; Semler, M.W.; Prekker, M.E.; Casey, J.D. BOUGIE Investigators and the Pragmatic Critical Care Research Group. Effect of Use of a Bougie vs Endotracheal Tube with Stylet on Successful Intubation on the First Attempt Among Critically Ill Patients Undergoing Tracheal Intubation: A Randomized Clinical Trial. *JAMA* **2021**, *326*, 2488–2497. [[CrossRef](#)] [[PubMed](#)]

69. Le Bastard, Q.; Jenvrin, J.; Gaultier, A.; Montassier, E. Bougie versus endotracheal tube alone on first-attempt intubation success in prehospital emergency intubation in patients without predictors of difficult intubation: Protocol for the BETA randomized controlled trial. *Trials* **2025**, *26*, 327. [[CrossRef](#)] [[PubMed](#)]
70. Al-Qasbi, A.; Al-Alawi, W.; Malik, A.M.; Manzoor Khan, R.; Kaul, N. Comparison of Tracheal Intubation Using the Storz's C-Mac D-blade(TM) Video-Laryngoscope Aided by Truflex(TM) Articulating Stylet and the Portex(TM) Intubating Stylet. *Anesth. Pain Med.* **2015**, *5*, e32299. [[CrossRef](#)] [[PubMed](#)]
71. Eum, D.; Ji, Y.J.; Kim, H.J. Comparison of the success rate of tracheal intubation between stylet and bougie with a hyperangulated videolaryngoscope: A randomised controlled trial. *Anaesthesia* **2024**, *79*, 603–610. [[CrossRef](#)] [[PubMed](#)]
72. Hughes, L.M.; O'Sullivan, E.P. Comparing hyperangulated videolaryngoscopy and Macintosh videolaryngoscopy—More than meets the eye. *Anaesthesia* **2024**, *79*, 1253–1254. [[CrossRef](#)] [[PubMed](#)]
73. O'Mahony, C.; O'Sullivan, M.P.; McBride, I.; Mannion, S. Failure Rates for Endotracheal Tube Placement Using Videolaryngoscopy in Patients with a Difficult Airway. *Crit. Rev. BioMed Eng.* **2021**, *49*, 1–8. [[CrossRef](#)] [[PubMed](#)]
74. Dallyn, B.; Hanratty, R.; Hillier, M.; Ainsworth, M.; Hansel, J.; Cook, T.M. Evaluation of five static or dynamic tracheal tube introducers during standard and difficult intubations with C-MAC® D-blade videolaryngoscopy in a manikin. *Anaesthesia* **2025**, *80*, 1074–1082. [[CrossRef](#)] [[PubMed](#)]
75. Nørskov, A.K. Preoperative airway assessment—Experience gained from a multicentre cluster randomised trial and the Danish Anaesthesia Database. *Dan. Med. J.* **2016**, *63*, B5241. [[PubMed](#)]
76. Cook, T.M.; Woodall, N.; Frerk, C. Fourth National Audit Project. Major complications of airway management in the UK: Results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. *Br. J. Anaesth.* **2011**, *106*, 617–631. [[CrossRef](#)] [[PubMed](#)]
77. Oglesby, F.C.; Ray, A.G.; Shurlock, T.; Mitra, T.; Cook, T.M. Litigation related to anaesthesia: Analysis of claims against the NHS in England 2008–2018 and comparison against previous claim patterns. *Anaesthesia* **2022**, *77*, 527–537. [[CrossRef](#)] [[PubMed](#)]
78. Joffe, A.M.; Aziz, M.F.; Posner, K.L.; Duggan, L.V.; Mincer, S.L.; Domino, K.B. Management of Difficult Tracheal Intubation: A Closed Claims Analysis. *Anesthesiology* **2019**, *131*, 818–829. [[CrossRef](#)] [[PubMed](#)]
79. Stiegler, M.P.; Tung, A. Cognitive processes in anesthesiology decision making. *Anesthesiology* **2014**, *120*, 204–217. [[CrossRef](#)] [[PubMed](#)]
80. Frova, G.; Sorbello, M. Algorithms for difficult airway management: A review. *Minerva Anesthesiol.* **2009**, *75*, 201–209. [[PubMed](#)]
81. Chrimes, N.; Higgs, A.; Law, J.A.; Baker, P.A.; Cooper, R.M.; Greif, R.; Kovacs, G.; Myatra, S.N.; O'Sullivan, E.P.; Rosenblatt, W.H.; et al. Project for Universal Management of Airways—Part 1: Concept and methods. *Anaesthesia* **2020**, *75*, 1671–1682. [[CrossRef](#)] [[PubMed](#)]
82. Kelly, F.E.; Frerk, C.; Bailey, C.R.; Cook, T.M.; Ferguson, K.; Flin, R.; Fong, K.; Groom, P.; John, C.; Lang, A.R.; et al. Human factors in anaesthesia: A narrative review. *Anaesthesia* **2023**, *78*, 479–490. [[CrossRef](#)] [[PubMed](#)]
83. Kelly, F.E.; Frerk, C.; Bailey, C.R.; Cook, T.M.; Ferguson, K.; Flin, R.; Fong, K.; Groom, P.; John, C.; Lang, A.R.; et al. Implementing human factors in anaesthesia: Guidance for clinicians, departments and hospitals: Guidelines from the Difficult Airway Society and the Association of Anaesthetists: Guidelines from the Difficult Airway Society and the Association of Anaesthetists. *Anaesthesia* **2023**, *78*, 458–478. [[CrossRef](#)] [[PubMed](#)]
84. Kelly, F.E.; Martinoni Hoogenboom, E.; Groom, P. Human factors and teaching benefits of videolaryngoscopes are based on evidence. *Anaesthesia* **2023**, *78*, 792–793. [[CrossRef](#)] [[PubMed](#)]
85. Lamperti, M.; Romero, C.S.; Guarracino, F.; Cammarota, G.; Vetrugno, L.; Tufegdizic, B.; Lozsán, F.; Frias, J.J.M.; Duma, A.; Bock, M.; et al. Preoperative assessment of adults undergoing elective noncardiac surgery: Updated guidelines from the European Society of Anaesthesiology and Intensive Care. *Eur. J. Anaesthesiol.* **2025**, *42*, 1–35. [[CrossRef](#)] [[PubMed](#)]
86. Sgalambro, F.; Sorbello, M. Videolaryngoscopy and the search for the Holy Grail. *Br. J. Anaesth.* **2017**, *118*, 471–472. [[CrossRef](#)] [[PubMed](#)]
87. McNarry, A.F.; Ward, P.A.; Paternò, D.S.; Sorbello, M. Oxygenation techniques in head and neck surgery. *Curr. Opin. Anaesthesiol.* **2025**, *38*, 834–840. [[CrossRef](#)] [[PubMed](#)]
88. Petrini, F.; Accorsi, A.; Adrario, E.; Agrò, F.; Amicucci, G.; Antonelli, M.; Azzeri, F.; Baroncini, S.; Bettelli, G.; Cafaggi, C.; et al. Recommendations for airway control and difficult airway management. *Minerva Anesthesiol.* **2005**, *71*, 617–657. [[PubMed](#)]
89. Sorbello, M.; Afshari, A.; De Hert, S. Device or target? A paradigm shift in airway management: Implications for guidelines, clinical practice and teaching. *Eur. J. Anaesthesiol.* **2018**, *35*, 811–814. [[CrossRef](#)] [[PubMed](#)]
90. Fuchs-Buder, T.; Romero, C.S.; Lewald, H.; Lamperti, M.; Afshari, A.; Hristovska, A.M.; Schmartz, D.; Hinkelbein, J.; Longrois, D.; Popp, M.; et al. Peri-operative management of neuromuscular blockade: A guideline from the European Society of Anaesthesiology and Intensive Care. *Eur. J. Anaesthesiol.* **2023**, *40*, 82–94. [[CrossRef](#)] [[PubMed](#)]
91. Desai, N.; Ratnayake, G.; Onwochei, D.N.; El-Boghdady, K.; Ahmad, I. Airway devices for awake tracheal intubation in adults: A systematic review and network meta-analysis. *Br. J. Anaesth.* **2021**, *127*, 636–647. [[CrossRef](#)] [[PubMed](#)]

92. Alhomary, M.; Ramadan, E.; Curran, E.; Walsh, S.R. Videolaryngoscopy vs. fiberoptic bronchoscopy for awake tracheal intubation: A systematic review and meta-analysis. *Anaesthesia* **2018**, *73*, 1151–1161. [[CrossRef](#)] [[PubMed](#)]
93. Jiang, J.; Ma, D.X.; Li, B.; Wu, A.S.; Xue, F.S. Videolaryngoscopy versus fiberoptic bronchoscope for awake intubation—A systematic review and meta-analysis of randomized controlled trials. *Ther. Clin. Risk Manag.* **2018**, *14*, 1955–1963. [[CrossRef](#)] [[PubMed](#)]
94. Merola, R.; Vargas, M.; Marra, A.; Buonanno, P.; Coviello, A.; Servillo, G.; Iacovazzo, C. Videolaryngoscopy versus Fiberoptic Bronchoscopy for Awake Tracheal Intubation: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *J. Clin. Med.* **2024**, *13*, 3186. [[CrossRef](#)] [[PubMed](#)]
95. Ahmad, I.; El-Boghdady, K.; Bhagrath, R.; Hodzovic, I.; McNarry, A.F.; Mir, F.; O’Sullivan, E.P.; Patel, A.; Stacey, M.; Vaughan, D. Difficult Airway Society guidelines for awake tracheal intubation (ATI) in adults. *Anaesthesia* **2020**, *75*, 509–528. [[CrossRef](#)] [[PubMed](#)]
96. Lundstrøm, L.H.; Nørskov, A.K.; Kjeldgaard, L.D.; Wetterslev, J.; Rosenstock, C.V. Implementation of video laryngoscopes and the development in airway management strategy and prevalence of difficult tracheal intubation: A national cohort study. *Acta Anaesthesiol. Scand.* **2023**, *67*, 159–168. [[CrossRef](#)] [[PubMed](#)]
97. La Via, L.; Maniaci, A.; Gage, D.; Cuttone, G.; Misseri, G.; Lentini, M.; Paternò, D.S.; Pappalardo, F.; Sorbello, M. Exploring the potential of artificial intelligence in airway management. *Trends Anaesth. Crit. Care* **2024**, *59*, 101512. [[CrossRef](#)]
98. Sorbello, M.; La Via, L.; Paternò, D.S.; Tutino, S.; Lo Giudice, E.C.; Lentini, M.; Maniaci, A.; Pappalardo, F. Artificial intelligence in airway management: A narrative review. *Br. J. Anaesth.* **2026**, *136*, 1606–1615. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.