



Advances in airway management during the induction of anesthesia: a narrative review

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Background and Objective: This review summarizes the new techniques and devices available including high-flow nasal oxygen (HFNO) therapy, apnoeic oxygenation, video laryngeal mask, video laryngoscope (VL), flexible tip bougie (FTB), novel drugs, and artificial intelligence (AI) in airway management during the induction of anesthesia. Airway management during the induction of anesthesia is crucial and has progressed considerably in the past decade. Preoxygenation can improve oxygen reserves and extend the safe apnea time. Recently, preoxygenation via HFNO was introduced with significant success. The role of apneic oxygenation is also increasingly recognized. The combination of visualization and traditional intubation equipment has become the method of choice for anesthesiologists. Tracheal tube introducers are devices that can successfully aid airway management, especially in the difficult airway. The design and shape of these devices are constantly evolving to optimize intubation. Anesthetic are constantly updated to ensure the safety and efficiency. Remimazolam is a recently approved anesthetic. Remifentanyl and dexmedetomidine are ideal drugs recommend in recently released Guidelines for Awake Tracheal Intubation (ATI) in Adults. The role of succinylcholine remains controversial and whether it can be replaced by rocuronium completely has triggered lots of researches. Finally, AI is a hot topic in medicine and it has been recently applied in airway management.

Methods: PubMed, Cochrane, and Scopus databases were searched with related keywords. All publication types in English that were related to adult humans between December 1993 and September 2021 were included.

Key Content and Findings: The recent advances during the induction of anesthesia described in this review include HFNO therapy, apneic oxygenation, visualization equipments including video supraglottic airway devices (SADs) and VL, FTB, novel drugs, and AI. Their appearance is expected to improve patients' safety during the induction of anesthesia.

Conclusions: The new techniques and devices do have a great impact on airway management in the induction of anesthesia.

Keywords: High-flow nasal oxygen therapy (HFNO therapy); visualization equipments; flexible tip bougie (FTB); drugs; artificial intelligence (AI)

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Introduction

Airway management is the footstone of anesthesia and advances in this field have significantly improved the safety of anesthetic procedures. Some complications may occur during

the induction of anesthesia. Therefore, effective airway management during the induction of anesthesia is crucial.

This review summarizes the new techniques and devices that have been introduced in recent years in the field

Table 1 The search strategy summary

Items	Specification
Date of Search (specified to date, month and year)	2021.10.1
Databases and other sources searched	PubMed, Cochrane, and Scopus
Search terms used (including MeSH and free text search terms and filters)*	See <i>Table 2</i>
Timeframe	1993.12–2021.9
Inclusion and exclusion criteria (study type, language restrictions, etc.)	Inclusion: English article relating to adult humans
Selection process (who conducted the selection, whether it was conducted independently, how consensus was obtained, etc.)	Relevant information was extracted by two reviewers independently
Any additional considerations, if applicable	No

*, please use an independent supplement table to present detailed search strategy of one database as an example.

Table 2 Detailed search strategy

Search strategy	Database
Systematic search	PubMed, Cochrane, and Scopus
Keywords: “preoxygenation” AND “high-flow nasal oxygen”; “apneic oxygenation”; “transnasal humidified rapid insufflation ventilatory exchange”; “video supraglottic airway devices”; “video laryngoscopy”; “video laryngoscopy” AND “awake intubation”; “remimazolam”; “remifentanyl”; “dexmedetomidine”; “rocuronium” AND “succinylcholine”; “sugammadex”; and “artificial intelligence” AND “airway management”	

of airway management for the induction of anesthesia, including high-flow nasal oxygen (HFNO) therapy, apneic oxygenation, visualization equipments including video supraglottic airway devices (SADs) and video laryngoscope (VL), flexible tip bougie (FTB), drugs in anesthesia, and artificial intelligence (AI). We present the following article in accordance with the Narrative Review reporting checklist (available at <https://joma.amegroups.com/article/view/10.21037/joma-21-3/rc>).

Methods

A literature search was performed using the PubMed, Cochrane, and Scopus databases between December 1993 and September 2021. The following keywords were used in the search: “preoxygenation” AND “high-flow nasal oxygen”; “apneic oxygenation”; “transnasal humidified rapid insufflation ventilatory exchange”; “video supraglottic airway devices”; “video laryngoscopy”; “video laryngoscopy” AND “awake intubation”; “remimazolam”; “remifentanyl”; “dexmedetomidine”; “rocuronium” AND “succinylcholine”; “sugammadex”; and “artificial intelligence” AND “airway

management”. All publication types in English that were related to adult humans were included. The titles and abstracts of all literatures were screened for relevance. Relevant information was extracted by two reviewers independently (*Tables 1,2*).

Oxygenation

Maintaining oxygenation is the principle objective during the anesthesia, and the induction period is no exception. Preoxygenation is an acknowledged techniques which can significantly delay safe apnea time. Oxygenation still exists during the absence of spontaneous respiration or mechanical ventilation which terms “apneic oxygenation”.

Preoxygenation

Preoxygenation is the administration of oxygen before the induction of general anesthesia and airway management. In 2003, guidelines from the American Society of Anesthesiologists Task Force on the Management of the Difficult Airway recommended “face mask preoxygenation before initiating management of the difficult airway” (1).

The physiological objective of preoxygenation is to increase the total store of oxygen in the body. The most significant increase occurs in the lungs where nitrogen in the functional residual capacity (FRC) is replaced with oxygen (often referred to as 'denitrogenating'). The aim of preoxygenation is to delay the onset of oxyhemoglobin desaturation during apnea, often referred to as the 'safe apnea time', ensuring a comfortable shield during times of apnea and hypoventilation. The face mask is the most commonly used device for preoxygenation and should be customized and configured securely to the patient. Patients who have an anatomical discrepancy with the mask such as beards or inadequate mask size may fail to achieve sufficient preoxygenation (2). In such cases, the use of transnasal catheters may be recommended.

HFNO therapy in preoxygenation

HFNO therapy is an innovative high-flow system capable of delivering up to 60–80 L min⁻¹ of heated and fully humidified gas with a fraction of inspired oxygen (FiO₂) ranging between 21% and 100%. HFNO has been widely used in pre-term neonates and pediatric care. More recently the technique has been introduced into anesthetic practice.

There are numerous physiological effects of using HFNO during preoxygenation. HFNO generates significant positive end-expiratory pressure (PEEP), which is generally dependent on flow rate, open or closed mouth breathing, the geometry of the upper airway, and the gender of the patient (3). HFNO can also flush the dead space of the nasopharyngeal cavity thereby reducing the overall volume of dead space. The alveolar ventilation can be increased over the minute ventilation ratio to improve the efficiency of the respiratory efforts (4). In addition, HFNO can reduce the resistance of the upper airway and decrease the resistive breathing effort (4). A constant FiO₂ corresponding to the set FiO₂ can be achieved as HFNO minimizes oxygen dilution with the room air. Lastly, HFNO improves mucociliary clearance and patient comfort.

Apneic oxygenation

During apnoea, oxygen continues to diffuse from the alveoli into the blood while the removal of carbon dioxide from blood to alveoli is limited so that a pressure gradient is created from the pharynx (atmospheric pressure) to the alveoli (subatmospheric pressure) which allows additional administered oxygen to enter the alveoli. Denitrogenation before apnoea facilitates apneic oxygenation. Cardiogenic oscillations may also play a role. Because of the periodic

contraction of the heart, intrathoracic pressure was altered, and gas exchange is facilitated (5).

"NO DESAT" which referred to "nasal oxygen during efforts at securing a tube" was first described by Dr. Levithan. It allowed unwarmed, dry oxygen to enter into the lung via standard nasal cannulae at 15 L min⁻¹ to extend safe apnoea time. Later, the combination of HFNO and apneic oxygenation appeared (<https://www.epmonthly.com/article/no-desat/>).

Transnasal humidified rapid insufflation ventilatory exchange (THRIVE)

HFNO is able to continuously deliver oxygen to an apneic patient. Using HFNO during apnea has been termed THRIVE. Patel and colleagues first applied THRIVE in anesthesia and demonstrated that it successfully contributed to extending the apnea time in 25 patients with difficult airways (3). A series of studies compared the use of THRIVE and face masks during preoxygenation. A randomized controlled trial in patients undergoing rapid sequence induction of anesthesia demonstrated that despite a significantly longer apnea time, THRIVE maintained a comparable blood gas profile (PaO₂, PaCO₂, and arterial pH) to face mask preoxygenation (6). More recently, Lodenius and colleagues assessed the relative declines in oxygen saturation over time with the two techniques and confirmed that there was a lower incidence of patients desaturating below 93% in the group preoxygenated with THRIVE (7).

HFNO is not an ideal substitute to face mask currently

HFNO presents several theoretical advantages, including being well-tolerated, non-invasive, and the ability to deliver continuous oxygen flow to perform apneic oxygenation. Although the use of HFNO in preoxygenation and during apnea is theoretically more advantageous than using a face mask alone, current studies remain inconclusive. A multicentre, randomised, controlled trial was conducted in patients undergoing emergency surgery where rapid sequence induction (RSI) was planned and proved that HFNO was comparable to face mask in maintaining adequate oxygen levels. However, patients in HFNO group had longer mean intubation and apnoea times (8).

In pregnant women who are at increased risk of having a difficult airway, HFNO (standard protocol involved 30 L min⁻¹ for 30 seconds followed by and 50 L min⁻¹ for 150 seconds) did not achieve comparable preoxygenation [end tidal O₂ (ETO₂) ≥90%] to face mask preoxygenation (9).

Similar outcomes were observed when the flow was increased to 70 L/min (10). Air entrainment may explain this deficiency because most pregnant women included in the studies could not tolerate breathing with their mouths closed. In morbidly obese patients who are more likely to present with obstructive sleep apnea, obesity hypoventilation (11), difficult intubation (12), and other comorbidities, hypoxemia will occur after 2–4 minutes of apnea despite sufficient preoxygenation. A randomized controlled trial found that apneic high-flow nasal oxygenation prolonged safe apnea time by 76 seconds (40%) and resulted in higher minimum SpO₂ in the morbidly obese surgical patients [body mass index (BMI) ≥ 40 kg·m⁻²] compared to face mask oxygenation during tracheal intubation (13). Another research demonstrated that preoxygenation with HFNO in obese patients provided lower ETO₂ after intubation and a higher rate of desaturation <95% (14). Nevertheless, a recent study drew a different conclusion, namely, that face mask with PEEP was superior to HFNO for preoxygenation in obese subjects, but both methods achieved an ETO₂ ≥ 0.85 after 5 minutes of preoxygenation (15).

Compared to adults, children have a smaller FRC (16), but a greater metabolic demand, so the time frame to establish a safe airway in infants and children is much shorter than that in adults. HFNO may play a potentially advantageous role in children and infants. A randomized trial in 48 healthy children in age groups 0–6 months, 7–24 months, 2–5 years, and 6–10 years, demonstrated that THRIVE successfully prolonged the apnea time (17). In awake fibre-optic intubation, HFNO is proved to improve oxygenation saturation and potentially, optimizes conditions for awake fibre-optic intubation (18).

The above-mentioned studies show that HFNO as an innovative technique used in oxygenation before intubation is still controversial. The current study has not confirmed that HFNO can completely replace the face mask. A larger population and more circumstances should be included in future to draw the decisive conclusion.

Visualization equipments

The combination of visualization and traditional intubation equipment undoubtedly is the major advance in practical anaesthesia in recent years. Visualization allows anesthetists to get a direct view of the anatomy of the larynx so that patients' safety could be improved. In addition, the real-time video ensures the ability of other team members (or trainers) to observe what the primary intubation performer

is seeing, optimizing, and the possibility of completing intubation.

Video SADs

The classic laryngeal mask airway (cLMA) invented by Dr. Archie Brain in the 1980s is one of the first SADs developed. It forms a seal around and behind the glottis to maintain a patient's airway during anesthesia. The 4th National Audit Project (NAP4) noted that SADs had been used in 56.2% of general anesthesia (19). Undoubtedly, SADs have become an essential tool in airway management.

In recent years, anesthetists have been trying to combine SADs and video. The examples include CTrach laryngeal mask airway and TotalTrack Video Laryngeal Mask.

The CTrachTM was a SAD with a built-in camera inside the bowl. After the insertion, direct visualization of the glottis could be available and tracheal intubation can be completed under continuous direct vision (20). However, it did not gain broader clinical use due to frequent obstruction of the view because of downfolded epiglottis or contamination of the lens (21).

More recently, the TotaltrackTM (Medcomflow S.A., Barcelona, Spain) video laryngeal mask was invented. It is a novel video-assisted intubating laryngeal mask which combines a laryngeal mask with a VL for simultaneous supraglottic ventilation and tracheal intubation in patients with anticipated and unanticipated difficult airway (22). Its safety and availability have been validated in both manikin (22) and patients (23). Totaltrack could perform tracheal intubation after securing the airway and establishing optimal ventilation within a few seconds which is more beneficial for patients with depleted physiological reserves, such as the morbidly obese.

Fibreoptic-guided tracheal intubation through an SAD is "Plan B" in the Difficult Airway Society (DAS) guidelines for the management of unanticipated difficult tracheal intubation (24). The exist of Totaltrack simplifies plan B without the need for adjuvants. The TotalTrack has been reported to serve as a rescue device for oxygenation and tracheal intubation in failed laryngoscopic, videolaryngoscopic, or fiberoptic intubation in eleven patients (25). In spite of the encouraging results Totaltrack performed in the research, limitations were still unavoidable. Totaltrack can only be inserted when the inter-incisor gap measures >2 cm, and insertion of the device can be more difficult in patients with large breasts or truncal obesity (23). Current researches on Totaltrack are limited, and more clinical trials are needed to compare this device

with direct laryngoscopy, videolaryngoscopes and other SADs to determine its precise role in airway management.

The use of visualization technology in combination with SADs in clinical practice makes them more competitive, especially in difficult airway and in the emergency situation of failed tracheal intubation. In conclusion, the SADs can monitor the glottis in real time or guide intubation, which is worth promoting in the clinical application (24,25).

Video laryngoscopy

Since the introduction of the GlideScope VL in 2001, this optical device has been widely used in airway management, especially in patients with difficult airways (26). A large retrospective comparative analysis from the Multicenter Perioperative Outcomes Group involving seven academic centers reported 1,427 cases of failed direct laryngoscopy (DL) in 346,861 patients between 2004 and 2013. The most frequently used and successful technique was VL among five intubation rescue techniques (27). Studies have shown that VLs could significantly reduce the incidence of postoperative complications such as oropharyngeal injury and hoarseness (28).

Despite the strengths of video laryngoscopy, there are certain disadvantages (24). First, fogging or secretions may obscure the view, decreasing the first-pass success rate (29). In addition, using VLs requires high hand-eye coordination which may be a challenge for beginners. Furthermore, because the image is only two-dimensional, users may not know where the blade or endotracheal tube should be positioned precisely, which may cause traumas.

Recently, anesthetists have experimented with the use of video laryngoscopy for awake intubation. Awake fiberoptic intubation is a gold standard technique for patients with anticipated difficult tracheal intubation (1). There are still some risks such as airway hyper-reactivity due to inadequate topical anaesthesia, oversedation with restlessness, nasal bleeding (30). The success depends on anesthetists' experienced technique and the ability to provide appropriate analgesia and sedation. Videolaryngoscope may be able to solve some problems.

Compared to fiberscope, videolaryngoscope is easier and quicker to learn and it can provide a better view of nearby structures. It creates space within the airway, allowing for administration of atomised local anaesthetic to the glottis and trachea. The direct view could reduce the potential for airway trauma.

A systematic review demonstrated the value of videolaryngoscopy as an alternative to awake fiberoptic

intubation in carefully selected patients and found that videolaryngoscopy was probably associated with a shorter intubation time. Limited by the number of included studies and a high degree of heterogeneity, whether videolaryngoscope performed better than fiberoptic in awake intubation was uncertain (31). In patients with periglottic tumour, awake intubation with videolaryngoscope was also feasible (32).

However, there are some limitations of awake videolaryngoscope-guided intubation. For patients who are difficult to insert videolaryngoscope such as patients with limited mouth opening, this is infeasible. In addition, further researches are needed for exploring the most suitable type of videolaryngoscope and optimal indications for awake intubation with videolaryngoscope.

The new FTB

The tracheal tube introducer, also known as the bougie, is a simple and inexpensive device that was first described by Macintosh in 1949. It can facilitate endotracheal intubation and improve first-attempt success (33). The bougie design is constantly being updated to achieve better performance.

The new FTB has an integrated slider along the surface which makes the tip move anteriorly and posteriorly while the pre-curved distal portion of the shaft allows the angulation to provide anterior flexion. The flexible tip is held, inserted, and used as a standard bougie unless the intubation practitioner has an additional ability to navigate the bougie tip. The FTB had a shorter time to successful intubation and fewer attempts were required compared to conventional bougies during the intubation of a difficult airway in a manikin (34,35). The above studies were performed with direct laryngoscopy.

Video laryngoscopy is increasingly popular clinically. However, while it improves the visualization of the vocal cords, the success rates of intubations are generally not increased. Further research should focus on intubation with FTB using VL in humans.

Drugs for the induction of anesthesia

Balanced general anesthesia emphasizes the co-administration of different drugs so as to minimize the dose of a single drug and achieve the desired effects while mitigating unexpected side effects (36). During the induction of anesthesia, it is vital to administer appropriate doses of sedation, analgesia, or muscle relaxants.

Sedatives

Intravenous (IV) anesthetics are commonly used for the induction of general anesthesia. Propofol is the most widely used IV anesthetic drug globally and has revolutionized anesthetic practice and significantly improved patient care since the regulatory approvals for induction and short-term maintenance of anesthesia were received in 1986 (37). However, propofol has certain limitations, such as a narrow therapeutic index, with the potential to cause cardiovascular and respiratory depression and hypoxia (38). Remimazolam not only has similar advantages, such as rapid effect and recovery, but it can also be quickly reversed by flumazenil, a benzodiazepine receptor antagonist, once respiratory depression occurs.

Remimazolam is an ultra-short-acting IV benzodiazepine sedative/anesthetic being developed by PAION AG and its commercial partners for application in anesthesia and procedural sedation (39). It has been approved in the U.S., the EU/EEA, and China for procedural sedation, and recently in Japan and South Korea for general anesthesia (<https://www.paion.com/remimazolam/produkt-informationen/leitsubstanz-remimazolam/>). In addition, two salt form anesthetics have been developed, namely, besylate and tosylate. Antonik and colleagues demonstrated that 0.01 to 0.30 mg/kg remimazolam took effect within 60 seconds after drug infusion and the depth of sedation increased with escalating doses. It can be rapidly metabolized, and the mean residence time was 1/7 of that of midazolam (40). Another clinical trial showed an encouraging success rate of remimazolam in patients undergoing colonoscopy and it was easily reversible by flumazenil. Patients who received the antagonist were generally awake within 1.3 minutes (41). Compared to midazolam, remimazolam has a faster onset of action, stronger sedative effect, and shorter recovery time. In contrast to propofol, remimazolam also has a rapid onset of action without causing significant respiratory depression of the circulation (40,42,43). Furthermore, once respiratory depression occurs, flumazenil, a benzodiazepine receptor antagonist, can be used to quickly restore respiration. Based on the above characteristics, remimazolam may be advantageous when used in anesthesia, especially in patients without an established artificial airway, such as during endoscopies.

A multi-centered clinical trial compared the efficacy and safety of remimazolam tosylate and propofol in 388 patients undergoing colonoscopy. Remimazolam was not inferior to propofol in terms of sedative efficacy (96.91% and 100%, respectively). Longer induction duration,

similar discharge time, and greater safety (lower rates of hypotension and respiratory depression) was observed with remimazolam compared to propofol (44). Several studies have been conducted to confirm the safety and efficacy of remimazolam during the induction period of general anesthesia (45). Controlled trials have shown slightly lower rates of induction success compared to propofol. However, remimazolam also resulted in lower rates of hypotension and milder pain at the injection site compared to propofol (46,47). Further experimental and clinical studies involving larger samples are needed to verify the advantages and disadvantages of remimazolam and to ensure it is safe for clinical use. Indeed, remimazolam may replace propofol as a potential drug for anesthesia induction in the future.

In patients with anticipated difficult tracheal intubation, awake fiberoptic intubation is gold standard. To improve patient's comfort and cooperation, appropriate sedation can be administered. The recently released 'Guidelines for Awake Tracheal Intubation (ATI) in Adults' by DAS has pointed out that remifentanyl and dexmedetomidine are ideal drugs with high levels of patient satisfaction and low risk of over-sedation and airway obstruction (48).

Remifentanyl is a potent short-acting synthetic opioid with fast onset and rapid metabolism. It can provide profound analgesia, suppress airway reflexes and show a minimal effect on cognitive function, so that it can be an attractive sedative drug for awake fiberoptic intubation (49). Moreover, remifentanyl has been recommended for managing 'at-risk' extubation to attenuate some undesirable responses such as coughing, agitation and haemodynamic disturbances (50).

Dexmedetomidine is an α_2 -adrenoceptor agonist with sedative, anxiolytic, sympatholytic, and analgesic-sparing effects. Moreover, dexmedetomidine has a minimal effect on the respiratory system, which will benefit patients with difficult airway (51). A recent meta-analysis including studies investigating elective awake fiberoptic intubation proved that dexmedetomidine resulted in fewer desaturation episodes compared to propofol and opioids with or without midazolam (52). A previous meta-analysis concluded that dexmedetomidine was effective, well tolerated, and associated with better intubation conditions and reduced recall (53). However, dexmedetomidine can cause severe bradycardia so the appropriate dose should be discussed in future.

Neuromuscular blocking agents

Neuromuscular blocking drugs (NMBDs) can be used to optimize intubation conditions by relaxing the jaw,

depressing the reflexes, and ensuring that the vocal cords are fully abducted, thereby ensuring that endotracheal intubation is easier with minimal airway complications. Succinylcholine was once the preferred neuromuscular blocking agent but there were several contraindications. Rocuronium was proposed as a good alternative to succinylcholine without any contraindications except for allergies. While there has been a remarkable uptake in the use of rocuronium during the induction of anesthesia, it remains controversial whether it can replace succinylcholine completely.

In 2008 and 2015, two reviews compared the use of rocuronium and succinylcholine for rapid sequence induction intubation and concluded that it was easier to achieve satisfactory intubation conditions with succinylcholine compared to rocuronium (54,55). More recently, a Cochrane systematic review also found that overall succinylcholine was more likely to provide good intubation conditions than rocuronium, with no statistically significant difference observed between 0.9–1.0 or 1.2 mg·kg⁻¹ rocuronium (56). Therefore, the general opinion is that an appropriate dose (1 mg·kg⁻¹ or more) of rocuronium could perform similarly to succinylcholine. Considering that there are fewer associated contraindications and complications, rocuronium may be a good alternative to succinylcholine. However, in the emergency room, administration of rocuronium remains controversial. In a recent non-inferiority randomized clinical trial involving 1,248 adult patients requiring out-of-hospital tracheal intubation, rocuronium (1.2 mg/kg) showed no non-inferiority in the success rate of first-attempt intubation compared with succinylcholine (57). Due to the long duration of rocuronium, once a patient reaches the “cannot intubate, cannot ventilation” stage, it would be fatal if the specific antagonist, sugammadex, is not immediately administered.

Sugammadex can reverse the effects of aminosteroid muscle relaxants such as rocuronium. It has been reported that at the dose of 16 mg/kg it was faster in reversing the rocuronium-induced neuromuscular block (1.2 mg/kg) than spontaneous recovery from 1 mg/kg succinylcholine (58). However, a recent research suggested that sugammadex may not always protect against arterial oxygen desaturation especially in obese and morbidly obese patients even with preoxygenation (59).

Therefore, rocuronium is preferable in expected non-difficult airway situations, while succinylcholine may be safer in difficult airway situations and in emergencies, unless

contraindications exist.

AI in supporting airway procedures

AI, including machine learning and deep learning, is defined as the development of algorithms that endow machines with the ability to reason and execute tasks. It has been applied to numerous aspects of medicine such as anesthesiology, especially in the area of airway management and intubation.

The real-time application of machine learning via images and videos may contribute to airway management procedures. In 2016, a novel AI system was developed to identify glottic opening with an accuracy of over 80%, thereby facilitating successful intubation (60). More recently, Matava and colleagues successfully developed a convolutional neural network that could classify, identify, and label vocal cords and tracheal rings from real-time videos with high sensitivity and specificity. The model may benefit beginners in the identification of key anatomical structures during laryngoscopy (61).

In addition to the identification of the airway anatomy to assist with intubation, intubation robots have also made great progress in the past few decades. The Kepler Intubation System was the first device to achieve remote control of a standard VL with the option of semiautomated intubation (62). This system has been applied in a limited number of patients with a high success rate of 91% (63). Models in the past were not fully automated, whereas, with the development of AI techniques, more advanced devices have been introduced. An automatic robotic endoscope via laryngeal imaging for tracheal intubation (REALITI) was proposed in 2020, with a capacity of real-time image recognition and automatic distal tip orientation. This model was tested in a simulated airway by seven anesthetists and seven participants with no medical training. Interestingly, considerable and comparable results were obtained in both manual and automatic modes (64). Unfortunately, the small number of participants in the latter study was insufficient to verify the results. Further research and advancements in intubation robots are required before they can be applied in the clinical setting.

The AI boom brings opportunities for the development of airway management. We expect intubation to become safer, faster, and may even become remote and automated. Currently, glottic identification by AI is yet to reach the same level as that achievable by an experienced anesthesiologist, and it will be some time before intubation robots achieve real automation.

Conclusions

The introduction of new technologies, such as HFNO for preoxygenation, as well as transformative devices, such as video SADs, VLs, and FTB, will ensure the efficiency and safety of anesthesia induction. Constantly updated drugs used for induction can also improve patient safety and comfort during anesthesia. Although the application of AI to airway management during the induction of anesthesia is still in its infancy, it is likely to cause revolutionary changes in the future.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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