Airway Management

Practice Guidelines for Airway Management of the German Society of Anaesthesiology and Intensive Care Medicine*

Introduction

Since 1993, practice guidelines for airway management have been adopted in the U.S., Canada, France and Italy [3, 7, 9, 12, 19]. All these national professional societies agree that a defined scope of action relevant to country-specific circumstances can reduce the number of airway-related complications.

During the evolution of these guidelines, a survey was conducted about how airway management is practiced at university and teaching hospitals in Germany. It was revealed that the repertoire of procedures actually implemented is rather limited and that even though alternate techniques involving laryngeal masks, combitubes and fibre bronchoscopes among others are practiced, their use is not applied in the broad range required [13]. Continuing education is largely unstructured and the impression has emerged that many hospitals tend to subscribe to a philosophy of "learning-by-doing" that underlies an unsystematic gathering of experience.

A review of anaesthesia-related mortality in Western countries has found prevalences of between 0.4 and 2 in 10,000 [10]. The French INSERM study revealed that deficient airway management is the cause of over 50% of the serious anaesthesia-associated complications

*Adopted by the DGAI (German Society for Anaesthesiology and Intensive Care Medicine) on March 6, 2004.

involving both fatal events and those leading to irreversible coma, but also in manageable situations [26]. The true figures that emerge from inferences in expert opinions and clinical case reports seem to indicate an underreporting of such frequencies in publications.

Objective

The objective of these practice guidelines is to ensure that the quality of medical practice complies with the specific standards of care and professional services set down by the German Society of Anaesthesiology and Intensive Care Medicine. The quality of these requirements is aimed at the level required of a board certified specialist.

The results of the survey showed that efforts should furthermore focus on disseminating alternative methods of maintaining free airways and on better cementing them in anaesthesiological practice, whilst developing criteria for structured continued medical education.

Pre-anesthesia airway screening

Whenever possible prior to administering anaesthesia, an airway history should be established and the findings used to guide airway management. This purpose is not only served by a pre-anaesthesia consultation, but also by studying any existing anaesthesia records, if available.

An airway-related examination is similarly required to establish any distinguishing features of the patient's mouth, face, dentition, jaw, tongue, neck and cervical spine.

The focused assessments described above that rely on grading systems according to *Mallampati, Patil* et al. [15, 18] to predict risk during difficult laryngoscopy have only moderate sensitivity and specificity and are therefore unsuitable for reliably predicting the difficulties to be encountered with the technique. By contrast, evidence in the literature suggests that isolated symptoms and, in particular, symptom clusters are predictive as to whether difficult airway management should be anticipated [7, 11, 20, 21]. Especially, if they occur in a cluster, the criteria listed below may indicate that face mask ventilation, placement of a pharyngeal breathing device or conventional intubation are impossible.

Mask ventilation

– Trauma, scarring, tumours or local inflammation of the lips and face

– Jaw anomalies

– Tooth loss

– Very large tongue or other pathological anomalies of the tongue

– Pathological anomalies of the pharynx, larynx or trachea.

Pharyngeal airway

– Extent of mouth opening, 2 cm and less (interincisor distance)

– Trauma, scarring, tumours or local inflammation of pharynx or larynx.

Tracheal intubation

– Very long maxillary incisors

– Prominent maxillary overbite

– The mandibular incisors cannot be brought on to or in front of the maxillary incisors.

– Extent of mouth opening, less than 3 cm (interincisor distance)

– Uvula is not visible with patient in sitting position, when tongue is protruded, or during

phonation

- Palate highly arched or very narrow
- Tissue of the mandibular space appears voluminous, indurated or non-resilient
- Thyromental distance of less than 3-fingerbreadths (6 cm)
- Short or thick neck
- Patient cannot touch tip of chin to chest, or cannot extend head.

The Four Stage Scheme

To illustate our concept of airway management a simple four stage scheme was devised, allocating the airway management techniques with increasing invasiveness to different stages (Fig. 1). There are four stages, starting from the awake condition with consciousness, spontaneous ventilation and intact reflex activity (Fig 2A) . Before mask ventilation can be performed, anesthesia is provided (Stage 1, Fig 1 and Fig 2B). At a deeper level of anesthesia, a supraglottic, pharyngeal airway like the LMA can be introduced (Stage 2). Intubation is executed after muscular relaxation is provided (Stage 3). The surgical airway (Stage 4) is left for the ultimate emergency situation, but can also be performed in case of an anticipated difficult airway.

Elective airway Management

Airway management is carried out by means of a face mask, pharyngeal device or tracheal intubation (Stage1-3). Careful assessment of less invasive techniques can be useful to avoid the risks of more invasive methods, whenever they are not indicated. Clinical studies have

substantiated the theory that preoxygenation increases patient safety [1, 6, 17, 28]. As a rule, the face mask, pharyngeal device or tracheal tube are used for anaesthesia, the latter in conjunction with muscle relaxation. Anaesthesia is administered with the face mask if there is no indication for a pharyngeal device. Likewise, a pharyngeal device, e.g. laryngeal mask, is utilized if there is no indication for intubation. The devices used for pharyngeal, supraglottic airway maintenance are summarized in Table 1.

The decision to use a more invasive pharmacological and technical approach should always be made in stages, bearing in mind that each measure must be quickly reversible and that each subsequent step should be verified before proceeding on to the next (Fig 1, 2B). For example, an assessment of mask ventilation should be done before carrying out muscle relaxation. If mask ventilation proves difficult, the two-handed mask grip is applied. The use of long-acting, non-depolarising muscle relaxants is not appropriate if it is not certain whether intubation can be carried out easily. During anaesthesia the possibilities of alternative airway maintenance should be tested and recorded, if possible, e.g. mask ventilation before applying a pharyngeal device or tracheal tube.

Conventional intubation is carried out using a Macintosh blade. Upon laryngoscopic visualization of the larynx, the difficulty to be anticipated with laryngoscopy and intubation can be classified into increasing grades as published by Cormack and Lehane [8]. If epiglottis, vocal cords and cricoid cartilage are completely visualised, the airway is classified as grade 1. If the vocal cords are only partially visible, the airway is classified as grade 2; if only the epiglottis can be visualised, the airway is classified as grade 3. Grade 4 is given, if none of these structures is within the visual field.

When the laryngoscopic findings allow a classification of Cormack and Lehane grades 2 - 4,

simple manoeuvres will improve the view. Here, manoeuvres such as the OELM (optimal external laryngeal manipulation [4]) – and/or BURP (backward upward rightward laryngeal displacement [24]) methods are appropriate. There is also the possibility to achieve the optimal laryngoscopic findings using other intubation instruments. In addition to the conventional and alternative instruments and blades, new video-optical laryngoscopes can be particularly useful to this end. Table 2 contains a list of alternative rigid laryngoscopes with which the Cormack and Lehane criteria can also be applied in a modified way. The McCoy levering laryngoscope offers the classic view, which may improve during the endoscopic manoeuvre.

The position of the airway instrument can be optionally checked by

- Inspecting the larynx during and after the insertion of the tube (tracheal intubation)
- Examining the respiratory movement of the ventilated chest
- Auscultation of the epigastrium and lungs on both sides.

Monitoring procedures such as

- Volumetry
- Capnometry (clear signal)
- Pulse oximetry (not calibratable, delayed signal)
- Endoscopic monitoring by fibre bronchoscope.

(The shaded methods provide the greatest safety when assessing the tracheal tube position).

Whenever there is a danger of aspiration, as during rapid sequence induction, the elements of low-risk tracheal intubation include medical prophylaxis, positioning with elevated upper body, placement of a gastric tube and gastric suctioning, the provision of powerful suction device equipped with a large-lumen suction catheter in preparation for anaesthesia induction,

sufficient pre-oxygenation of the conscious patient, cricoid pressure, short-acting muscle relaxation, ablation of manual ventilation and tracheal tube with stylet.

Definition of difficult airway management

These definitions apply to clinical situations where a trained, board-certified anaesthetist, well versed in alternative methods, is engaged. Airway management is defined as difficult at the moment that the selected technique fails.

1. Difficult face mask ventilation

Face mask ventilation fails due to unavoidable leaks or excessive ventilation resistance. Mostly, clinical signs are present, such as absent respiratory movements of the chest, absent or inadequate or spastic breath sounds, cyanosis, gastric flatulence, low or falling oxygen saturation, absent or inadequate volume measurements of exhaled air, and clinical signs of hypoxemia and hypercapnia.

2. Difficult pharyngeal airway maintenance

Placement of a pharyngeal instrument is not possible even after repeated attempts, and, as a result, ventilation cannot be carried out. It is not possible to achieve an adequate seal on the pharyngeal level.

3. Difficult laryngoscopy

Even after repeated attempts, it is not possible to insert the laryngoscope in such a way that a portion of the vocal cords can be visualised.

4. Difficult tracheal intubation

Tracheal intubation fails although it was possible to visualise portions of the vocal cords by laryngoscopy. These difficulties might be due to pathological changes of the larynx or trachea.

5. Failed intubation

Placement of the tracheal tube has failed completely.

Difficult airway management

Preparations

The patient is informed about the measures required, and the benefits and disadvantages of the techniques used. A mobile unit containing the instruments required for difficult airway maintenance is available (Table. 3). In addition to the anaesthetist and anaesthesia nurse, a medical or non-medical assistant is involved. Pre-oxygenation is an important part of the individual measures. Table 3 lists some instruments and materials for such a mobile unit.

Strategy

The strategy used for the procedure depends on the patient's general status, the intervention and the anaesthetist's options. The basic options are to perform airway instrumentation on the conscious patient or secondary to anaesthesia induction, to maintain or interrupt spontaneous breathing, or to select a non-invasive or invasive technique (cricothyrotomy, tracheotomy). Planning which type of procedure is indicated and the order in which the measures are to be carried out is indispensable. This planning must also address the question as to which options are otherwise available if individual steps fail and where help is available if the situation becomes unmanageable with the equipment at hand and individuals present.

Anticipated difficult airway management

It is paramount to keep the patient conscious and breathing spontaneously until the airway is secured using a pharyngeal or tracheal instrument specifically designed for airway maintenance (Fig 3). In an uncooperative patient, at least spontaneous breathing should be maintained. Fibreoptic intubation or placement of a laryngeal mask with the patient awake and/or under mild sedation and local anaesthesia are associated with a high success rate and low risk. Retreat is always possible.

In exceptional cases, where the patient can no longer be transferred to a specialised hospital, elective tracheotomy under local anaesthesia may become necessary prior to a surgical intervention with difficult airway maintenance, particularly if alternative methods of airway management are not available or prove unsuccessful (Stage 4, Fig 1, 2).

Another approach involves airway instrumentation secondary to anaesthesia induction. This approach should be selected when instrumentation of the awake patient is not feasible. A pharyngeal airway can be used as a conduit for intubation when intubation is indicated. The use of regional anaesthesia (RA) is principally suited to prevent airway-related morbidity and mortality. Nevertheless, it does not basically solve the problems associated with difficult airway instrumentation since a switch to general anaesthesia will be required with an occasional frequency. Therefore, in order to avoid difficult airway situations, a strategy for managing the difficult airway should always also be formulated for the cases where regional anaesthesia is employed.

Unanticipated difficult airway maintenance

Unanticipated difficult airway maintenance, especially intubation, is a problem central to conventional airway algorithms. The management strategy should also include the possibility

to call for help or to activate an emergency alarm.

Since the patient is unconscious and usually medicated with a muscle relaxant, the options in this situation are restricted to four, whereby the strategy should always aim at the most minimal invasiveness (Fig 3):

1. Continue intubation attempts on the anaesthetised, muscle-relaxed patient, also utilizing alternative intubation methods and changing the anaesthetist (Stage 3). During this time, face mask ventilation is required.
2. Return to management with a laryngeal mask, intubation laryngeal mask or another pharyngeal instrument (Stage 2). If required, intubation can now be carried out blindly or endoscopically, e.g. using the laryngeal mask as a conduit.
3. Wait for spontaneous breathing and perform fibreoptic intubation under steady spontaneous breathing (Stage 1).
4. Wait for the patient to awaken spontaneously (Stage 0). Attempt anaesthesia induction at another time, e.g. by planned fibreoptic intubation on the awake patient.

The first option carries the risk of injury and oedema formation and should only be carried out with great caution by the most experienced anaesthetist available. It should not be attempted too often so as not to endanger the patient. The second possibility is selected to keep the anaesthetist's hands free whilst accomplishing adequate anaesthesia. At this point, the decision is taken as to whether intubation is required or not. If required, intubation can be carried out blindly with the intubation laryngeal mask, or fibreoptically under direct vision. If intubation fails, options 3 and 4 can still be carried out. The principal course of action in unanticipated difficult intubation is away from the more invasive and therefore more

dangerous high stages, just the opposite from the steps taken in elective airway management (Fig 1, 2, 3).

There are alternative methods for difficult intubation that can be applied when sufficient experience with the specific techniques is available (Table. 4). Table 5 shows some devices that are useful in managing difficult intubation.

The "can't intubate, can't ventilate" situation

If oxygenation and ventilation are not possible despite extensive attempts at mask ventilation and intubation (the "can't intubate, can't ventilate" situation), pharyngeal instruments (laryngeal mask, Combitube) or a forward strategy aimed at cricothyroidotomy or emergency tracheotomy are indicated (Fig 3).

Cricothyroidotomy can be carried out using three different approaches [2, 25, 27]: The percutaneous cricothyrotomy with a 2-mm cannula for oxygen insufflation or jet ventilation with a 4-mm cannula and the surgical approach for the insertion of a 6-mm tube. For the short-term, oxygenation should be secured with the thin cannula; ventilation is usually not possible. The reliable egress of the respiratory gases to the cranial is indispensable to prevent barotrauma. Surgical cricothyrotomy creates the best ventilation conditions. Emergency tracheostomy should be reserved for the surgeons or ear, nose and throat specialists who perform such surgeries on a regular basis.

Airway management in pathological conditions of the cervical spine

Special clinical situations such as cervical spine injury or advanced rheumatoid arthritis require special positioning and laryngoscopy conditions and are therefore considered dangerous for the integrity of the cervical spinal cord [5]. It is imperative that this risk be minimized through carefully positioning and placement of a neck collar or head extension.

Awake fibreoptic intubation or laryngeal mask intubation prevent movements of the head and cervical spine to the greatest possible extent; these procedures can thus be regarded as very safe under such circumstances.

On the other hand, it has not been proven unequivocally that conventional intubation attempts jeopardize the cervical spinal cord [16, 22, 23]. There are no data in the literature indicating that conventional intubation techniques cause damage as long as compliance with specific treatment criteria such as head and neck positioning, neck collar or extension is assured and the cervical spine is not moved beyond the limits typical for the method.

Documentation and patient information

The particular circumstances of difficult airway maintenance should be documented meticulously in the anesthesia record. It is recommendable to inform the patient about the time, hospital and type of the care in writing and using generally understandable terms. Additionally, an entry must be made in the anaesthesia identification (ID) card issued by the DGAI (German Society for Anaesthesiology and Intensive Care).

Removal of the airway instrumentation

Consistent with the strategy for difficult intubation, a concept for tracheal tube removal is also required which depends on the type of surgery, the patient’s general status and the anaesthetist's experience. Ideal locations include operating theatres and intensive care units where all measures for airway maintenance are available in the event that unimpaired respiration does not commence spontaneously. The strategy and the preformulated methods

should focus on the problems to be anticipated.

Follow-up care

Any difficult airway management should be documented in the medical records in a way that ensures safe treatment in the future. This also includes an entry in the medical records, a mention in the doctor's report and information for the attending surgeon. The patient should be informed about the difficulties encountered and be able to present the written information as well as the filled-in anaesthesia ID card. The written information must indicate which methods of each treatment stage were difficult and which methods could be used successfully and are thus recommendable. In addition, the ID card should state the name of the treating physician, the hospital, the time, date and the type of care given.

Continuing medical education

The principles of airway management are learned by acquiring theoretical knowledge and gaining practical skills on mannequins and patients. Time for this learning process should be allocated as an integral part of all continuing medical education, but may certainly extend beyond this. The best way to learn these principles and develop these skills takes 4 steps [14]. A board-certified specialist well-versed in the objectives set forth in these practice guidelines must be trained in all four of these steps. An instructor can be employed to teach individual methods from step 3. Skilled experts in airway maintenance with board certification and senior consultant status should be responsible for the continuing education of anaesthetists in-training and especially for the instruction of future teachers.

1. Learn the basic theoretical principles, be familiarized with the instruments

2. Learn the basic principles of airway management on mannequins, cadavers, simulators and patients; participate in a course on airway maintenance
3. Gain knowledge about alternative methods of airway maintenance under supervision. Perform fibreoptic intubation on anaesthetised patients without difficult airways and then on awake patients with difficult airways.
4. Perform airway maintenance on patients with extreme pathology; train constantly; participate in advanced courses.

The anaesthetist's attitude and work ethic is fostered by an appreciation for airway management. This attitude becomes second nature during specialisation training. It is the responsibility of the medical director of the department in cooperation with the senior consultants to identify deficits in a junior anaesthetist's attitude, skills and capabilities and to remedy them. The elements of airway management must also be an integral part of the continuing education discussions and board certification examination.

Prepared by the task force on guidelines for Airway Management of the German Society of Anaesthesiology and Intensive Care Medicine

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Published in the journal Anaesthesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie 2004; 45: 302-306

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Tables

Table 1: Pharyngeal instruments for securing the airway
Laryngeal mask
Laryngeal tube
Combitube

Table 2: Alternative rigid intubation instruments
Lever blade laryngoscope *(McCoy*)
Straight blade (*Miller* or *Henderson)*
Retromolar intubation fiberscope *(Bonfils)*
Bullard laryngoscope

Table 3: Contents of a mobile unit for difficult airway management
Alternative laryngoscopes
Stilets, gum elastic bougie, tube exchanger
Laryngeal mask airways, intubating laryngeal masks
Combitube
Other pharyngeal instruments of choice
fibrerbronchoscopy
Instruments for jet ventilation, e.g. Manu-Jet®
Cricothyroidotomy sets
Surgical knives

Table 4: Alternative intubation methods
Alternative rigid instruments
Intubating laryngeal mask and other pharyngeal intubation instruments
Instruments for fibreoptic intubation
Intubation tracheoscopy (emergency tube)
Blind intubation
Transillumination (Trachlight)
Retrograde intubation

Table 5: Assistive devices for difficult airway management
Stilets
Gum elastic bougie
Tube exchanger
Magill forceps
Tongue forceps
Mainz adapter
Endoscopy mask
Optosafe
Slotted Guedel tubes

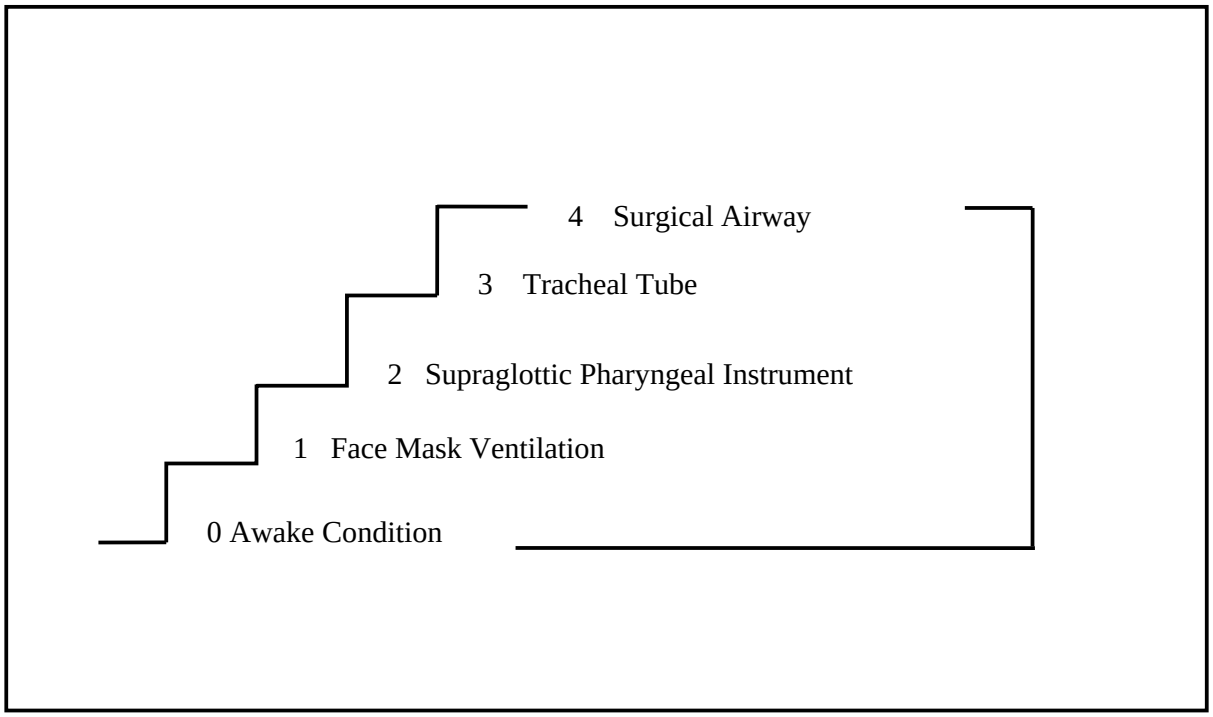

Fig 1: Four Stage Scheme

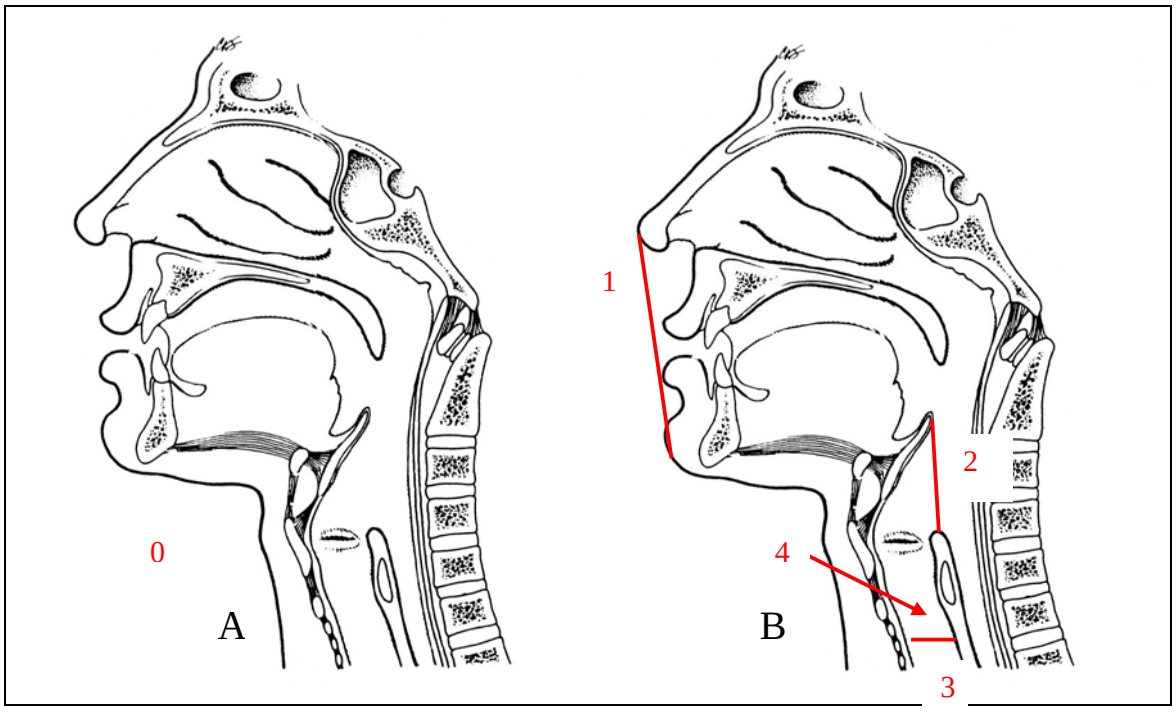

Fig 2: Anatomical View with A: conscious state (Stage 0), B: Anesthetic State with Airway Stages 1-4

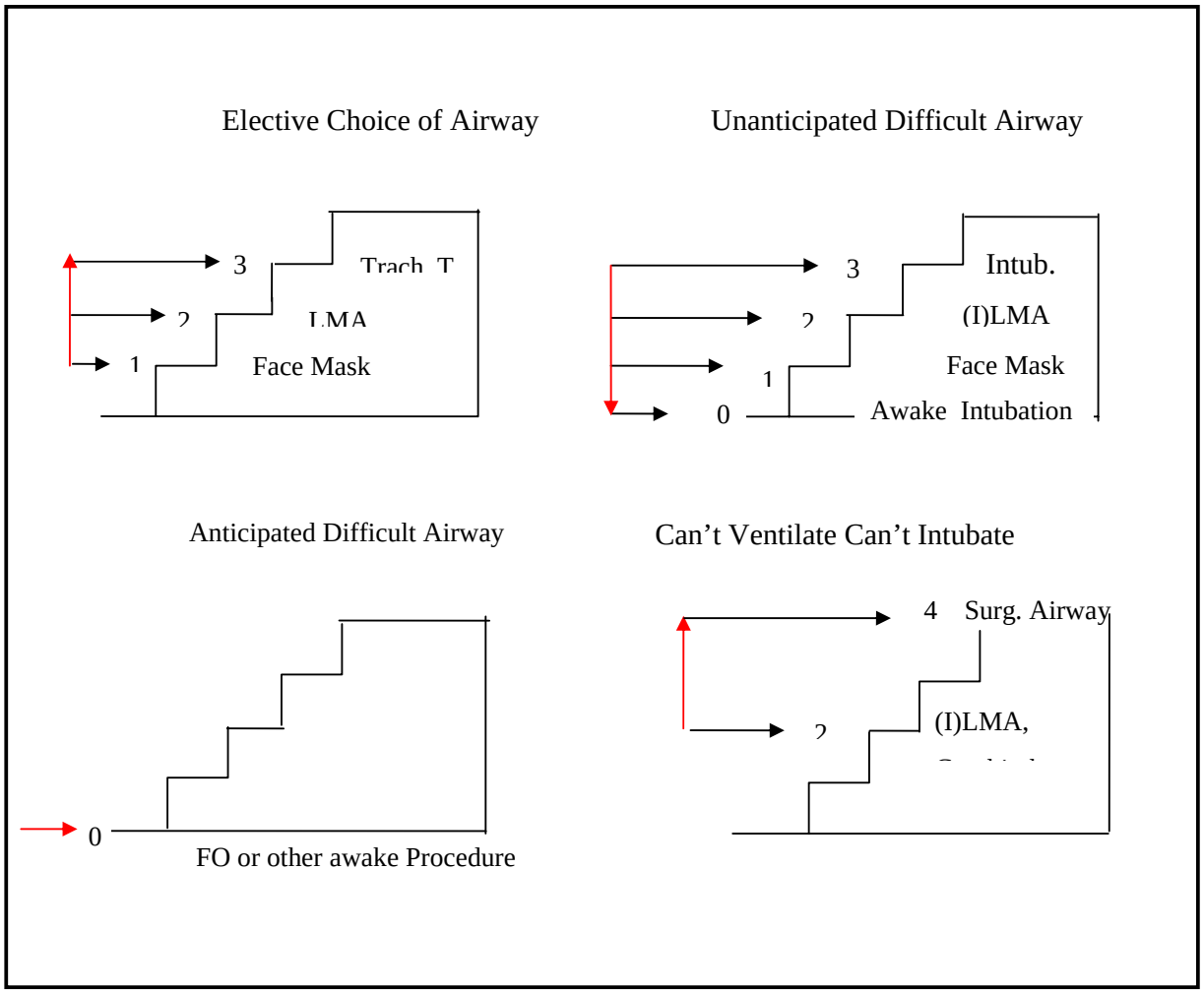

Fig 3. Application of the Four Stage Scheme to the principal management options: elective choices, unanticipated difficult airway, anticipated difficult airway, can't ventilate can't intubate situation.