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# The Role Of Awake Fiberoptic Intubation In The Difficult Airway

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**Abstract**

Awake fiberoptic intubation (AFOI) is a specialized technique used by anesthesia providers to decrease the risk of airway management during tracheal intubation of a predicted difficult airway. The rate of AFOI has decreased, and the advent of the video laryngoscope may be a contributing factor. However, there is still a need for AFOI. This case study reviews the relevance of, current indications for, and best practices for performing AFOI. Is AFOI still relevant in current anesthesia practice when managing airway difficulties such as limited mouth opening, obstructive sleep apnea, limited neck extension, head and neck pathology, morbid obesity, and progressive airway compromise? The Difficult Airway Society's 2020 guidelines for AFOI in adults is used as an example to evaluate the performance and outcomes of the case study presented in this paper.

*Keywords:* Awake fiberoptic intubation, difficult airway, video laryngoscope

## The Role of Awake Fiberoptic Intubation in the Difficult Airway

In a traditional anesthesia induction and intubation sequence, medications are administered to abolish the respiratory effort in the patient, but the trachea has not been intubated. Under normal circumstances, the time between loss of respirations and intubation of the trachea should be less than 2 minutes. During this time of apnea, the anesthesia provider should attempt to ventilate the patient using a mask and the reservoir bag on the anesthesia machine. Most often, the trachea is intubated after one attempt at laryngoscopy. However, if the circumstances are not ideal and the patient cannot be ventilated using the mask and bag, the apneic period may be prolonged. This prolongation can increase the patient's risk for oxygen desaturation and airway trauma, especially if repeated attempts are needed to intubate the trachea. The patient is extremely vulnerable to anoxic injury during this time. The patient could remain apneic until the effects of the induction medications have worn off or are reversed. This describes a can't intubate – can't ventilate scenario (CICV), and if not managed quickly and efficiently, can result in severe and permanent harm to the patient. If a CICV situation is anticipated, AFOI offers a safe and effective method for intubating the trachea.

AFOI is unique because it couples the flexibility and maneuverability of the fiberoptic scope with the safety of a spontaneously breathing patient. For these reasons fiberoptic intubation in the awake patient is especially well suited for management of the predicted difficult airway.

## Awake Fiberoptic Intubation: A Case Report

In February of 2020, a 77-year-old female (Patient X) presented to the Maine Medical Center emergency department (ED) in Portland, Maine with airway swelling and respiratory distress. The patient was three days post total thyroidectomy for a toxic multinodular goiter. She

was 1.6 meters tall and weighed 95 kilograms, giving her a body mass index of 37. No allergies were documented, but possible causes being investigated included anaphylaxis, angioedema, an infectious process, and a surgical hematoma. While in the ED she was given intramuscular epinephrine as treatment for suspected anaphylaxis, inhaled racemic epinephrine for stridor, and glycopyrrolate to manage her secretions. Her neck was swollen and large but without signs of an obvious hematoma. Her airway exam revealed full range of motion in her neck, a normal mouth opening, a thyromental distance greater than 3 fingerbreadths, and a Mallampati score of 3. However, her tongue, lips, and oropharyngeal tissue were all swollen. She was only able to speak in one-word sentences due to shortness of breath and inability to manage her secretions. Complicating matters further, the patient only spoke Creole and needed the aid of a real-time video interpreter accessed by a tablet. Pertinent past medical history included obesity, hypertension (HTN) (taking lisinopril), type 2 diabetes mellitus, paranoid schizophrenia, and post-traumatic stress disorder.

Due to the likelihood of impending airway compromise, awake intubation was planned, and the patient was transferred from the ED to the operating room (OR). The surgeon who had performed the original thyroidectomy was present and available for immediate surgical access, in the event that the airway could not be secured by standard or advanced intubation techniques. Anesthesia staff in the room included a Certified Registered Nurse Anesthetist (CRNA), two physician anesthesiologists, and a Student Registered Nurse Anesthetist (SRNA).

Once in the OR, Patient X was given supplemental oxygen via a nasal cannula at 5 liters per minute. She was then sedated with 20 mcg of iv dexmedetomidine. Her airway was topically anesthetized with 3cc of 4% nebulized lidocaine and 3 cc of 4% atomized lidocaine over 10 minutes due to physician anesthesiologist preference. Initially, the 4% nebulized lidocaine was

used intermittently by the patient due to intolerance of the mask, thus the decision was made to augment airway anesthetization with atomized 4% lidocaine. She was in a high Fowler's position, spontaneously breathing, and able to follow commands via the video interpreter. The initial two attempts at AFOI were made via the mouth with a Williams intubating airway and an Ambu aScope 4 Broncho 5.0-millimeter (mm) fiberoptic bronchoscope. No airway structures or landmarks were visualized during the two attempts due to severe soft tissue swelling surrounding the larynx.

The plan was changed to a nasal approach. Patient X's nasopharynx was topically anesthetized and dilated using 2% lidocaine jelly placed on sequentially larger nasal airways. Oxymetazoline spray was administered intranasally to decrease the risk of epistaxis. The fiberoptic scope was switched to a 3.8-mm slim model in order to more easily navigate the nasopharynx. A 6.0mm Ring-Adair-Elwyn (RAE) nasal tube was pre-loaded onto the scope. An initial attempt was made via the right naris, but the scope was unable to be passed into the oropharynx. Next, the fiberoptic scope was passed through the left naris and successfully maneuvered into the posterior oropharynx; however, only the base of the tongue could be identified. Airway structures such as the epiglottis, vocal cords, and glottic opening could not be identified.

At this point the attending physician anesthesiologist verbalized the need for a back-up plan should the AFOI fail. The CRNA in the room suggested the concurrent use of a video laryngoscope (VL) with the fiberoptic scope. The rigid blade of the VL could be useful to compress swollen tissue and help provide a line of sight for the fiberoptic scope. Awake intubations can also be done with a VL alone (Ahmad, 2019). This technique was not attempted because during the final attempt the fiberoptic scope found the trachea. The fiberoptic

bronchoscope was blindly advanced through the swollen tissue of the posterior oropharynx. The camera's view was initially completely obscured, but when an image was restored, a clear view of tracheal rings was identified. The scope was advanced until visualization of the carina confirmed tracheal intubation. The 6.0 mm nasal RAE tube was advanced over the scope and into the trachea. Once placement was confirmed by continuous waveform capnography, general anesthesia was induced with 150 mg of propofol.

The total time from entering the OR to intubation was 39 minutes. Exploratory surgery was performed to rule out the presence of a hematoma in the neck. No post-surgical bleeding was identified, so the incision was closed, and a drain was placed. Patient X remained nasally intubated and was transferred to the intensive care unit (ICU) for stabilization. After resolution of her airway swelling, she was extubated and made a full recovery. A final diagnosis of angioedema was made and her lisinopril was discontinued.

## Literature Review

### Methods

A literature search was conducted using databases EBSCO host, CINAHL Complete, Cochrane central register of controlled trials, Cochrane database of systematic reviews, MEDLINE, open dissertations, and Google Scholar. Both literature searches were performed using the keywords "difficult airway" and "awake fiberoptic intubation." The search was limited to results published after 2015 and focused on the adult population only. Results involving pediatric patients were not the focus of this paper and so were eliminated. Using a literature review table, results were organized into categories of sedation, topicalization, fiberoptic intubation, alternative intubating techniques, and the difficult airway.

**Defining the Difficult Airway**

A systematic review of airway physical examination tests by Roth et al. (2018) classifies difficulties associated with the airway into difficult mask ventilation, difficult laryngoscopy, and difficult intubation. The authors further defined difficult laryngoscopy as a Cormack Lehane grade of III or IV, and a difficult intubation as one requiring more than two attempts by more than one provider, use of specialized equipment, or failed passage of the endotracheal tube. The Difficult Airway Society (DAS) stated that in any tracheal intubation a maximum of three attempts should be made by a single provider with the fourth attempt made by a more experienced provider (Frerk et al., 2015). Another consideration is the physiologically difficult airway in which the patient's level of acuity puts them at increased risk for cardiovascular collapse if a first pass attempt at intubation fails (Mosier et al., 2015). Mosier (2015) describes four physiologic derangements that increase the risk for cardiovascular collapse as the following: hypoxemia, hypotension, severe metabolic acidosis, or right-sided heart failure. An analysis of closed claims involving difficult intubations from 2000 to 2012 showed that 76% of those cases involved American Society of Anesthesiologists (ASA) Patient Status (PS) III and IV patients (Joffe et al., 2019).

Huitink and Bouwman (2014) argued that the title "difficult airway" is confusing because it does not incorporate the context surrounding a patient's airway. In their opinion, the difficult airway should be changed to the "basic" and the "advanced" airway (Huitink & Bouwman, 2014). Their classification system considers the contextual complexities of practitioner experience, time sensitivity, and patient acuity, as well as anatomical variations of each patient. This system uses a checklist with the acronyms PHASE and HELP ET for assessing a patient's airway (Huitink & Bouwman, 2014). Defining what constitutes a difficult airway remains a

challenge for healthcare providers and further research should focus on building consensus and clarifying the definition of a difficult airway.

**Incidence**

The incidence of difficult intubation is estimated to be between 8 - 13% (Das et al., 2017). Complications of airway management are infrequent but serious. The Fourth National Audit Project (NAP4) project estimated that airway management resulted in one serious complication per 22,000 general anesthetics, with death or brain damage complicating 1:150,000 (Frerk et al., 2015). Whitten (2018) predicted the number of difficult airways in the US to be 37,500 per year. Das et al. (2017) predicted that the incidence of complications during intubation in critically ill patients in the ICU and ED ranges from 22% to 54%. This rate of incidence highlights how the physiologic variability of patient acuity can affect the incidence of difficult airway management (Das et al., 2017). Burch and Furyk (2020) used three different definitions for a difficult airway with three different rates of incidence. The three definitions were a difficult view, difficulty placing the tube, and failed intubation, and the incidences were 10.1%, 1.9%, and 0.1%, respectively (Burch & Furyk, 2020).

**Predicting the Difficult Airway**

Roth et al. (2018) did not find a test that was both sensitive and specific for predicting airway difficulties. They stated that most tests have better specificity than sensitivity, meaning that airway assessments are better at indicating which patients will likely not present difficult views on laryngoscopy or be difficult to intubate rather than predicting which patients will have difficult airways, but this may seem counterintuitive (Roth et al., 2018). While many anesthesia providers use airway assessments to gauge the difficulty of mask ventilation, laryngoscopy and intubation, research shows that the predictive value of these airway assessments are better at

identifying easy airways than difficult ones. In a review of 188,064 cases in the Danish Anesthesia Database, which was conducted to better understand the predictive value of airway assessments, there were 3,391 difficult intubations; 93% were not predicted to be difficult (Nørskov, et al., 2015).

While the lack of predictive value of airway assessments in identifying difficult mask ventilation, laryngoscopy and intubation should be alarming to anesthesia providers, these assessments are not without any value and some airway assessments are better than others. Roth et. al. (2018) showed that the upper lip bite test was the most sensitive for predicting difficult laryngoscopy, and the modified Mallampati was the most sensitive for predicting difficult intubation. The authors asserted that the definition of a difficult airway is not standardized, further complicating both the identification and reporting of difficult airways.

**Management of the Difficult Airway**

There are several algorithms created for management of the difficult airway. Perhaps the most widely adopted are the DAS and the ASA algorithms (Frerk et al., 2015; Levine & DeMaria, 2013). Chrimes (2016) presents a streamlined algorithm called the Vortex, designed to be used as a real-time cognitive aid during the management of a difficult airway. The Vortex is based on a circular model rather than the previous two algorithms, which are based on a flow chart. Chrimes (2016) stated that his circular algorithm was designed to allow the anesthesia provider to move in and out of zones of safety while making multiple attempts at securing the airway. A closed claims analysis of difficult intubations revealed that three quarters of claims between 2000 and 2012 exhibited failures in judgment (Joffe et al., 2019). The lapses in judgment included the lack of a plan for airway management, the failure to utilize a supraglottic airway as a bridge to oxygenation during a CICV emergency, and delays in attempting a surgical

airway (Joffe et al., 2019). If a CICV emergency is encountered, psychological preparations of the provider may be as important as technical preparation. It is commonly seen during emergency airway management a provider will repeat ineffective interventions. In addition, the difficult airway management algorithm is often not followed correctly during an emergency (Xu et al., 2017)**.**

There are numerous options for managing and securing an airway and each has its strengths and weaknesses. Hagberg (2014) listed airway management adjuncts such as ETT guides, lighted stylets, viewing stylets, rigid video laryngoscopes, rigid indirect fiberoptics, and supraglottic ventilatory devices. The author also listed special airway techniques for management of the difficult airway, such as the following: awake intubation, flexible fiberoptic intubation, retrograde intubation, tracheal jet ventilation, cricothyrotomy, and tracheostomy (Hagberg, 2014). Of note, Hagberg (2014) differentiates between three types of cricothyrotomies (needle, percutaneous, and surgical) and advocates for the usefulness of retrograde intubations, which, in her opinion, are simple and straightforward. The breadth and complexity of airway management tools and techniques could be a source of confusion for less experienced providers and a point of contention for providers unwilling to adopt new technologies.

### *Awake Fiberoptic Intubation*

According to Ahmad et al. (2019) and the DAS, AFOI has a favorable safety record and has been the gold standard in the management of the predicted difficult airway. However, Ahmad et al. (2019) reported that AFOI accounted for only 0.2% of all annual intubations in the United Kingdom. In their systematic review and meta-analysis of randomized controlled trials, Cabrini et al. (2019) reported only 12 of 2045 AFOI failures (0.59%) and only 7 severe adverse events (0.34%) occurred, yet no permanent harm or death was reported. AFOI is unique because

it maintains spontaneous ventilation and intrinsic airway tone until intubation is confirmed and general anesthesia is induced. Indications for AFOI include the following: limited mouth opening, obstructive sleep apnea, limited neck extension, head and neck pathology, morbid obesity, or progressive airway compromise (Cabrini et al., 2019). AFOI is indicated for predicted difficult airways, especially those that represent a risk for difficult or impossible mask ventilation (Cabrini et al., 2019). Relative contraindications to AFOI include local anesthetic allergy, bleeding in the airway, and an uncooperative patient, yet the only absolute contraindication is patient refusal (Ahmad et al., 2019).

Ahmad et al. (2019) defines a failed AFOI as failure to achieve tracheal intubation after 3 attempts by one anesthesia provider and a final attempt by a second provider. At this point, the procedure should be aborted, and the patient should be allowed to recover. If airway compromise makes aborting the intubation attempt impossible, then front of neck access (FONA), also known as a surgical airway, must be considered (Ahmad et al., 2019). If awake front of the neck access is not possible, then induction of general anesthesia with muscle relaxation to facilitate intubation may be considered as a high-risk, last resort (Ahmad, et. al. 2019).

There are several reasons why there is low utilization of AFOI, and one is that AFOI is considered a high-stress procedure for practitioners (Ahmad, et. al. 2019). Hanning et. al. (2018) described three misconceptions concerning AFOI that likely dissuade anesthesia providers from attempting AFOI: it is time-intensive, it can be uncomfortable for the patient, and it is a difficult skill to learn. In the case studies presented, the median time to intubation using AFOI was 10 minutes after entering the OR, compared with 14 minutes when using standard intubation techniques (Hannig et al., 2018). The author noted that some of the efficiency gained in the AFOI group over the standard intubation group was due to accomplishing certain tasks in the

pre-op area, such as an IV start, monitoring, sedation, and topicalization (Hannig et al., 2018). The authors stated that the actual time to perform the tracheal intubation during AFOI was less than 2 minutes. Hannig et al. (2018) believe that it takes 15 to 20 attempts for an anesthesia provider to learn AFOI.

**Topicalization**

Approaches to airway topicalization are variable across published literature on AFOI. Cabrini et al. (2019) were unable to perform a meta-analysis of topicalization trials due to a high degree of heterogeneity between studies with regards to premedication, sedation, and measured outcomes. No one regimen of airway topicalization was found to be significantly better than the others (Cabrini et al., 2019). Ahmad et al. (2019) recommended of the use of lidocaine due to its low cardiac and systemic toxicity and rapid speed of onset. The route of administration can be topical or percutaneous. The DAS stated there is insufficient evidence to recommend a route of administration. However, Ahmad et al. (2019) reported patient discomfort, increased plasma concentrations, and increased incidence of systemic toxicity with the percutaneous route. The topical route is associated with variable absorption (Ahmad et al., 2019). If a nasal approach is planned, then a topical vasoconstrictor such as oxymetazoline is recommended (Ahmad et al., 2019). Among ten randomized controlled trials involving 547 patients and ten approaches to topicalization of the upper airway, Cabrini et al. (2019) found a 0.7% failure rate and no adverse outcomes. This implies that despite high variability in approaches to airway topicalization during AFOI, the particular approach may not adversely affect the success of AFOI.

**Sedation**

Awake tracheal intubation can be accomplished without sedation, but it may be useful to relieve patient anxiety, provide amnesia, provide analgesia, or work as an antitussive (Ahmad et

al., 2019). Cabrini et al. (2019) found 37 trials with 1334 patients involving sedation regimens comparing the use or combination of dexmedetomidine, opioids, propofol, and sevoflurane. Their analysis indicated fewer episodes of desaturation with dexmedetomidine and fewer episodes of apnea with sevoflurane when compare with other sedatives (Cabrini et al., 2019). Similar to the literature on airway topicalization, it is difficult to compare sedation techniques in AFOI due to heterogeneity of sedation regimens in published studies (Cabrini et al, 2019). Confounding the challenge in understanding the best approach to sedation, Cabrini et al. (2019) stated that the quality of the topical anesthetic approach likely has a significant effect on the efficacy of sedation, further complicating efforts to compare sedation techniques.

Meena et al. (2020) studied the effectiveness of 30 mg/kg versus 45 mg/kg of magnesium sulfate as a sedative during AFOI. They found that the higher dose provided more blunting of the sympathetic response to intubation, provided adequate sedation, and did not cause respiratory depression (Meena et al., 2020). Dexmedetomidine provided adequate patient comfort, minimal cardiovascular side effects, little respiratory depression, and fewer periods of apnea for sedation during AFOI (He et al., 2014). Dexmedetomidine has been studied alone and in combination with opioids, benzodiazepines, and ketamine (Hu et al., 2012; Jafari et al., 2020; Liu et al., 2015; Mir et al., 2017; Singh et al., 2019; El Sharkawy, 2019). Over-sedation poses the greatest risk during AFOI and it is therefore recommended that a sole agent be used (Ahmad et al., 2019). Dexmedetomidine or remifentanil are both associated with high levels of patient satisfaction and are low risk for over-sedation or airway obstruction (Ahmad et al., 2019).

### *Video Laryngoscopy*

A video laryngoscope (VL) is an intubating tool with an integrated camera and video display (NICE, 2018). It provides indirect visualization of the upper airway for the purpose of

tracheal intubation. The VL consists of four components: an interchangeable blade, a high-resolution camera with a light source, a monitor, and a power source (NICE, 2018).

In their 2013 update to the management of the difficult airway, the ASA stated that when compared to direct laryngoscopy (DL), VL showed improved views of the glottis, an increased incidence of successful intubations, and increased first-pass intubations. In non-difficult airways, VL was shown to have significantly better intubation success rates and significantly fewer post-operative complications when compared with DL (Liu et al., 2019). A systematic review by Lewis et al. (2019) compared various VL devices with DL using a Macintosh blade, in both difficult and non-difficult airways and found that video laryngoscopes could improve the success of tracheal intubations when the patient had a difficult airway (Lewis et al., 2019). Furthermore, there were fewer failed intubations in predicted and anticipated, as well as simulated, difficult airways (Lewis et al., 2019).

The use of VL resulted in less airway trauma and edema versus DL (Lewis et al., 2019). However, the systematic review did not indicate that VL resulted in less time or fewer tracheal intubation attempts than DL (Lewis et al., 2019). Similarly, there was also no evidence that VL resulted in fewer incidences of hypoxia or respiratory complications (Lewis et al., 2019). Frerk et al. (2015) indicated that VL offered an improved view of airway structures over DL. They also mention the use of flexible fiberscopes or optical stylets, such as Bonfils (Karl Storz), Shikani (Clarus Medical), or Levitan FPS scope™ (Clarus Medical) as alternatives to VL, but warn that obtaining proficiency with these devices requires practice (Frerk et al., 2015).

Certain patient conditions have been associated with first-pass failure to intubate when using a VL, such as blood in the airway, obesity, airway edema, and cervical immobility (Joshi et al., 2017). Joshi et al. (2017) looked at the first-pass intubation success of residents and fellows

when using a VL on ICU patients. Jarzebowski et al. (2018) hypothesized that the introduction of VL would decrease the rate of AFOIs at their institution. Their study looked at two months of intubations before VL was introduced at a single institution compared with a two-month period after the introduction of VL (Jarzebowski et al., 2018). They did not find a statistically significant reduction in AFOI for predicted difficult airways, but they did report a trend towards a significant reduction (Jarzebowski et al., 2018). The report found a significant change in the method chosen to intubate predicted difficult airways with an increase in VL and a decrease in fiberoptic intubations (awake and asleep) and DL (Jarzebowski et al., 2018). These findings may indicate that practitioners were more likely to reach for a VL than DL when faced with a predicted difficult airway.

A multi-center randomized controlled trial by Kleine-Brueggeney et al. (2016) compared channeled and non-channeled video laryngoscopes in simulated difficult airways. The non-channeled video laryngoscopes were superior in first-pass intubation rates and the McGrath provided the quickest time to tracheal intubation of 53 sec (Kleine-Brueggeney et al., 2016). The authors noted that their study was limited by the fact that they only tested simulated cervical immobility and limited mouth opening, and therefore conditions found in trauma and obese patients were not tested (Kleine-Brueggeney et al., 2016). Simulated difficult airways can be accomplished by placing a cervical collar on a study participant and then attempting tracheal intubation (Gupta, 2017). The author cited a study reporting that in 75 of 76 simulated difficult airways, no part of the glottic opening was visible when using DL with a Macintosh blade. Gupta (2017) added that the cervical collar limits both mouth opening and cervical mobility.

González-Giraldo et al. (2020) reported 7 case studies of patients in which fiberoptic intubation was unsuccessful and the subsequent rescue of the airway by video laryngoscopy.

Although this scenario is rare, it highlighted the innate differences between the two technologies and that specific patient characteristics, such as those found in patient X, may be better suited for one over the other. In one case, the patient was accidentally extubated during a position change (González-Giraldo et al., 2020). In the remaining cases, there was either an anatomical narrowing of the airway that was impassable by the bronchoscope, or there was a mass present that the bronchoscope could not manipulate (González-Giraldo et al., 2020).

The National Institute for Health and Care Excellence (NICE, 2018) medtech innovation briefing reported improved outcomes for VL when compared with DL. Outcomes measured included better overall success rates of intubation, a reduction in the time to intubation, superior visualization of the glottis, fewer intubation failures, and a greater first-pass success rate with VL (NICE, 2018).

## Discussion

Intubation is a critical moment in anesthesia care, and it may be the most vulnerable moment perioperatively for patients. Failure to secure an airway can lead to traumatic injuries of the mouth and upper airway, including the vocal cords, permanent anoxic injury to vital organs like the brain, or even death. Cook et al. (2011) reported complications related to airway management at a rate of one in every 12,120 anesthetics. These complications included events such as difficult or delayed intubation, failed intubation, and CICV situations.

Fiberoptic intubation relies on the muscle tone of a spontaneously breathing patient to keep the path of the scope clear. An awake patient also allows the intubation process to be safely aborted if it is unsuccessful. This is in contrast to the more common intubation technique involving the induction of general anesthesia and loss of spontaneous respirations before the

trachea is intubated. It highlights the importance of recognizing the indications of possible difficulties managing an airway in the OR.

**The Difficult Airway Can be Difficult to Predict**

The DAS estimates an 8-13% incidence of difficult intubations (Das et al., 2017). As many as 93% of difficult airways are unanticipated, and when an airway is predicted to be difficult, it turns out only 25% actually are (Norskov et al., 2015). Common airway assessments may be poor predictors of airway difficulties. The upper lip bite test offers the best indication for possible difficulties with laryngoscopy, and it is still only 63% accurate (Burch & Furyk, 2020). The modified Mallampati test is 51% accurate for predicting difficulties with intubation (Burch & Furyk, 2020). The modified Mallampati test differs from the standard Mallampati because it describes in greater detail the oral structures seen in classes I through III, and it adds a fourth class in which only the hard palate is visible (Isono, 2008).

It appears that the decision to use an AFOI should be made before the patient is taken to the OR. An experienced anesthetist may make an airway assessment immediately upon meeting a patient. An airway assessment of the patient can inform the anesthetist about possible challenges when managing that patient's airway. For example, the presence of a beard may indicate difficulties achieving a seal during mask ventilation. The presence of a cervical collar may communicate the need for an intubation technique such as AFOI or VL that does not require neck articulation.

The experience of one provider may not mirror the experience of another when assessing and managing the airway of the same patient. There may be discrepancies between providers in their skill level and confidence when managing an airway. There may also be physiologic variations or changes over time in the patient that could affect management of the airway

(Mosier et al., 2015). For example, Patient X's airway did not indicate the need for AFOI during her original intubation for thyroidectomy. However, three days later, the physiologic changes present upon her admission to the ED warranted a completely different approach to managing her airway. Presumably, if she returns to the OR in the future, she may not require an AFOI for subsequent intubations.

**The Evolution of Fiberoptic Intubation**

The technology for fiberoptic scopes was first adapted for use in medicine by gastroenterologist Basil Hershowitz in 1961 with his flexible gastroscope (Calder, 2010). In 1965, Dr. Murphy, a resident in anesthesia at the National Hospital for Nervous Diseases at Queen Square in London, used a fiberoptic scope to perform the first nasotracheal intubation on an anesthetized spontaneously breathing patient (Calder, 2010). The fiberoptic scope he used was very different from the instruments used today. Dr. Murphy's fiberoptic scope had a flexible arm with a camera at the end, but he could not articulate the end with the camera to improve his view. His fiberoptic scope also had no working channels to allow for the suction of secretions.

Modern fiberoptic bronchoscopes are flexible and the distal tip can be articulated by manipulating a dial on the proximal handle, as well as ports that exit at the distal end of the scope and can be used to administer local anesthetic, irrigate with saline, take biopsies, or apply suction. The first dedicated fiberoptic laryngoscope (a shorter version of the fiberoptic bronchoscope, designed for viewing the upper airway) was introduced in 1972, and in 1990, the first textbook on fiberoptic intubation was published (Calder, 2010). Interestingly, Dr. Murphy found that he was only able to visualize airway structures with the fiberoptic scope if muscle relaxants were not administered to the patient. He found that with muscle relaxation the soft tissue in the airway of the patient would obscure the view of the camera. Therefore, a

spontaneously breathing patient offered the best intubating conditions. Although Patient X was spontaneously breathing, her swollen oral soft tissue rendered the fiberoptic bronchoscope nearly useless when trying to identify her airway structures. This highlights the conditions necessary for optimal use of a fiberoptic bronchoscope. In his experience, fiberoptic intubations were especially useful in patients with cancer of the tongue, vallecula, and glottis (Calder, 2010).

Since that time, AFOI has evolved to become the gold standard for managing the predicted difficult airway, especially in those patients who have a high risk of being difficult to ventilate via a mask, or those who have a high risk of progressing to a can't intubate, can't ventilate (CICV) scenario (Ahmad et al., 2016).

**Indications and Limitations of AFOI**

Certain patient factors and presentations should alert the anesthesia provider to the possibility of difficult airway management, such as head and neck pathologies, ankylosing spondylitis of the cervical spine, or tumors of the upper airway (Cabrini et al., 2019). Other predictors of airway difficulties include a limited mouth opening, cervical instability, obesity, obstructive sleep apnea, or progressive airway compromise (Ahmad et al., 2019). A minimal mouth opening of approximately 2 cm is needed for video laryngoscopy (Hannig et al., 2018). Despite the knowledge of these predictors of airway difficulties, the National Audit Project 4 (NAP4) found numerous cases where AFOI was indicated but not used (Cook et al., 2011). The NAP4 reviewed all incidences of airway management complications from ICUs, EDs, and anesthesia cases from 2008 to 2009 in the United Kingdom and Northern Ireland. The DAS' 2020 guidelines for AFOI indicated that only 1-2% of AFOIs fail (Ahmad et al., 2019). AFOI accounts for only 0.2% of all intubations in a year in the United Kingdom, and of those AFOI that fail, the number of deaths or permanent harm to the patient is nearly zero (Ahmad et al.,

2019; Cabrini et al., 2019). It appears that a spontaneously breathing patient increases the margin of safety during tracheal intubation.

There are limitations related to intubating the trachea with a fiberoptic bronchoscope. Endotracheal tubes must have an interior diameter large enough to allow the fiberoptic scope to fit inside (Alhomary et al., 2018). A pediatric (or size small) fiberoptic scope will not fit in an endotracheal tube with an internal diameter smaller than 5.0 mm. The fiberoptic bronchoscope must be completely removed from the airway in order to make the exchange over the distal end of the scope (Alhomary et al., 2018). Conditions in the airway related to secretions, blood, or collapsed soft tissue could obscure the camera at the distal end of the scope. Unlike a traditional DL blade, which is rigid, the fiberoptic bronchoscope is flexible and may not be well suited to manipulating soft tissue to gain a better view of airway structures (Alhomary et al., 2018). The fiberoptic bronchoscope is relatively large and requires two hands to use, which may necessitate the need for a second anesthesia provider to assist.

**Current Recommendations for AFOI**

The following are recommendations related to AFOI in the difficult airway, airway topicalization and sedation based upon our review of available literature. Cook et al. (2011) recommend that anesthesia providers lower their threshold for using AFOI. Knowledge of the indications for, and the skills to use, a fiberoptic bronchoscope is likely to be familiar to all anesthesia providers. However, in practice, the incidence of AFOI is very low and it is sometimes indicated but not implemented (Ahmad et al., 2019; Cook et al., 2011). Cook et al. (2011) reviewed 186 cases of airway compromise over one year in the United Kingdom and found 18 cases of failed tracheal intubation where AFOI should have been used. Two of these cases ended in cardiac arrest and death (Cook et al., 2011).

A common side effect of AFOI is periods of oxygen desaturation in the patient. Ahmad et al. (2019) recommend that all patients undergoing AFOI should receive supplemental oxygen. The most effective method for decreasing the incidence of desaturation is oxygen administration through a high-flow nasal cannula (Ahmad, 2019). Patient X received oxygen via a nasal cannula at 5 L/min. The anesthetic record indicated that she experienced several brief episodes of desaturation. Her lowest reading was an $SpO_2$ of 75%. Supplemental oxygenation should be utilized throughout AFOI attempts.

Anesthesia providers associate the use of the fiberoptic bronchoscope with high-stress levels, increased time to intubation, discomfort for the patient, and as being a technically challenging skill (Ahmad et al., 2019). These perceptions are real but are also modifiable. Increased familiarity with AFOI through practice and use of a checklist can increase provider confidence, decrease provider stress, increase time efficiency, and make the experience more comfortable for the patient (Ahmad et al., 2019). A retrospective study by Joseph et al. (2016) of the elapsed time from entry to the OR to complete an AFOI found that on average, 24 minutes is needed. For comparison, the authors found an average time for a standard induction and tracheal intubation was 14 minutes after entry to the OR (Joseph et al., 2016). The AFOI for Patient X took 39 minutes to complete from the time she entered the OR. During that time, the airway was prepped with local anesthetic, additional intravenous access was established, three approaches with the fiberoptic scope were made, and communication with the patient was mediated through an interpreter.

Using fiberoptic bronchoscopy takes practice and requires a unique set of skills. The attending physician anesthesiologist for Patient X was considered an expert in AFOI within the department and was elected to be the lead airway management provider during the case. An

argument could also be made that, under his guidance, a less experienced provider might benefit from practicing AFOI. It can take ten asleep fiberoptic intubations in order to become proficient, and 15 to 20 AFOI to become proficient (Hannig et al., 2018; Johnson et al., 1989). Fifteen to 20 could be considered the minimum number of attempts to become proficient at AFOI, and then continued practice with fiberoptic scopes will be necessary to maintain that minimum level of proficiency (Ahmad et al., 2016). Also, considering it can take upwards of 50 or more intubations using DL before practitioners become minimally proficient, becoming proficient in AFOI is theoretically easier (Joseph et al., 2016). It appears that DL is more difficult to master than AFOI, yet anesthesia providers use DL so often that providers will gravitate towards it even in the face of obvious indicators of difficult intubation where AFOI may be the better technique.

***Topicalization***

When performing an awake intubation, the key to successful intubation and patient comfort is adequate anesthetization of the glossopharyngeal and superior laryngeal nerves in the airway (Ahmad et al., 2019). There are two approaches to accomplish this: topical or percutaneous administration of local anesthetic. Topical administration has the benefit of being technically easier, but it may provide a less dense block of the nerves and require higher doses due to variable absorption (Ahmad et al., 2019). Percutaneous administration can provide a very dense and complete block but has two drawbacks. First, it involves the use of a needle either in the patient's mouth or around their neck, which may cause anxiety in the patient (Ahmad et al., 2019). Second, it is associated with higher plasma concentration levels of local anesthetic (Ahmad et al., 2019).

Review of the literature indicates that, like sedation regimens, there is wide heterogeneity in local anesthetic techniques (Cabrini et al., 2019). However, no adverse events or failed

intubations were related to any of the anesthetizing techniques reviewed (Cabrini et al., 2019). The DAS (2019) does not recommend a route of administration but does recommend using lidocaine during AFOI. Lidocaine has a favorable cardiovascular and systemic toxicity risk profile (Ahmad, 2019). The maximum recommended dose for topical lidocaine should not exceed 9 mg/kg of lean body weight (Ahmad, 2019). According to the anesthetic record, Patient X received 960 mg of topical lidocaine via nebulizer and atomizer. This is significantly more than the maximum recommended dose; however, the patient did not exhibit signs of local anesthetic systemic toxicity. It is possible she did not receive all that was charted due to variable rates of absorption associated with the topical route of administration.

***Sedation***

Sedation for AFOI has been extensively studied, yet clear recommendations remain challenging due to heterogeneity amongst published literature. Patients who present for an AFOI may have respiratory symptoms that can be exacerbated by even a slight increase in sedation. The patient may need to remain in a seated or tripod position in order to maintain a patent airway. For Patient X, her position of comfort was seated on a stretcher with her legs hanging off each side. She was able to tolerate a high Fowler's position during the AFOI. Increased levels of sedation may relax the muscles of the upper airway and can possibly lead to obstruction of airflow (Ahmad, 2019). An AFOI can be done without sedation and only topicalization of the airway (Ahmad, 2019). However, the patient may benefit from the anxiolytic effects of sedation due to a decreased sensation of air hunger, and it may make the awake intubation more tolerable. Patient X was sedated with 0.15 mcg/kg of dexmedetomidine and remained awake, spontaneously breathing, able to follow instructions and remain cooperative throughout the procedure.

Cabrini et al. (2019) reported wide heterogeneity in sedation regimens for AFOI, making it difficult to compare them to one another. Dexmedetomidine exhibited the best safety profile, provided good intubating conditions and patients reported fewer episodes of recall (Cabrini et al., 2019). Ahmad et al. (2019) recommended using either dexmedetomidine or remifentanil as the sole agents for sedation. If a secondary agent is necessary, the authors suggest considering midazolam because it is reversible. Increasing sedation to compensate for inadequate airway topicalization should be avoided (Ahmad, 2019). Cook et al. (2011) suggested that a second anesthesia provider be present to administer sedation and treat sequelae during AFOI. The case study involving Patient X had four anesthesia providers in the room. The attending physician anesthesiologist administered the local anesthetic and performed the intubation. The certified registered nurse anesthetist (CRNA) managed sedation with dexmedetomidine, provided supplement oxygenation via HFNC, monitored the patient's vital signs and potential sequelae, and induced the patient under general anesthesia once the airway was secure. The second physician anesthesiologist was facilitating communication with the patient and the video-interpreter. The student registered nurse anesthetist (SRNA) monitored the intubation and assisted with airway management equipment.

**Fiberoptic Bronchoscope Versus Video Laryngoscope**

Video laryngoscopes have proven to be an easy-to-use and highly adaptable addition to the anesthesia provider's airway management tools. The first commercially available VL, the GlideScope, was introduced in 2001 by Dr. John Pacey (Glick et al., 2013). Since then, numerous variations have been developed. The compact McGrath VL has been found to be slightly superior to other models (Kleine-Brueggeney et al., 2016). There may be a high degree of overlap between DL and VL. There is strong evidence indicating that the VL consistently

offers better views of the upper airway when compared with DL (Apfelbaum et al, 2013; Lewis et al., 2016; Liu et al., 2019; NICE, 2018). National associations such as the American Association of Nurse Anesthetists (AANA), the ASA, and the DAS have advocated for the use of the VL in the management of both the unanticipated, and the anticipated difficult airway (Apfelbaum et al, 2013). An advantage of the VL over the fiberoptic bronchoscope is the VL makes use of either a disposable plastic blade or an interchangeable re-usable blade. This feature allows the VL to be quickly cleaned between cases.

There has been speculation that the introduction of VL has decreased the rate of AFOI and might eventually replace fiberoptic intubations altogether. Jarzebowski et al. (2018) reviewed the rates of AFOI for one year after the introduction of VL to their institution. They reported that VL did not replace AFOI in their institution, but they did report an increased use of VL in the management of predicted difficult airways over any other technique including AFOI. It is likely that rates of VL will continue to increase.

There are certain airway characteristics that may be better suited to management with AFOI. For example, conditions that can complicate airway visualization, such as blood in the airway, obesity, airway edema, and cervical immobility have been associated with a higher rate of failure to intubate on the first attempt using a VL (Joshi et al., 2017). Most of these conditions are indications to consider AFOI. Blood in the airway is difficult to manage with both VL and AFOI because the camera lens can become obscured. Kristensen et al. (2020) published a review of management techniques for the bleeding airway. Suction catheters like a Yankauer, along with supplemental oxygen, should be attempted first (Kristensen et al., 2020). If the bleeding is above the larynx, the authors suggest the use of a Supraglottic airway device (SAD) in conjunction with

a fiberoptic bronchoscope to isolate the trachea from the source of bleeding. Therefore, it seems unlikely that fiberoptic bronchoscopy will be replaced.

### *Awake Video Laryngoscopy*

Video laryngoscopes have been utilized during awake intubations. At the start of the 3rd and final attempt at AFOI with Patient X, it was suggested that using a VL next may help improve the chances of success. The 3rd attempt was successful, so a VL was not used, but being able to guide the blade in under the direction of the camera coupled with the ability to sweep soft tissue out of the way may have improved the view of the larynx. When compared with AFOI, use of a VL in awake intubations has a shorter time to intubation (Alhomary et al., 2018). A benefit of using a VL in an awake intubation is there is no limit to how small of an endotracheal tube can be used (Alhomary et al., 2018). Very small diameter endotracheal tubes can be used because the tube does not have to be threaded over the fiberoptic bronchoscope. For the same reason, it is easy to exchange endotracheal tube sizes during intubation without removing the VL from the airway (Alhomary et al., 2018).

## Conclusion

AFOI is considered the gold standard in difficult airway management, yet it remains an under-utilized technique (Ahmad et al., 2016). Keeping a patient awake during intubation of the trachea does three things: preserves muscle tone in the upper airway, maintains a patent airway, and allows the procedure to be safely aborted if needed. These characteristics could be beneficial in any tracheal intubation, but in certain patients, the increased safety margin is considered best practice (Ahmad et al., 2019; Glick et al., 2013). Patient X exhibited a decreased physiologic reserve, difficulty maintaining a patent airway while awake, and the likelihood that she may deteriorate further. A standard induction would likely have caused her airway to obstruct and

there was a high probability that she would be difficult to mask ventilate due to her edematous airway. AFOI was selected as the best approach to airway management in Patient X and successful tracheal intubation was achieved with no apparent long-term sequelae.

The advent of the VL has made indirect visualization of the upper airway technically easier and more convenient for the anesthetist in the OR. The use of VL appears to have created a wide bridge between DL and fiberoptic bronchoscopy. However, it does not appear that VL is poised to replace it. The fiberoptic bronchoscope retains two unique abilities over the VL. First, it is able to pass through the nasopharynx or the oropharynx. Second, it can articulate the distal end of the scope to change the view or aid in navigation into the trachea.

Attempts have been made to standardize the steps of an AFOI, but more research is needed to compare the efficacy of various topicalization strategies in conjunction with differing sedation regimens. A review of the literature reveals an underutilization of AFOI by anesthesia providers. More research should be done to determine why anesthesia providers do not utilize AFOI more readily. The incidence of AFOI is not likely to increase enough to make periodic practice of AFOI unnecessary. More research into effective practice strategies for AFOI could help alleviate issues of confidence and familiarity in AFOI for anesthesia providers.

AFOI remains the best option for management of certain predicted difficult airways and is a valuable rescue technique in the unanticipated difficult airway. Therefore, anesthesia providers should review best practices in AFOI, including airway topicalization, sedation and fiberoptic scope management, in order to increase personal proficiency and confidence with AFOI and rates of utilization of AFOI.

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