How Do I Prepare Myself and My Staff for a Difficult Airway?

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14.1 Introduction

Airway management is a broad term summarizing a large number of procedures and techniques, all aimed to control the patients' airways with different strategies and devices, but with the common target to oxygenate the brain ventilating the lungs.

Every procedure in perioperative setting starts either with the management of the airway or with a plan to care for it in the whole perioperative period. The topic is

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one of the most debated in the literature, being perceived as a mandatory competence for every specialist in anesthesia and intensive care.

Failed intubation, ventilation, or oxygenation remains still too often a cause of perioperative and periprocedural adverse events [1–3] and special care and educational efforts should be adopted to prevent them.

A lot of recommendations for the best practice in terms of education and risk management strategies have been focused in international guidelines [4] and recommendations for best clinical practice, issued also to avoid rare, though critical, events such as the cannot intubate–cannot oxygenate (CICO) scenario, whose incidence in anesthesia ranges between 1:500,000 and 1:50,000 anesthetic procedures [2, 5].

The aim of this review is to discuss the possible strategies to get well prepared to deal with a difficult airway patient, with special emphasis on prediction of difficult airways, team preparation, and crisis management.

14.2 What Makes an Airway *Difficult*?

This is an insidious question to answer, mostly because a univocal definition of what makes an airway *difficult* is missing [6].

If we look at literature data, incidence of difficult laryngoscopy ranges from 1 to 13% [7] and more, depending on the setting, on the operator's experience, and on the available devices.

Nevertheless, taking a closer look at epidemiological data, we do realize that the same concept of *difficulty* is not homogeneous, as it might be defined on the basis of the number of laryngoscopic attempts, on intubation failure, ventilation failure or both, and on desaturation (with different thresholds). The same *difficult laryngoscopy* concept might be equivocal, depending on the grading system (4 or 6 steps Cormack-Lehane, or Percentage of Glottic Opening—POGO), on the device used, and on the individual experience of the performing operator.

Not a case, a very recent paper [8] and a Cochrane review [9] underline the heavy limitation of airway difficulty predictive tests, recognizing a (anyway limited) predictive value to upper lip bite test or Mallampati score.

On the other hand, recent papers support the idea of extending the concept of difficulty also to nonpure anatomical concepts, meaning that an anatomically *easy* airway could be physiologically difficult as in Critical Care patients [10], because of environment and setting (OR, ICU, hospital wards and Rapid Response Systems, out-of-hospital), experience, team composition, and skills, including the nontechnical ones [11].

In this perspective, a specific example of perioperative/periprocedural risk could be represented by the obese patients [12] or by Obstructive Sleep Apnea (OSA) patients, who are at higher risk of difficult intubation and difficult ventilation, also with normal body weight and normal anatomical findings.

With such premises, and due to the well-known limitations of the *science* in predicting a difficult airway [13, 14], we strongly support a pathway strategy based on a patient-tailored approach [15]. Such an approach should promote the idea that any airway risk should be alerted by an examination based on multiple tests, for any level of difficulty (difficult ventilation, laryngoscopy, supraglottic airway placement, and cricothyrotomy) [16] and including nonanatomical evaluations, resources and devices availability, and last but not least, team composition.

This approach might probably result in overestimation of difficulties, but through the filtering role of a multileveled predicting approach will dramatically reduce the incidence of unexpected critically difficult airways and, consequently, of critical accidents.

What we should aim at is not to predict only the difficult cases, but to plan (every) airway crisis management, the elaboration of a safety pathway being the main goal of any prediction strategy. Moving the target is our only objective, from airway control (whichever the mean) to patients' oxygenation [17] (Fig. 14.1).

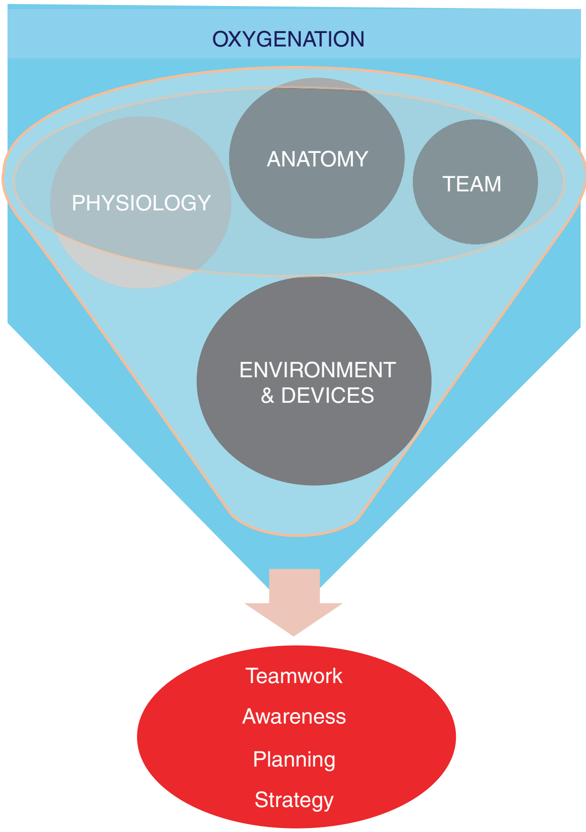

Fig. 14.1 The concept of *oxygen funnel* in predicting airway management

14.3 Direct or Indirect Laryngoscopy?

Laryngoscopy, as introduced by Sir Macintosh, has been considered a cornerstone in airway management. This concept is still actual; nevertheless, it needs to be someway revised and updated. Direct laryngoscopy, as based on achievement of the *line of sight* [18], has a certain failure range, due to anatomical factors and to operator's experience [19].

There are great enthusiasm and some evidence favoring the use of videolaryngoscopes (VL), either Macintosh-based or with hyper-angulated blades to rescue a failed conventional (direct) laryngoscopy, if not as the first choice for any intubation [20].

This message is probably too premature, as there are some issues to be considered: learning curve with videolaryngoscopes is probably steeper than with direct laryngoscopy [21]. A recent meta-analysis was not able to demonstrate a clear benefit and larger success in the clinical reality with VLs [22], not forgetting that no VL could provide patients' oxygenation [23], so they cannot be considered as a rescue tool for difficult ventilation or severely desaturating patients, not forgetting the availability and costs issues [24].

Last but not least, there is evidence that the success rate of direct laryngoscopy could be improved. A recent paper [25] showed that, when used as a rescue technique after failed conventional laryngoscopy, VLs might fail up to 8% of cases, and in these cases, rescue intubation was performed with flexible fiberoptic intubation (FOI) or with optimization of conventional laryngoscopy using a tracheal introducer. Similar data regarding bougies' performance come from recent and large studies [26, 27], suggesting that we are probably underestimating (correct) the use of some devices such as tracheal introducers, focusing our attention more on technological evolution. We should probably move in both directions, and improve the teaching of "old" airway management skills such as tracheal introducer's correct applications and skills.

As a general message, when preparing for a difficult airway patient, we need to consider a predominant role for VLs, independently on the use of a Macintosh or a hyper-angulated blade, yet considering the benefits coming from a shared video output (targeted help, decision making, and education).

Hyper-angulated blades have shown to shift the difficulty from laryngoscopy (always improved) to intubation (*you see that you fail* paradox), so an important message should be to use better what we already have, to develop adequate skills, and to plan our strategy in the function of expected difficulty.

A severely limited mouth opening represents a contraindication for the use of VLs, and in a difficult to ventilate patient (OSA, beard, neck irradiation, and severe obesity), the first choice should be the maintenance of spontaneous breathing before choosing a direct or indirect laryngoscopy technique. In this perspective, interesting and promising evidence comes from the opportunity to use VLs with airway topicalization in spontaneous breathing patients [28].

Optical and video stylets represent other important resources, coupling the familiar use of a stylet empowered with a direct vision facility. However, more evidence is needed to support their routine use, which remains strictly operators' experience-dependent [29].

Another important point that deserves discussion together with laryngoscopy is the correct use of available *perioxygenation* techniques.

Whichever the choice for airway access in the anesthetized patient, before suppression of consciousness and spontaneous breathing, an adequate preoxygenation should be considered mandatory, including EtO_2 monitoring, so to provide a safe and durable extension of apnea time, and choosing the best technique based on the patient's physiology, cooperation, and clinical situation [30]. This might include the choice of positive pressure ventilation (PPV) preoxygenation as it allows leaks compensation and FRC recruitment [31] or the use of *high flow nasal oxygen* (HFNO) with humidified warmed high flow oxygen as a promising strategy to provide preoxygenation in selected patients [32]. A *delayed sequence intubation* could be considered in un-cooperative critical patients as a kind of procedural sedation, the procedure being preoxygenation [33].

Nevertheless, despite adequate preoxygenation, desaturation might occur during airway instrumentation. For these reasons, a novel technique described as *apneic oxygenation* has been proposed to further extend the safe apneic window. It consists of oxygen delivery to be maintained also during apneic phases of airway instrumentation, with either low flow nasal oxygen (*nasal oxygen during attempts securing a* tube—NODESAT [34]) or other means of pharyngeal oxygen delivery or high flow nasal oxygen [35].

14.4 Face Mask Ventilation and Supraglottic Airway Devices

Difficult mask ventilation is definitively difficult to predict, and data from the literature suggest that it might occur in 0.5–5% of patients [36], depending on the definition used, and that it might be associated with difficult laryngoscopy in 0.4% of cases (1 patient in 250) [37]. Recently, a dedicated score with satisfactory performance has been proposed to predict difficult ventilation on the base of clinical evaluation [38].

Based on these premises, we might affirm that preoxygenation should be adopted in any patient, especially accepting the faulty nature of prediction, not forgetting that desaturation is time-dependent, with a logarithmic pattern, and it is faster in critical patients [39]. As a result, any rescue technique for difficult ventilation/oxygenation should be counterbalanced against time.

This last assumption calls for early access to supraglottic airway devices (SADs), early cricothyrotomy if needed, with implications for wise use of neuromuscular blocking agents (NMBAs) and reversal.

SADs have been introduced in clinical practice in the early 1990s with Dr. Brain's Laryngeal Mask Airway, and since then, a fast and variable evolution has been observed [40]. Data from ASA Closed Claims project [1] actually demonstrated a life-saving role of SADs during difficult/failed intubation and ventilation, acting as a bridge to spontaneous ventilation or alternative techniques. NAP4 [2] clearly demonstrated advantages of so-called second-generation SADs, providing gastric access and better sealing, so that nowadays no difficult airway cart should miss a SAD, hopefully, a second-generation one [41].

The real issue remains developing adequate experience and learning curve, taking account of specific SAD's performance and confidence required for optimal use [42]. Regular training in elective conditions will represent the safest and most effective way to develop adequate skills to solve a critical airway scenario with a SAD, including newer opportunities represented by intubating SADs [40].

The role of NMBAs remains essential, and it is still widely debated; if on the one hand they optimize laryngoscopic and intubating conditions [43], there is still an ongoing debate on their ability to improve [44] or not patients' ventilation [45]. This question remains quite difficult to solve, due to heterogeneity of factors determining difficult ventilation and patients' tolerance to desaturation, and a reasonable suggestion might be to counterbalance the choice of suppressing spontaneous breathing with patients' risk factors and physiological reserve, accepting a safety overestimation rather than a risk underestimation.

A crucial point could be represented by an adopted strategy for NMBA administration and the availability of a reversal strategy. Sugammadex is actually the *ideal* reversal strategy when rocuronium is administered, and it has been shown to make OR turnover faster and to reduce postoperative residual curarization and complications [46]. According to a recent Cochrane review, time to NMBA reversal from a posttetanic count of 1–5 to a train-of-four ratio >0.9 with sugammadex when administered at 4 mg/kg was 2.9 min [47]. If we look at historical Benumof's paper for hemoglobin desaturation curves [48], we might accept that a quick reversal strategy could be of some help when facing unexpected difficult laryngoscopy and/or difficult/failed ventilation, time for reversal falling in the safe area of desaturation curve in a certain range of patients.

A recent and elegant simulation study [49] showed that the duration of neuromuscular blockade was certainly longer when comparing 1.0 mg/kg succinylcholine (10.0 min) than with 1.2 mg/kg rocuronium followed 3 min later by 16 mg/kg sugammadex (4.5 min), whereas oxygen saturation and ventilatory depression could be unacceptable in specific situations such as obese and morbidly obese patients, where complete reversal might take as long as 15 min in 5% of individuals.

In such cases, a reversal strategy should be carefully considered, and sugammadex probably preloaded in a syringe so as to reduce also the time necessary for preparation and administration, especially if full reversal dose needs to be used in obese patients.

Never forget that sugammadex reversal might be totally ineffective in the case of airway edema or (iatrogenic) trauma, considering also the co-administration of hypnotic and analgesic drugs [50].

14.5 Spontaneous Breathing Techniques

As a matter of fact, we do not have the perfect airway device to solve any situation, but we need to find the best device for single patient's specific features. Even the most extreme airway could be managed with adequate planning, preparation, and resources, including the use of ECMO techniques [51].

Awake techniques or better spontaneous breathing techniques need to be addressed in this perspective, and they represent the gold standard in patients in which a severe difficulty with airway management and precisely with ventilation/oxygenation (including poor apnea tolerance) might be expected [4].

Spontaneous breathing techniques include fiberoptic (comprising video-endoscopes and disposable flexible devices) intubation, VL intubation, awake insertion of SADs (with or without subsequent intubation) [52], awake *preemptive* cricothyrotomy [53], or awake tracheostomy [54].

The key to any spontaneous breathing technique is local anesthesia and airway topicalization [55]. Despite confounding, *awake* airway management techniques are often provided with different types and grades of sedation, the key point remaining assurance of spontaneous breathing and airway patency [56]. No evidence is available to recommend a technique or a drug over another, some of them having better performance on tolerance, on airway reflexes, or on complications; nevertheless, no sedation regimen should be considered a subsidiary or substitutive for an adequate airway topicalization [57].

Awake intubation techniques might also be supported with oxygen delivery, either using dedicated patient's interfaces or combination with HFNO [58].

Awake/sedated FOI is not routinely performed (1–2% of total intubations in best-performing hospitals), either because of the rarity of situations requiring it and because of a certain reluctance from anesthesiologists, probably due to lack of confidence and adequate education and training [59]. When performed with adequate skills, the failure rate is very low (1–2%) [60] and complications are rare and mild (including unintended over-sedation), but being operator's experience-dependent [61] and with a steep learning curve [62].

Facing this scenario, we might hypothesize a growing role for the use of video-laryngoscopes for awake intubation techniques [60], thanks to some potential advantages (better view, familiarity, and preexisting skills) and to a theoretically less steep learning curve, with the same success and low complication rates with similar patient comfort [28].

It is important to underline that the FOI technique should not at all be abandoned, as some patients might benefit only from this technique, as the case of severe limitation of mouth opening [4] and highly instable cervical spine [63].

Whichever the technique is chosen for intubation and/or ventilation, $EtCO_2$ control needs to be considered mandatory. Both ASA Closed Claims Analysis [1] and NAP4 [2] indicate a certain number of unrecognized esophageal intubations or cases of misinterpretation of abnormal capnographic waves; thus, confirmation of intubation needs to be objectively performed, abandoning subjective (auscultation) and *old-style* techniques (such as tube fogging) in favor of direct view with fiberoptic scope or videolaryngoscope and repeated and normal morphology capnographic waves [4]. Ultrasounds could also be used as ancillary tests, providing expertise with the technique [64]. Intubation confirmation should also be double-checked in particularly challenging cases or in any case of doubt so as to avoid fixation errors or confirmation biases [65].

14.6 Extubation

Data from ASA Closed Claims Analysis [1] and NAP4 [2] suggest that accident patterns in airway management have changed; introduction of new devices and development and diffusion of guidelines and algorithms strongly contributed in reducing the number of airway-related events at the induction of anesthesia [1]. On the other hand, the number of accidents during extubation and in the postoperative phases remained unchanged if not increased.

Many reasons lay behind these findings, including nontechnical and communication issues [2], and certain settings are more at risk of extubation-related complications.

Any difficult intubation has to be considered a difficult extubation, but we must also admit that a certain number of easy intubation might end in difficult extubations because of patients' characteristics, type of surgery, and specific complications (typically head and neck surgery) [66, 67]. The key issue remains an adequate and effective prediction of difficult extubation.

Different tests have been suggested, with special reference to the cuff leak test, which shows different performances in terms of sensitivity and specificity, also because of variability in performance [68]. The search for post extubation stridor (PES) has also been suggested [69], recognizing its value in early recognition of airway obstruction.

Extubation should be given the same attention of intubation, and it should be planned and prepared with the same care and attention. Not a case, different guidelines provide a dedicated paragraph on extubation [4] and the Difficult Airway Society recently provided dedicated guidelines for extubation [67]. Different devices and techniques are available to provide a *protected extubation*: remifentanil-assisted extubation has been proposed to minimize hemodynamic reactions, and similarly with extubation over an LMA in the so-called Bailey's maneuver [42].

The most effective safe extubation technique is represented by extubation over an airway exchange catheter, and it has been described in either pediatric [70] or adult patients [71].

Airway exchange catheters are long, typically hollow, catheters, which could also be used to provide oxygen supplementation during airway instrumentation or when left in place. Particular care should be adopted in regard to the depth of insertion in the airway, visualized re-intubation if needed [72], and limitation of oxygen flow, to avoid the possibility of barotrauma [73]. Despite their educated use, there is a certain failure rate of AEC-based extubation techniques due to catheter dislodgement (up to 10%) [74], and few data are available for success or failure rates of eventual re-intubation. This maneuver might fail despite a catheter in place, thus addressing attention to prompt availability of airway cart to provide alternative rescue techniques [75].

14.7 Cricothyrotomy and (Emergency) Front of Neck Access (eFONA)

Cannot intubate–cannot oxygenate (CICO) scenario is a rare though life-threatening event occurring in the anesthetized patient whenever intubation and ventilation (including SADs) fail. Combination of these conditions is a quite uncommon event, found in 0.4% of the population, and generally incidence of CICO is rare, ranging from 0.0019% in operatory room, relatively higher figures in the emergency department and ICU setting and up to 2.7–11% in case series in the field [76].

The recent DAS 2015 guidelines [77] group the different opportunities to access the cricothyroideal membrane under the term FONA, which might be someway misleading. To date, the best technique to manage the CICO scenario is cricothyrotomy (CT), mostly because it is fast, it goes through a superficial, avascular (or poorly vascularized), and relatively protected tract of trachea [76]. The approach remains debated, with arguing pro and cons of needle CT, surgical CT, or cannula (Seldinger vs. non-Seldinger technique), and the key points might be summarized as follows:

1. needle cricothyrotomy has a high failure rate, and needs a high-pressure oxygen source or dedicated devices to be effective;
2. surgical three-step technique or scalpel-bougie technique as recommended from DAS guidelines seems to be the faster and more effective, though most of the data come from manikin studies and few clinical evidence is available;
3. Seldinger technique, though claimed to be slower, appears safer and more appealing for anesthesiologists, as based on a nonsurgical and familiar principle [76];
4. the classical approach to trigger a CT based on severe and irreversible desaturation should be abandoned in favor of an early decision to start the procedure linked to awareness that any other oxygenation means has failed or might not be effective [78].

Any debate on superiority and effectiveness seems far to be solved, due to rarity of CICO and impossibility to arrange adequately powered and methodologically correct trials; nevertheless, this debate seems to be someway futile and moving away from the real issue, that the best CT is the one we succeed to avoid through adequate preparation, planning, and correction of human factors [79].

Modern approach to CICO should be in fact based on early awareness of progression to CICO, with team sharing and progressive preparation; decision to perform FONA should be early and clearly advised and helped. In this perspective, the chosen technique becomes less important in respect of the aforementioned concepts, providing adequate training.

Manikin and animal models or cadavers are suitable for training, and manikin studies clearly demonstrate that any anesthesiologists become capable of performing a Seldinger-based CT in less than 1 min after five attempts [80]. Similar data someway represent the proof that performing a CT is probably much easier than the decision to perform it.

14.8 The New Challenge: Non-technical Skills

One of the cornerstone papers in airway management is probably represented by the large national audit conducted in the UK and known as National Audit Project 4.

These impressive results from NAP4 [2] clearly showed that the most important causes of airway management events were the consequence of nontechnical issues such as patient characteristics (77%), flawed judgment (59%), and the level of education and training (49%) before technical failures or devices unavailability. Many accidents could have been prevented or minimized with communication optimization and with the adoption of cognitive aids such as checklists and adequate planning.

The living proof of NAP4 findings was the Elaine Bromilay case [81], which triggered a kind of real revolution, starting from the UK, in managing the airways, focusing most of the efforts on nontechnical issues. In this perspective, the DAS guidelines introduced the concept of *stop-and-think* in their algorithm, and the ICU working group embedded in the DAS 2018 guidelines for airway management [82] either checklists or precise figure of operators involved in intubation, bringing the concept of *ergonomy* to bedside.

Airway management today needs to be re-designed in light of either technical or non-technical issues and needs to implement the *no-blame* policy through audits, and to incorporate cognitive aids [78] and supports to minimize the *human factor* [83], opening the boundaries of modern teaching and training also toward simulation, debriefing, and teamwork development [84].

14.9 Airway Management as a *Continuum of Care*

Airway management is a complex task requiring a high level of attention, adequate skills in different techniques, and the ability to evaluate every single patient and to provide a tailored strategy for treatment. Many errors do come from inadequate experience with devices and techniques, but most of them come from inadequate positioning of devices and tools in a preplanned strategy.

We should redraw our priorities and redefine our behavior, moving the idea of airway management as device-based to an idea of a perioperative and periprocedural continuum that needs to be target-oriented, where the only achievable target is, and must be, patients' oxygenation.

Airway management is not only intubation and extubation, but also it starts with the patient's evaluation and ends once the patient is safely extubated and transferred into an adequate level of care postprocedural site.

In this perspective, airway management strategy needs to be developed and adopted anytime and everywhere, including Nonoperating Room Anesthesia (NORA) and Monitored Anesthesia Care (MAC), evidence suggesting that many accidents do also occur in these so-called remote locations [85].

To conclude, the best way to prepare for a difficult airway patient is to be prepared for a difficult airway in any patient, or, better, to prepare the airway of each patient in the best possible way. Placing the devices in the strategy and not making the strategy as a device sequence, oxygenation remains to be the only target to pursue.

We should take into account anatomical and physiological findings, finding out the available resources, and above all preparing a strategy to be shared and discussed with the team, including specific attention for postprocedural care when and if needed.

Human factors remain the last challenge to improve patients' safety and outcomes, and the largest effort of every airway manager, and in general healthcare providers, should be aimed at "prevention is better than cure", which could not be more true for (difficult) airways.

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