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Review of Difficult Airway Management

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Original Research Article

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Abstract: The incidence of difficult airway and it's management frequently occur in the operating room. The anesthesiologists possess important responsibility to manage the difficult airway. Airway difficulties may be anticipated by the patient's airway assessment and asking previous anesthetic experience. Mallampati classification, Cormack and Lahane glottic appearance and Wilson Risk Sum are the most common methods to assess airway. An unpredictable difficult airway may occur, difficulty by mask ventilation, difficulty with intubation or can nor intubate cannot ventilate situation. American Anesthesia Association (ASA), DAS (Difficult Airway Society) create guidelines for difficult airway management .These guidelines provide a strategy to manage unanticipated difficulty with tracheal intubation. In this review general evaluation of the difficult airway management was made.
Keywords: difficult airway; preoperative evaluation; guidelines for difficult airway management.

INTRODUCTION

One of the main functions of the anesthesist in anesthesia practice is to maintain open airway and respiratory functions in respiratory depression that may develop with the normal effect of anesthetic agents. Many materials, devices and strategies have been developed to maintain open airway and ventilation. One of these alternatives is the procedure of endotracheal intubation. In routine practice, the procedure of inserting endotracheal tube (ETT) in trachea with the aid of laryngoscope is termed as endotracheal intubation [1].

However, it may not be possible to carry out this procedure easily in each patient. The condition called as '' difficult intubation'' was defined as'' the need for multiple interventions for tracheal intubation in the presence or absence of tracheal pathology''in difficult airway algorhythms of American Anesthesia Association (ASA) 2013 and DAS (Difficult Airway Society) 2013. It was originally defined by ASA in 2003 as '' insertion of at suitable tube with conventional laryngoscopy with more than three interventions, duration of more than 10 minutes or both [2]. However, due to the inadequacy of this definition, algorhythm was revised in 2013.

Preoperative evaluation and estimation of difficult airway

Evaluation of the airway is the first stage of successful airway management. Prediction of difficult airway helps to decrease the complications associated with inadequate ventilation, oesephageal intubation and difficult intubation [3]. Before anesthesia administration, history should be obtained from the patients and conditions that may affect airway such as systemic diseases, previous operations, traumas, body scars, treatments received, allergy and history of difficult intubation should be noted [4].

Conditions that may lead to difficult airway

Physiological, anatomical causes

Short, broad and muscular neck structure, small and backward shifting mandibula, protruding upper incisors, small mouth, long and highly arched palate, narrow and long mouth structure, movement restriction in mandibular joint, large tongue, large tongue root, excessive weight and high larynx [3, 4].

Congenital anomalies

In achondroplasia: Obtructive sleep apnea, in acromegaly; macroglossia in Anderson syndrome: severe midfacial hypoplasia in Arthogriposis multiplex; restricted mouth opening in Beckwith-Wiedeman syndrome; macroglossia in Carpenter syndrome; and hypoplastic mandibula may make intubation more difficult.

In Chubby Puffer syndrome; obstruction in upper airways, and cleft lip-palate ventilation difficulty and subglottic stenosis may occur. In cretinisim and hypothyroiditis, macroglossia, in Criducahat syndrome;

micrognathia, laryngomalacia, small larynx and epiglottis in Crouzon disorder, tracheomalacia and airway stenosis in Cystic Hygroma; cysts in tongue, neck and mediastinum in Down syndrome; subglottic stenosis, large tongue, instability in atlantoaxial joint in Edward syndrome; micrognathia in Epidermolysis bullosa; bullous lesions in pharynx and larynx in Farber's disease; sphingomyelin storage in larynx in Freeman- Sheldon Syndrome; fibrosis in facial muscles, limited mouth opening in Goldenhar syndrome: mandibula hypoplasia in hemophilia: risk of hematoma development in hereditary angioneurotic edema: edema in airway due to use of devices in hystiocytosis X': fibrosis in larynx in I-cell disease; restricted mandibular movement and nuchal rigidity in Klippel-Feil syndrome fusion of neck vertebrae, in Meckel syndrome; micrognathia and cleft epiglottis in Mobius syndrome; micrognathia in Morquois syndrome; atlantoaxial instability in Myositis ossificans; nuchal rigidity and limited mouth opening in Nooan syndrome; micrognathia in Oral-facial-digital syndrome; cleft lip-palate, hypoplastic mandibula-maxilla, in Patau syndrome; micrognathia in Pierre Robin syndrome cleft palate, micrognathia, in Pompe disorder; macroglossia in Scleroderma: fibrosis in skin, wounds in mouth in Silver-Russel syndrome; micrognathia in Smith-Lemni-Opitz syndrome; micrognathia, Tracheosephagal fistula, Subglottic stenosis in Treacher Collins syndrome ; micrognathia, microstomia, larynx stenosis and obstrcuctive sleep apnea syndrome render intubation more difficult.

Sleep apnea syndrome : Mask ventilation problems and the risk of airway obstruction with anesthesia inductionare present. In Osteogenesis imperfecta requires extreme care to be taken during positioning and intubation [5-7].

Inflammatory, degenerative and fibrotic events

Absces, epiglottitis, infectious mononucleosis, croup, rheumatoid arthritis, osteoarthritis, temporomandibular joint disorders, ankylosing spondylitis, calcifications in laryngeal joint, fibrosis in skin and neck (burn, radiotherapy), systemic diseases.

Obstructive lesions in the airway

Tonsillar hypertrophy, cyst, adenosis and tonsillar hypertrophy occurring in sleep apnea, hematoma, deformity associated with trauma, macroglossia, paratracheal pressure, large thyroid gland, morbid obesity, subglottic stenosis, space occupying lesion, tumor etc.

Endocrine causes: Acromegaly, large goitre, long term diabetes.

Factors leading to difficulty in mask ventilation

Having beard, large mandibula, missing teeth, history of snoring, advanced age, BMI>26.

Special groups

Pregnant women (increased airway edema, large breasts, increase in fat tissue), newborn, (anatomic differences,obese patients [6-8].

Tests and investigations to determine difficulty in intubation

Oropharyngeal appearance

It is the evaluation called as Mallampati classification. It is a test showing the ratio of tongue to oral cavity. It is based upon the appearance of pharynx formations. While the patient is in sitting position and head is in neutral position and the mouth is completely open and tongue completely outside. It has four classes [9];

- Class 1: All palate archus including bilateral tonsilar pili is visible until its base.
- Class 2: Large part of tonsillar pili and majority of uvula are visible.
- Class 3: Only palatum durum and velum are visible.
- Class4: Only palatum durum is visible.
- Class 3 and 4 has risk of difficult intubation.

Determination of the opening of mouth (inter incisor distance)

It should be 4 cm or over. Conditions such as fibrosis, scar, infection, trismus, scleroderma, temporomandibular joint disorders may lead mouth opening to be restricted.

Upper lip biting test

Lower teeth are are brought in front of upper teeth. Hence, mobility of temporomandibular joint (TMJ) is evaluated. TMJ movement restriction may emerge due to causes such as infection, radiotherapy (RT), scar associated with previous surgery, rheumatoid arthritis, osteoarthritis or trauma in mandibula.

Tiromental distance

It is also known as Patill sign. It is the measurement of the distance between lower middle end of mandibula and thyroid notch in larynx while head is in extension and mouth closed. Overlapping of laryngeal axis and pharyngeal axis during laryngoscopy is important. If it is short, it will be difficult to straighten the angle between joints. If it is 6 cm. or shorter, this is a risk factor for difficult intubation [10].

Sternomental distance

It is the measurement of the distance between mentum and sternal notch while the head is in complete extension and mouth closed. If it is 12.5 cm or shorter, this is considered as a risk factor.

Horizontal mandibula length

It is the measurement of the distance between corner of mandibula and mentum. If it is 9cm or shorter, difficult intubation is expected.

Mobility of Atlantaoccipital joint, extension degree of the head

Cervical movement, neck extension movement restriction, cervical vertebra osteoarthritis, anklosing spondylitis, scar tissue, rheumatoid arthritis, or counterindication of neck flexion due to cervical vertebra injury. Above conditions may lead to movement restiction.

*Angle between upper teeth occlusal aspect and horizontal plane: It is normally 35 degree. It is among the bed side tests. In this test, patients sits upright and looks straight ahead. Patient brings neck to extension to open the joint to maximum. The angle between occlusal aspect and horizontal line is evaluated. The degree of narrowing is evaluated according to mouth opening. Grade I: no narrowing, Grade II: 1/3 narrowing, Grade III: 2/3 narrowing, Grade IV: complete lack of opening.

*The angle between mouth corner- tragus line and horizontal line. Patient lies in supine position with head at extension. If the angle is under 80 degrees, the risk of intubation difficulty is considered.

CormackLehane (CL) score

It is a classsification made according to the appearance of vocal cord and epiglottis under laryngoscopy. Accordingly, Grade 1: Glottis is easily visible Grade 2: posterior commissura of Glottis is visible, Grade 3: only epiglottis is visible Grade 4: none of the structures are visible Grade 3 and 4 are risk factors for difficult intubation [11].

Wilson risk score

Wilson *et al*., combined weight, head and neck movements, jaw mandibular movements, small mandibula and protruding teeth factors and made an evaluation each factor was scored between 0 and 2 and 75% sensitivity and 85% specifity was obtained in their analysis [4], and for each group, score 2 was considered as risk of difficult intubation.

Table-1: Wilson risk score

Risk Factors	Risk Level
Weight : < 90	0
90-110	1
> 110	2
Head and neck movement : > 90	0
90	1
< 90	2
Mandibular movement : Mouth opening > 5	0
or subluxation > 0	1
Mouth opening < 5 or subluxation= 0	2
Ağız açıklığı < 5 veya subluksasyon< 0	
Backward shifted mandibula: Normal	0
Moderate	1
Excessive	2
Protruding upper teeths: Normal	0
Moderate	1
Excessive	2

Prayersign

In patients with long term (juvenile) diabetes, stiff joint syndrome associated with joint rigidity and tight skin may occur. Fourth and fifth phalanx joints are usually involved. Patients have difficulty in bending their fingers and palmar areas. If cervical involvement and atlantooccipital involvement also occurs, intubation difficulty may develop. Joint involvement is evaluated with prayer sign test, which evaluates to what degree the palmar area of the patient contacts a flat surface. Patients with joint involvement, can not completely joint their palms [12-14].

Difficult airway

In general, difficults airway is defined as the difficulty encountered by an experienced anesthesia consultant in mask ventilation and/or tracheal intubation [15]. Difficult airway occurs associated with factors such as personal characteristics of the patient, available facilities in the clinic, and the experience, choices and skill of the clinician, components of difficult airway are described as difficult mask ventilation, difficult laryngoscopy, difficult tracheal intubation and unsuccessful intubation [16].

Difficult mask ventilation

While carrying out ventilation with face mask and FiO_2 %100, if SpO_2 < %90, experiencing difficulty in mask ventilation due to one or more of factors such as improperly placed mask, excessive gas leak, increased resistance loss in gas entrance and exit.

Conditions indicating inadequate mask ventilation are as follows; cyanosis, desaturation, inability to measure expiratory gas flow with spirometry, absence of respiratory sounds, inadequacy

or absence of chest wall movements, auscultation findings of severe airway obstrcution, air entrance to stomach, distension and hemodynamic changes associated with hypoxemia and hypercabia (arhythmia, hypertension, tacycardia etc.). In conditions encountered with difficult mask, a rapid evaluation should be made for these signs. Respiration of the patients and open airway is evaluated with inspection and auscultation. Evaluation should be made for cyanosis, pallor, hypersalivation, gastric content, foreign body in mouth and pharynx, maxillofacial and cervical trauma. Abnormal respiratory sounds, wheezing and stridor are manifestations of partial airway obstruction. Stridor in inspiration is a sign of stricture upper part of larynx while wheezing heard in expiration is a sign of stricture below larynx. They indicate the presence of difficulty in ventilation. Present conditions should be evaluated for the maintenance of ventilation or changes should be made. If the presence of foreign body in airway is considered, Heinrich maneouver may be performed, and it may be removed with a suitable forceps of finger. In order to provide airway patency;

- Head and neck is positioned again. Head is brought to extension and mandibula is elevated. In conditions when tongue moves backwards, airway use may be considered.
- If the size of the mask is not suitable for the face of the patients, masks at different size or form may be tried.
- If ventilation remains inadequate, position of head, gas leak from mask and elevation of mandibula is checked again.
- After muscular relaxation, airway obstruction may occur with the shift of mandibula to front on temporomandibular joint. Hanging ramus to upwards with little finger may improve this condition.
- If ventilation is still inadequate, two hand mask technique is attempted.
- If there is still no response to these efforts, intra oral area is checked again with direct laryngoscopy and or finger. If present, the cause of obstruction is removed. If there is no obstructive condition, airway edema (infection, anaphlaxy, trauma etc.), laryngospasm , bronchospasm (asthma, foreign body, irritants, anaphylaxy etc.) edema (irritants, anaphylaxy, infection, neurogenic shock, heart failure) may be considered and treatment for them may be administered.
- In case the problem continues, different airway devices such as supraglottic airway devices may be used.
- If ventilation is not still possible in spite of all attempts, help should be sought immediately and difficult airway algorhythm should be implemented [16, 17].

Difficult Laryngoscopy

It is the inability to visualise any part of vocal cords after more than one attempt with classical laryngoscopy [13]. There are some conditions of carrying out laryngoscopy under direct vision. Adequate flexion of lower cervical vertebrae, adequate extension of the head over atlantooccipital joint, mouth opening being large enough to allow entrance of laryngoscope, and phayrngeal cavity being large enough to allow laryngoscopic view are prerequisites for laryngoscopy and intubation procedures. When one or more of these conditions can not be met, situations such as difficulty in seeing larynx and placing tube in larynx or both arise. In this respect, preoperative evaluation of the patients may aid in the prediction of difficult laryngoscopy [17].

Difficult Tracheal Intubation

ASA (American Anesthesia Association) 2003, DAS (Difficult Airway Society) 2004, defined difficult tracheal intubation in their difficult airway algorhythms as '*The need for multiple attempts for tracheal intubation in the presence or absence of tracheal pathology'*. The definition of difficult intubation is in fact a subjective evaluation. It may vary depending on the person who will carry out intubation, conditions and the person who will undergo intubation. As to complications, it may even lead to fatal results. Therefore, the practician should determine before hand what he/she should do under these conditions. Many algorhythms have beeen developed for this purpose. There are difficult airway flow charts prepared by ASA (Amerikan Anesthesia Association) in 2013 by, DAS (Difficult Airway Society) in 2015. These algorhythms may be used as guide in struggle against difficult airway [16, 18].

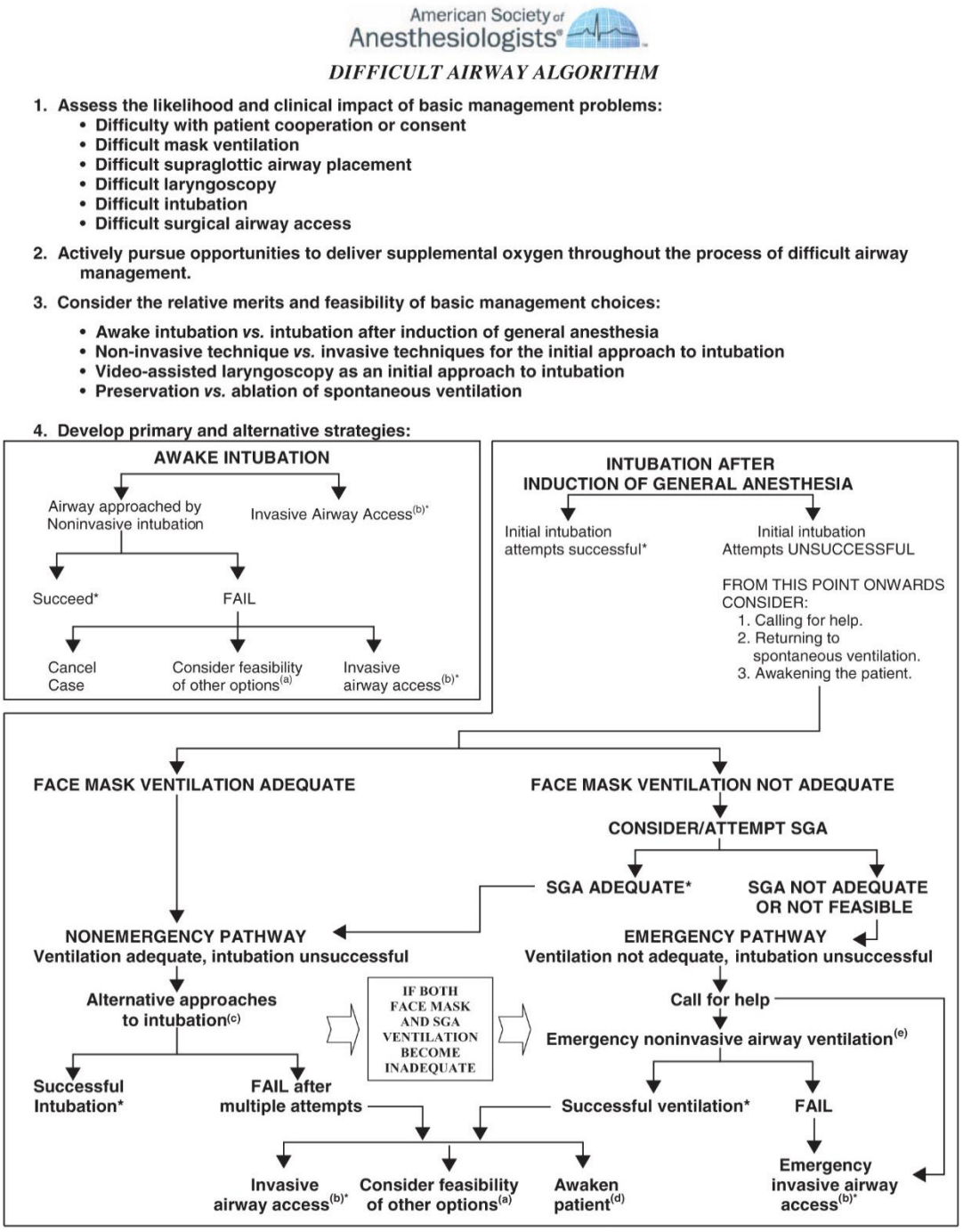
Unsuccessful intubation

It is the misplacement of endotracheal tube after more than one attempt.

Difficult airway algorhythms

When difficult airway is not managed properly, it may lead to serious complications. A clinician confronted with difficult airway should be informed beforehand on what should be done in this situation. However, both the effort to act rapidly due to urgent conditions, and the presence of may different devices and techniques for use in difficult airway may bring about a complex and confusing picture. In order to prevent this confusion and serious complications, and to guide the clinician, various difficult airway algorhythms have been developed. The most commonly accepted and most recent algorhythms are desrcibed below:

ASA Difficult Airway Algorhythm [16]



***Confirm ventilation, tracheal intubation, or SGA placement with exhaled CO_2.**

a. Other options include (but are not limited to): surgery utilizing face mask or supraglottic airway (SGA) anesthesia (e.g., LMA, ILMA, laryngeal tube), local anesthesia infiltration or regional nerve blockade. Pursuit of these options usually implies that mask ventilation will not be problematic. Therefore, these options may be of limited value if this step in the algorithm has been reached via the Emergency Pathway.

b. Invasive airway access includes surgical or percutaneous airway, jet ventilation, and retrograde intubation.

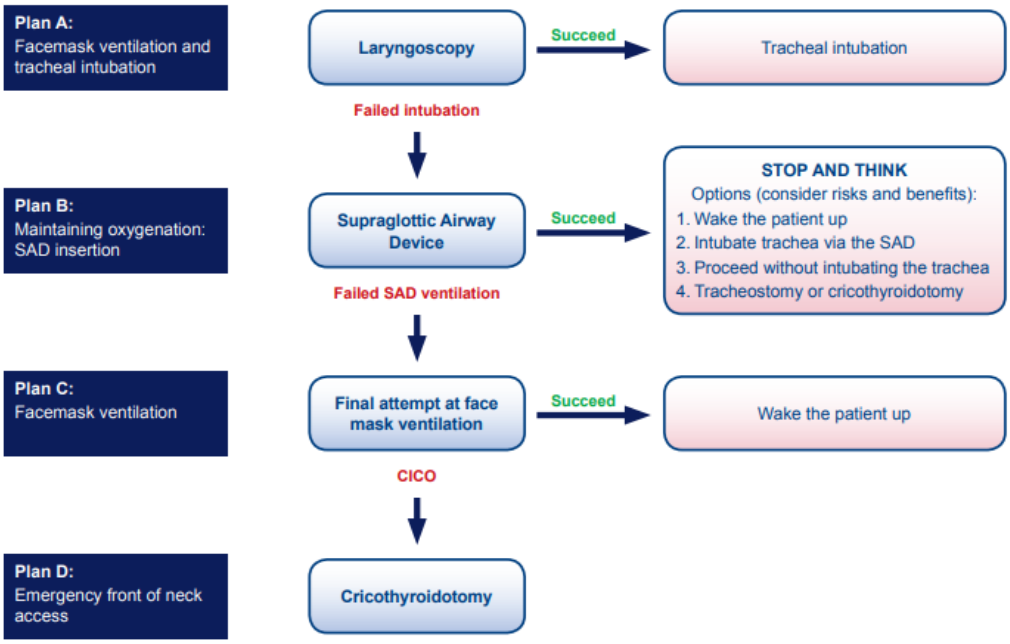
c. Alternative difficult intubation approaches include (but are not limited to): video-assisted laryngoscopy, alternative laryngoscope blades, SGA (e.g., LMA or ILMA) as an intubation conduit (with or without fiberoptic guidance), fiberoptic intubation, intubating stylet or tube changer, light wand, and blind oral or nasal intubation.

d. Consider re-preparation of the patient for awake intubation or canceling surgery.

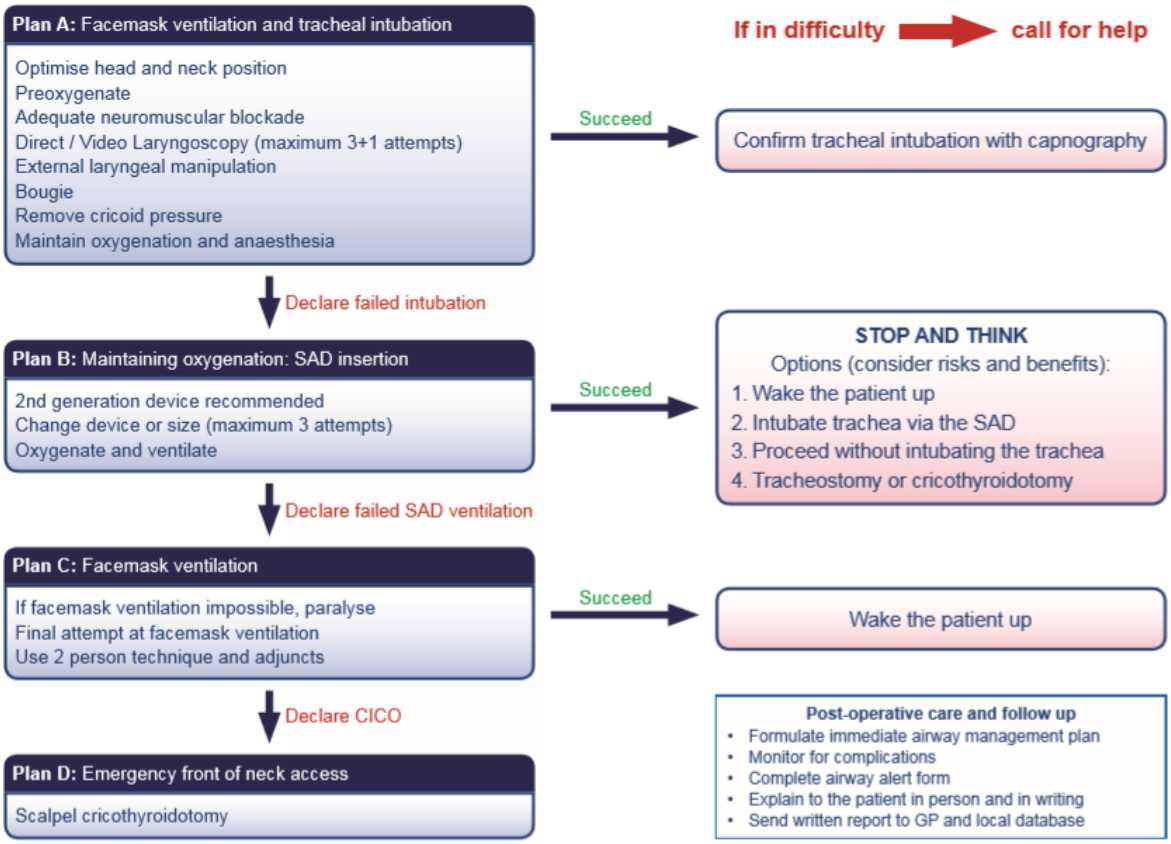
e. Emergency non-invasive airway ventilation consists of a SGA.

Fig-3: DAS 2015general overview of difficult airway CICO(can't intubate can't oxygenate) SAD (supraglottic airway device):

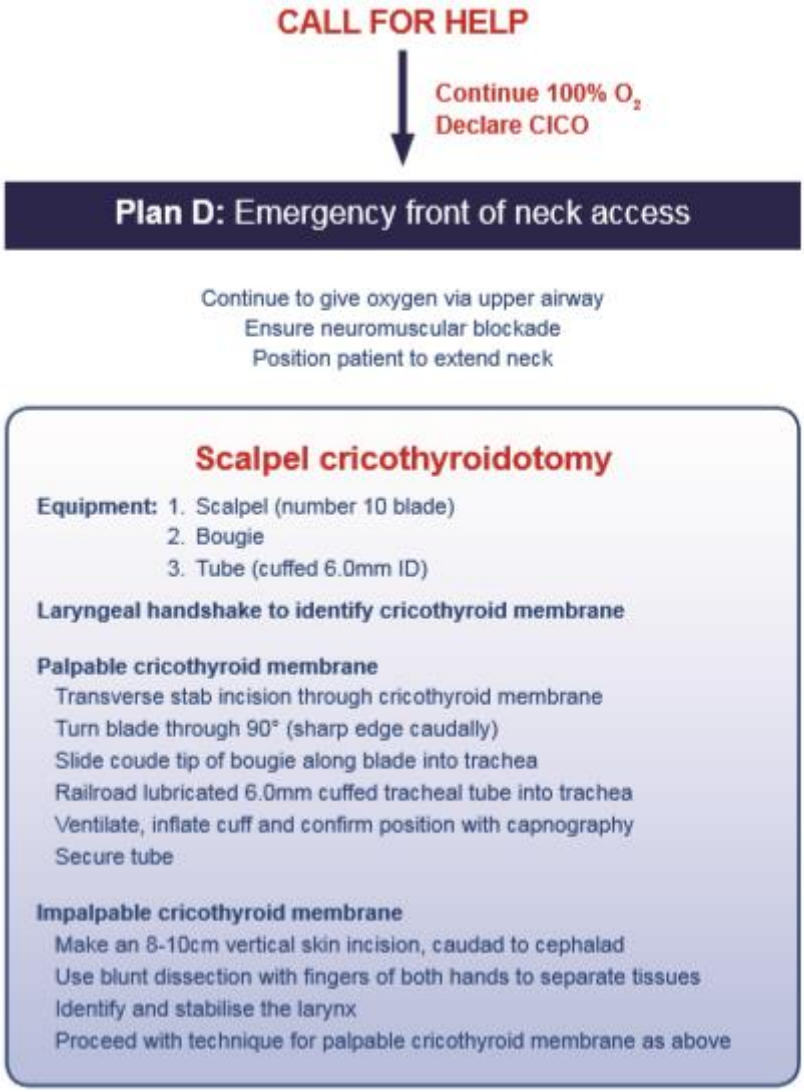
DAS (Difficult Airway Society) *Algorhythm [18]*



DAS Difficult Intubation Guidelines – Overview



Management Of Unanticipated Difficult Tracheal Intubation In Adults



Failed Intubation, Failed Oxygenation In The Paralysed, Anaesthetised Patient

Extubation of the patient with difficult airway

In patients with difficulty in obtaining open airway, problems are also likely to occur during extubation. These problems may be severe enough to require reintubation of the patient associated with difficulty in ventilation. Therefore, just as it is prior to intubation, experienced team and all kinds of material and devices should be kept ready.

Recommendations; a-A plan should be prepared for extubation in difficult airway. This plan should be prepared taking type of surgery, general condition of the patient, and information and skill of the clinician into account.

Necessary components of extubation plan:

- Comparison of the advantages of awake intubation with those of extubation under deep anesthesia.
- Establishment of clinical factors that may lead to difficulty when ventilation is required after extubation.
- Determination of a strategy against the probability of failure in ventilation after extubation.
- Having a system as a guide in case of reintubation: Tube changing stylets , catheters may be used for this purpose. Stylet is placed into the lumen of tube without removing the tube. This system is left in trachea while removing the tube. In case of reintubation, it may serve as guide or in systems with a possibility of jet ventilation, ventilation may be possible again via this route.

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