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CONSENSUS STATEMENT

Spanish Society of Anesthesiology, Reanimation and Pain Therapy (SEDAR) Spanish Society of Emergency and Emergency Medicine (SEMES) and Spanish Society of Otolaryngology, Head and Neck Surgery (SEORL-CCC) Guideline for difficult airway management. Part II

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KEYWORDS
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Rapid sequence induction;
Airway extubation;
Teaching

Abstract: The Airway Management section of the Spanish Society of Anesthesiology, Resuscitation, and Pain Therapy (SEDAR), the Spanish Society of Emergency Medicine (SEMES), and the Spanish Society of Otorhinolaryngology and Head and Neck Surgery (SEORL-CCC) present the Guide for the comprehensive management of difficult airway in adult patients. Its principles are focused on the human factor, cognitive processes for decision-making in critical situations, and optimization in the progression of strategies application to preserve adequate alveolar oxygenation in order to enhance safety and the quality of care. The document provides evidence-based recommendations, theoretical-educational tools, and implementation tools, mainly cognitive aids, applicable to airway management in the fields of anesthesiology, critical care, emergencies, and prehospital medicine. For this purpose, an extensive literature search was conducted following PRISMA-R guidelines and was analyzed using the GRADE methodology. Recommendations were formulated according to the GRADE methodology. Recommendations for sections with low-quality evidence were based on expert opinion through consensus reached via a Delphi questionnaire.

PALABRAS CLAVE
Manejo de la vía aérea;
Guía clínica;
Sedación consciente;
Anestesia general;
Intubación endotraqueal;
Mascarilla laríngea;
Traqueostomía;
Obstrucción de la vía aérea;
Monitorización

Guía de la Sociedad Española De Anestesiología, Reanimación y Terapéutica del Dolor (SEDAR), Sociedad Española de Medicina de Urgencias y Emergencias (SEMES) y Sociedad Española de Otorrinolaringología y Cirugía de Cabeza y Cuello (SEORL-CCC) para el manejo de la vía aérea difícil

Resumen La sección de Vía Aérea de la Sociedad Española De Anestesiología, Reanimación y Terapéutica del Dolor (SEDAR), la Sociedad Española de Medicina de Urgencias y Emergencias (SEMES) y la Sociedad Española de Otorrinolaringología y Cirugía de Cabeza y Cuello (SEORL-CCC) presentan la Guía para el manejo integral de la vía aérea difícil en el paciente adulto. Sus principios están focalizados en el factor humano, los procesos cognitivos para la toma de decisiones en situaciones críticas y la optimización en la progresión de la aplicación de estrategias para preservar una adecuada oxigenación alveolar con el objeto de mejorar la seguridad y la calidad asistencial. El documento proporciona recomendaciones basadas en la evidencia científica actual, herramientas teórico-educativas y herramientas de implementación, fundamentalmente ayudas cognitivas, aplicables al tratamiento de la vía aérea en el campo de la anestesiología, cuidados críticos, urgencias y medicina prehospitalaria. Para ello se realizó una amplia búsqueda bibliográfica según las directrices PRISMA-R y se analizó utilizando la metodología GRADE. Las recomendaciones se formularon de acuerdo con la metodología GRADE. Las recomendaciones de aquellas secciones con evidencia de baja calidad se basaron en la opinión de expertos mediante consenso alcanzado a través de un cuestionario Delphi.

Known or anticipated difficult airway

Awake management is the preferred option for securing the known or anticipated difficult airway (DAW) (expert statement **[E.S.]** 85.7%)[1] because it (1) preserves airway (AW) patency and spontaneous ventilation, increases respiratory reserve, and confers protection against aspiration by preserving laryngeal reflexes,[1,2] (2) allows a gradual transition

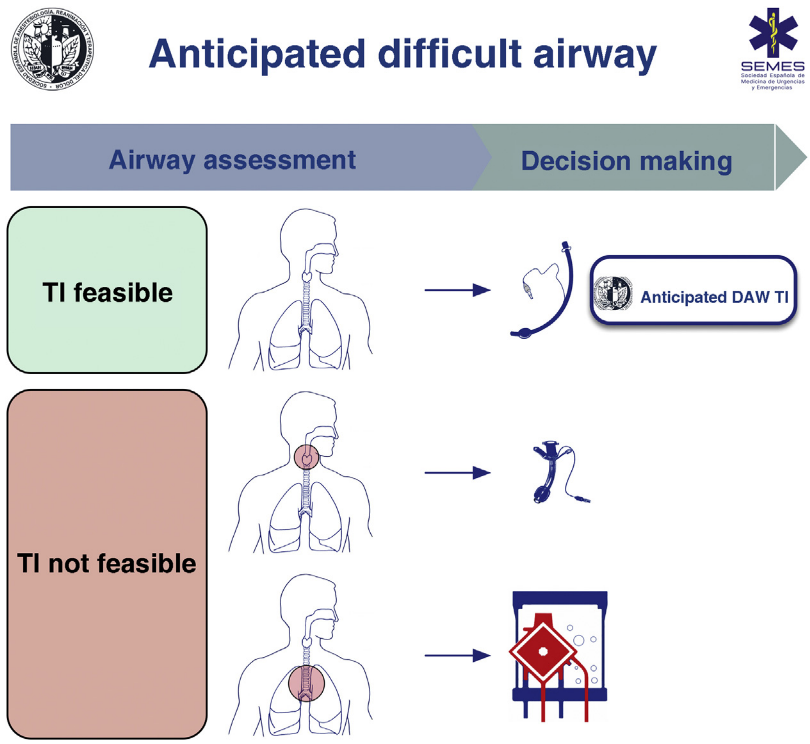


Figure 1 Cognitive aid to facilitate decision-making in the management of anticipated difficult airway. TI: tracheal intubation; DAW: difficult airway.

to positive pressure ventilation (PPV) and a slow induction of general anaesthesia (GA) given the risk for haemodynamic collapse,[3,4] (3) facilitates the procedure, because it inhibits soft tissue collapse, dilates peritracheal structures, allows for better location of the glottis by preventing the larynx from taking a more anterior position, and allows visualisation of air bubbles in the case of distorted anatomy, (4) allows the patient to remain in a sitting position, and cooperate, and enables assessment of their neurological status, and (5) allows all treatment options to remain open and decisions to be made according to the findings.[1,5–8]

A known or anticipated DAW requires a team-based strategy with thorough multidisciplinary discussion of sequential plans (primary and alternative) to achieve oxygenation, ventilation, and protection against aspiration.[1,7,9,10]

Safe management of DAW secondary to obstructive disease requires consideration of respiratory status, cause, location, and degree of obstruction (greater or less than 50%) through clinical signs and symptoms, imaging, and fibronasolaryngoscopy (FNL).[1,7,10,11] The risks and benefits of each approach should be carefully considered and the decision agreed by the medical and surgical team.[1] Fig. 1 shows a cognitive decision aid for the treatment of an anticipated DAW. The lower plans act as rescue strategies in the event of failure of the upper plan, which should be selected as the primary plan. Awake AW management is recommended in all cases. (1) Supraglottic lesions causing mild obstruction that can be overcome with an endotracheal tube (ETT) allow tracheal intubation (TI), usually with fibrobronchoscopy (FOB). (2) Obstructive supraglottic lesions with stenosis greater than 50% (or with inspiratory stridor at rest 50%),[7] non-obstructive supraglottic lesions that prevent TI (or associate TI with unacceptable morbidity), and glottic or subglottic lesions make tracheostomy or cricothyrotomy advisable as the primary approach.[10] (3) Lower tracheal obstructive lesions not salvageable with an ETT or tracheal cannula require extracorporeal membrane oxygenation (ECMO).[10]

Active oxygenation strategies should be implemented throughout the procedure. High-flow nasal oxygen therapy (HFNO), although it requires further validation in this setting, may be the technique of choice. HFNO is recommended over conventional low-flow nasal cannula (**E.S.** 91.4%).

Awake tracheal intubation

When it is feasible to secure the AW non-invasively, awake TI is still the gold standard for DAW management[3,12,13] because it is safe and reliable.[14,15] Four elements are critical to the success of the procedure: continuous oxygenation, topicalization of AW, sedation (optional), and selection, experience, and appropriate management of the TI device and technique. The ideal protocol in terms of efficacy and safety is unknown, and therefore the most appropriate protocol must be chosen according to the clinical context and individual patient characteristics, and the operator's experience and preferences.[16–18] Fig. 2 shows the aid proposed by the Spanish Society of Anaesthesiology, Reanimation and Pain Therapy (SEDAR) Spanish Society of Emergency and Emergency Medicine (SEMES), and Spanish Society of Otolaryngology, Head and Neck Surgery (SEORL-CCC) for TI of the anticipated DAW.

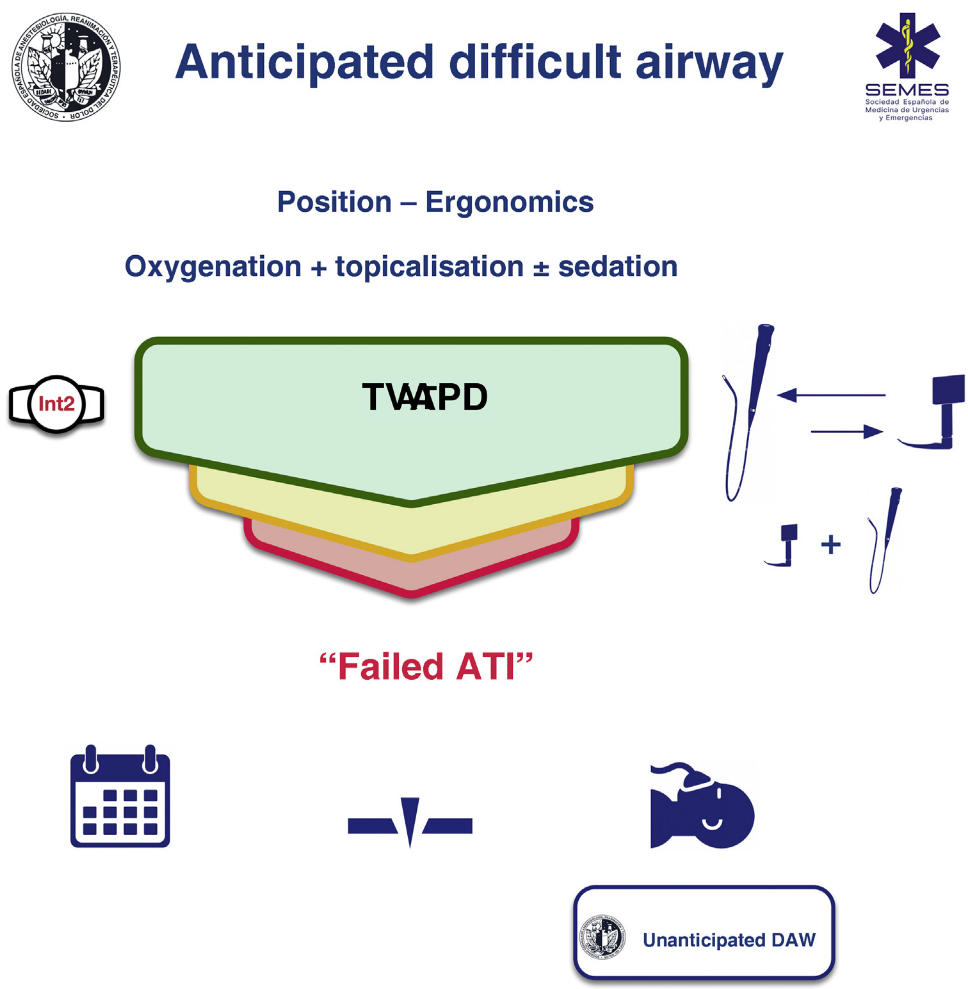


Figure 2 Cognitive aid proposed by SEDAR SEMES for tracheal intubation of unanticipated difficult airway. ATI: awake tracheal intubation. DAW: difficult airway; Int2: second operator.

Oxygenation

Continuous oxygenation increases safety by preventing or minimising hypoxaemia.[12,19] Conventional methods may be insufficient to prevent desaturation.[20] HFNO allows longer tolerance of potential AW obstruction, hypoventilation, or apnoea period.[20–23] Therefore, although the evidence is incipient, it is becoming the method of choice.[13,24]

Non-invasive ventilation (NIV) with endoscopic mask may have a role in IT of critically ill patients with severe hypoxaemia (**E.S.** 82.9%).[25]

Topicalisation

Topical anaesthesia of the AW is the key element of the procedure, because it is the main determinant of its success.[1] With its good cardiovascular and systemic toxicity risk profile, lidocaine (2%–4%) is the most widely used local anaesthetic (LA).[12,19,26–28] The maximum total dose should not exceed 9 mg/kg.[13,29] The minimum dose necessary should be used.

The ̆spray-as-you-go ̈(SAYGO) technique, using an epidural catheter or atomisers, and regional blocks (glossopharyngeal, superior laryngeal, transtracheal injection) are the most commonly used methods for topical anaesthesia of the respiratory mucosa.[2,12,27] They are usually used in combination.[28] There is no evidence as to which method is superior,[16] although nerve blocks are more invasive, require multiple bilateral injections, require experience, and are associated with a higher incidence of complications.[2,13,16] Transtracheal block (lidocaine 4%, 4 mL) is perhaps the most useful invasive method as (1) it provides anaesthesia of the subglottic larynx, upper trachea, and even supraglottic structures,[30] (2) its success rate is greater than 95%,[12] and (3) complications are rare (1:10,000), although they can be significant.[28,31]

The SAYGO technique can minimise the risk of aspiration, as laryngeal reflexes are maintained until just before passing the ETT.[2] Premedication with an antisialogogue is recommended to optimise LA efficacy and field of view, glycopyrrolate (3 μg/kg) being the antisialogogue of choice (**E.S.** 80%) due to its rapid onset of action, nil effect on the central nervous system (CNS), and moderate vagolytic effect.[2,12,32] Its administration 15–20 min beforehand reduces the dilution and oesophageal elimination of LA by secretions.[1]

Regardless of the method used, topicalisation should include the oral cavity, nasal cavity if nasotracheal intubation is planned, oropharynx, periglottic area, larynx, and trachea.[1,30] Otherwise, device insertion and TI trigger reflex responses of the AW, such as cough or laryngospasm, as well as a cardiovascular response mediated by the sympathetic nervous system.[33]

Sedation

Sedation is an optional adjunct to adequate topical anaesthesia in awake airway management (ATI) (**E.S.** 88.6%)[16] because awake TI with prior psychological preparation can be safely and effectively performed without it.[19,28,34] It should never compensate for poor topicalisation. While very high levels of anxiety may increase the physiological stress response and reduce tolerance, over-sedation may cause loss of cooperation, respiratory depression, hypoxia, hypercapnia, AW obstruction, aspiration, or cardiovascular instability.[19,35,36] Therefore, the administration of sedation must be justified through a thorough risk-benefit analysis. The objectives to be achieved are (**E.S.** 94.3%),[1,19,35] (1) effective anxiolysis and amnesia while maintaining patient cooperation (conscious sedation; Ramsay sedation score 2–3)[28,37] and (2) analgesia to suppress cough and gag reflex, and reduce haemodynamic response while preserving AW patency, spontaneous ventilation, and avoiding aspiration. Careful monitoring is required to avoid overdosing and it is recommended that a second anaesthetist be exclusively responsible for injecting and monitoring the effects of sedation.[13,19]

The different sedation regimens have shown a satisfactory level of efficacy and safety.[16] Dexmedetomidine, with its anxiolytic, sedative, analgesic, and sympatholytic properties, may have a better efficacy and safety profile by producing fewer episodes of apnoea and desaturation, and is well tolerated and associated with better TI conditions and lower recall compared to other drugs,[16,38–40] although it may cause episodes of severe bradycardia and hypotension.[35] Its ability to maintain the integrity of respiratory function, even with deep levels of sedation, makes it a good choice for patients at risk of AW obstruction and/or respiratory failure.[35] Opioids, particularly remifentanil, attenuate cough and gag reflex, although they may increase the incidence of chest rigidity and laryngospasm[6,13,19] and are linked to a high incidence of recall when used as a single drug, requiring administration with a benzodiazepine such as midazolam.[19,28] In general, monotherapy is more predictable and reliable, although its safety is enhanced with the availability of specific opioid and benzodiazepine antagonists. Remifentanil is a good option when topical anaesthesia is not possible.[35,41] Propofol is associated with a low incidence of recall at the expense of an increased risk of excessive sedation, AW obstruction, and cough.[13,35,42] Table 1 shows the main drugs used for sedation.

Device

FOB-guided TI is classically considered the method of choice in the awake patient[2,17,37,43] because of its versatility and unique combinability with other devices in any treatment plan,[44] and its efficacy and safety.[16,45] However, it is a complex skill that require regular practice, is fallible, and is not available for all patients.[37,46]

Elective awake TI with video laryngoscopy (VL) may be faster than FOB-guided, which may decrease the risk of aspiration, and be associated with equivalent success rates, safety profile, and patient and operator satisfaction.[17,43,47,48] Furthermore, the competence required for its use is easy to acquire and maintain.[46,47] It is therefore a valid alternative technique as a first-line treatment.[13,17,46–49] The video laryngoscopes indicated for this context are those with a hyperangulated blade, with or without a guide channel. In certain circumstances, VL offers additional advantages over FOB.[17,37,43] It also allows an ETT of any diameter to be selected,[37] it can be changed without removing the device,[47] and its passage through the vocal cords can be observed, unlike advancing blind with FOB, which reduces the risk of injury from the ETT and associated trauma.[37,50,51] However, unlike FOB, its use is not feasible with a buccal opening of less than 18—20 mm or a space-occupying lesion in the oral cavity, [37] and may result in increased cervical spine movement in patients with instability without manual stabilisation,[52] although the results appear similar.[53,54] Therefore, VL cannot completely replace FOB-guided TI.[37,43]

There is insufficient evidence as to which technique is ideal, and therefore selection of the device must be context-sensitive.[43,48] The two approaches are virtually equivalent and complementary[43]; a failed attempt of one can be rescued with the alternative and both can be used in combination, primarily to treat very difficult AW.[2,17,37]

Single-use flexible FOBs have a similar safety profile to reusable FOBs,[55,56] although they may be associated with benefits in terms of cost-effectiveness, cross contamination, infection, and resource utilisation.[57,58]

Procedure

The conditions of all four components should be optimal from the first attempt to maximise the likelihood of success and minimise the number of attempts. If the selected primary technique (FOB or VL) fails, the alternative technique should be used (**E.S.** 80%). A third attempt may benefit from a multimodality approach consisting of the combination of VL + FOB (**E.S.** 100%), therefore using the advantages of both devices.[59] This combination may improve the first attempt success rate, reduce TI time, reduce morbidity,[60,61] and could be the approach of choice in AWs with severely distorted anatomies.

The combination of a supraglottic airway device (SAD) and FOB may be useful as a rescue technique to maintain oxygenation, maintain AW patency, and perform TI through the SAD (**E.S.** 100%).[62,63] The SAD acts as a conduit to for an FOB-guided TI, maintaining oxygenation and AW patency and isolating the periglottic structures from any secretions or blood. At the same time, it facilitates locating the glottis and decreases the difficulty of advancing the ETT over the FOB,[51] while the latter allows the SAD to be placed in the correct location. The new laryngeal video masks could simplify this technique.[65,66]

The total number of attempts should be limited to three (**E.S.** 88.6%) because repeated attempts increase the risk

Table 1 Main drugs used for sedation in awake airway management.

Drug	Dose	Effects	Advantages	Disadvantages
Dexmedetomidine	Bolus of de. −1.0 μg/kg over 10 min; followed by infusion of .5−1.0 μg/kg/hour	Sedation/analgesia/amnesia/antisialogogue	Respiratory profile Safe	Bradycardia, hypotension
Remifentanil	Infusion of .03−.1 μg/kg/min; Bolus of .05−.1 μg/kg	Analgesia/antitussive	Suppresses cough reflex	Respiratory depression Laryngeal reflex depression Recall of procedure
Midazolam	Boli of .015−.03 mg/kg	Amnesia/sedation	Concomitant use with opioids Amnesia Minimises side effects	Respiratory depression
Fentanyl	Boli of .7−1.5 μg/kg	Analgesia/antitussive	Rapid onset	Respiratory depression Laryngeal reflex depression
Propofol	Infusion of 25−75 μg/kg/min; bolus of 25−75 μg/kg	Sedation	Amnesia Synergistic effect with other drugs (reduction in doses required)	Oversedation Airway obstruction Episodes of hypoxaemia Does not suppress cough reflex
Ketamine	Boli of .07−.15 mg/kg	Sedation/analgesia	Preserves muscle tone and airway protective reflexes Opioid sparing effect Concomitant use with dexmedetomidine increases haemodynamic stability	Agitation (co-administration with midazolam to avoid), inadequate level of sedation, intense cough, and unpleasant recall Increased secretions (requires antisialogogue as premedication) Myocardial depression in states of catecholamine depletion

Doses taken from Gil K, et al.[6].

of oedema, laryngeal bleeding, and complete obstruction of the AW.[51] It is especially important in the presence of a pre-existing obstruction because it can rapidly progress to a can't intubate-can't-oxygenate (CICO) situation.[9,67] Each failure should be followed by an assessment of each of the four components of the technique to determine whether optimisation is feasible.

Factors such as surgical approach, anatomical features, extubation plan, and operator preference determine the choice of TI route.[68]

The inability to advance the ETT over the FOB, stylet, or an exchanger through the vocal cords due to impingement upon periglottic structures, primarily the right arytenoid cartilage,[2,50] is one of the main reasons for TI failure,[19,51] and glottic or subglottic damage.[50,69] ETTs with a conical opening made of silicone such as LMA Fastrach™ (Teleflex Medical, Dublin, Ireland),[70] those with a central opening and posterior facing bevel such as the Parker Flex-Tip™ (Parker Medical, Highlands Ranch, CO USA),[71–74] LMA Fastrach™,[75] and BlockBuster (Tuoren Medical Instrument co, Ltd, Changyuan city, China),[69] and flexible material and reduced or no anterior curvature such as the reinforced LMA Fastrach™ and flexometalic ETTs[69,76] reduce the incidence of this complication.[50,69,72,76,77] The Parker Flex ETT is recommended over conventional ETT for FOB-guided TI in the general population (**1 B**), posterior placement of the bevel or 90° anti-clockwise rotation so that the bevel faces posteriorly facilitate its advancement.[78–80] Other useful manoeuvres include cervical spine flexion and release of jaw thrust or cricoid pressure.[51,80] It is recommended to decrease the difference between the external diameter of the FOB and the internal diameter of the ETT to facilitate FOB-guided TI (**E.S.** 85.7%),[2,51,81] or to use an intubation catheter between the FOB and the ETT (e.g. Aintree catheter, AIC, Cook Critical Care, Bloomington, IN, USA). Similarly, a device-specific ETT is recommended facilitate VL-guided TI.[82] Parker Flex ETT rather than conventional ETT is suggested for FOB and laryngoscopy in the general population to reduce complications (**1 C**).

Smaller sized ETTs allow a better laryngeal view during laryngoscopy and facilitate TI by reducing the impact on periglottic structures.[51,83,84] Also, large ETTs are associated with increased morbidity.[83,85–90] ETTs up to 6.0 mm internal diameter allow access for intubation devices, suction devices, and small-calibre FOB. PPV can be performed without increasing the risk of ventilator-induced lung injury or air trapping,[91,92] even when high minute volumes (MV) are required. There is also no demonstrable increased risk of aspiration or cuff pressure damage when smaller ETTs are used; they may even provide a better seal than the larger ETTs.[93] Smaller ETTs may not be safe in all cases, such as in patients with heavy secretions or limited airflow. Therefore, a smaller ETT than usual is recommended with VL and FOB (**D.E.** 85.7%) for safe treatment performing a risk-benefit analysis according to the clinical context.[83,84,90,94]

After visual confirmation of TI (passage of the ETT through the glottis with VL and identification of the carina and advancement of the ETT over FOB to two to three tracheal rings above the carina) it is recommended to induce GA after establishing cuff pressure and capnographic confirmation of TI (**E.S.** 94.3%).[2]

Alternative techniques and approaches should be planned in advance and applied without delay after failure of the primary approaches (**E.S.** 100%).[12,67] In the event of failed awake TI, there are three alternative plans: (1) postponement of the procedure unless the situation requires immediate treatment, (2) awake front-of-neck access (FONA), or emergency FONA in case of obstruction and loss of AW control, (3) GA induction with complete neuromuscular blockade (NMB) and follow-up of the unexpected DAW algorithm. This is a high-risk option. Deep sedation or GA with spontaneous ventilation induced with ketamine might be a more favourable preliminary step than the establishment of apnoea [95] (Fig. 2).

Given the high likelihood of awake TI failure, it is recommended to prepare the FONA plan in parallel (̈double configuration)̈ to treat a potential total obstruction (**E.S.** 88.6%)[96]; the incision line is anticipated by marking the cricothyroid membrane (CTM),[3] the neck and material are prepared with the surgical team present.[9] Multidisciplinary management and coordination with ENT is essential.[1,97]

Recommendation

A Parker Flex ETT is recommended over conventional ETT for FOB-guided TI in the general population.

Strong recommendation; moderate level of evidence (⊕⊕⊕⊖)

A Parker Flex ETT is recommended over conventional ETT for FOB-guided TI in the general population.

Strong recommendation; low level of evidence (⊕⊕⊖⊖)

Alternative awake techniques

Front-of-neck access technique

Awake tracheostomy under local anaesthesia is recommended in the presence of pre-existing critical AW compromise (**E.S.** 82.9%). In the upper AW with significant distortion or obstruction due to neoplasia, haematoma, severe oedema, bilateral vocal cord paralysis, or haemorrhage, awake FONA under local anaesthesia as the primary plan may be the safest option to secure the AW,[67,98–102] because, (1) instrumentation of the upper AW may precipitate bleeding, oedema, increased occlusion, and even distal seeding of a tumour,[7,9] (2) topical anaesthesia may exacerbate a pre-existing occlusion,[1,103] or cause laryngospasm,[1,9] and (3) FOB can cause a c̈ork in a bottleëffect[7] with complete collapse. Multidisciplinary DAW teams are associated with better first attempt success rates and faster time to securing a DAW.[104]

The recommended technique is tracheostomy performed by a trained professional.[105] Sedation should be avoided if possible. HFNO appears to be effective in extending safe apnoea time,[106] although extreme caution should be exercised and the use of electrical instruments should be limited at the time of tracheal opening.[107] The procedure requires the patient's cooperation as supine decubitus and cervical spine extension is often poorly tolerated.[106] Once a capnographic record is available, anaesthetic induction is performed.[108] The full moon view of the wall of trachea with FOB confirms correct cannula location. A crescent image indicates the need to reposition or change the cannula.

Awake cricothyrotomy would be the most indicated technique for emergent critical airway compromise (**D.E.** 91,4%) as it enables a surgical AW to be established more rapidly.[109]

Extracorporeal membrane oxygenation

ECMO under local anaesthesia in the awake patient may be the safest option when all four conventional plans are expected to be impossible, unsuccessful, or ineffective with risk of complete obstruction of the AW (**E.S.** 90.6%). Technological advances have made it possible to incorporate ECMO in AW management in these situations to ensure adequate oxygenation.[110,111] This is the case of tracheobronchial or extrinsic pathologies, such as anterior cervical spine pathology, which result in a critical central airway obstruction or prevent the performance of an FONA.[67,110] In these cases, elective ECMO under local anaesthesia in the awake patient may be the safest option.[67,112,113] Once a controlled environment is achieved, the AW is secured to prevent aspiration. Table 2 shows the main indications for ECMO.

Given the cost and its potential complications,[111,114–116] ECMO must be supported by a careful multidisciplinary decision-making process.[116] In uncertain indications, a system prepared with cannulated vessels may be possible and a perfusionist present prior to AW management.[116]

The respiratory support provided by veno-venous ECMO is associated with fewer complications, does not require therapeutic levels of anticoagulation, and allows the use of a single double-lumen cannula, making it the technique of choice in these situations.[110,111] In cases with associated haemodynamic compromise requiring cardiorespiratory support, such as large mediastinal masses, veno-arterial ECMO, or even a conventional cardiopulmonary bypass circuit may be necessary.[110]

In extreme cases such as massive haemoptysis or central foreign bodies, ECMO may be a last resort.[64,117] However, setting it up can be complicated and requires considerable time, so it cannot currently be considered a rescue

Table 2 Main indications for extracorporeal membrane oxygenation (ECMO).

Tracheobronchial pathology
• Tracheobronchial tumours with critical stenosis
• Tracheal stenosis of non- tumour cause (sequelae of prolonged intubation or tracheostomy, obstructive tracheal papillomatosis)
• Tracheal deformities
• Tracheal trauma (accidental or iatrogenic)
• Haemoptysis (the need for anticoagulation may complicate haemostasis)
• Pathologies requiring complex surgery (bronchopleural fistulae, tracheooesophageal fistulae, carinal resections)
• Complications arising from tracheal stents
• Foreign bodies in the airway
Extrinsic pathology
• Thyroid neoplasm or large goitres with severe tracheal invasion or compression
• Mediastinal masses with severe compression of the airway and/or great vessels, or heart chambers

technique for a CICO situation after GA induction, although several published cases have described its use in this context.

Unanticipated difficult airway

Peri-procedural oxygenation

Covered in the relevant section.

Airway management

TI is associated with more complications than other non-invasive plans, and therefore it should not be a ''rash act'', but an active decision and should be only performed when truly indicated.[118]

Any approach to the AW should aim to minimise the number of attempts to avoid a CICO situation and the need for FONA. Planning and optimisation play a key role.[119]

Given the unreliability of predictors,[120,121] planning should be geared towards managing a potentially difficult AW.[122] Decision-making should be context-sensitive, rather than focussed on specific devices and techniques.[8,123]

The first attempt should be under a priori optimal conditions (**E.S.** 100%) to maximise the probability of success (''make your first attempt your best attempt'').[119,122,124–126] Additional attempts are only justified when there is room for improvement and involve the summative effect of optimisation, or allow substantial improvement in the likelihood of success (e.g., change the size, type of device, adjuvant, or operator as needed).[119,127]

Between attempts, face mask ventilation (FMV), and anaesthetic depth and NMB should be checked. Adequate ventilation between attempts with face mask (FM) or second-generation SAD (2 GSAD) provides an opportunity to ''stop and think'' to reformulate the strategy, or deploy new resources while maintaining first principles. Fig. 3 shows the treatment algorithm for unexpected TI.

Failure of non-invasive plans requires declaration of a CICO situation, ensuring adequate NMB, and immediate FONA regardless of peripheral oxygen saturation value (SpO_2).

Tracheal intubation

Videolaryngoscopy

Failure of the first attempt at TI implies a lower probability of success in subsequent attempts.[60,119,128] Multiple attempts may result in trauma, oesophageal intubation, hypoxaemia, cardiovascular events, a CICO situation, unexpected admission to the critical care unit, or death.[129–134] In addition, up to 93% of difficult TIs are unanticipated.[121] Therefore, the most appropriate primary technique should be the one that offers the highest guarantee of a first-attempt TI (**E.S.** 94.3%).[119,122,124–126]

Most meta-analyses, despite great heterogeneity[135,136] suggest the superiority of VL (Appendix A, supplementary material 4). Overall, VL compared to direct laryngoscopy (DL) increases success at the first attempt,[137–150] improves visualisation of the glottis,[140,141,143,145–148,150–158] and decreases complications, primarily trauma, and the incidence of oesophageal intubation[141,142,144–147,149,152,155–157,159–162] by as much as 50%.[150]

The emergence of the COVID-19 pandemic,[135,163–167] the reduction in costs[18] and widespread availability, and incipient positive data on cost-effectiveness,[168,169] quality of care,[129] teaching, documentation, teamwork (it favours the shared mental and human factors [HF] model),[122,167,170–173] and mastery of the technique with regular practice[129] have overcome resistance to change,[174,175] making VL practically the gold standard for laryngoscopy and DAW.[171]

In view of the above, SEDAR SEMES SEORL-CCC recommends the routine use of VL over DL as the primary device for TI (**1 B**). Devices with standard Macintosh-type blades (allowing direct and indirect laryngoscopy) are appropriate for AW management without predictors of difficulty, while those with hyperangulated blades (with or without guide channel) are indicated for known or anticipated DAW (**E.S.** 94.3%).[120,135,176,177] The latter are the devices of choice for rescue after a first unsuccessful attempt.[14,178–180] It is therefore recommended that VL and the necessary competence be available in any location where the AW is managed.

Inability to pass the ETT through the glottis is the most common cause of failed TI with VL.[166,172,173,181,182] However, with adequate competence it is rare for this problem not

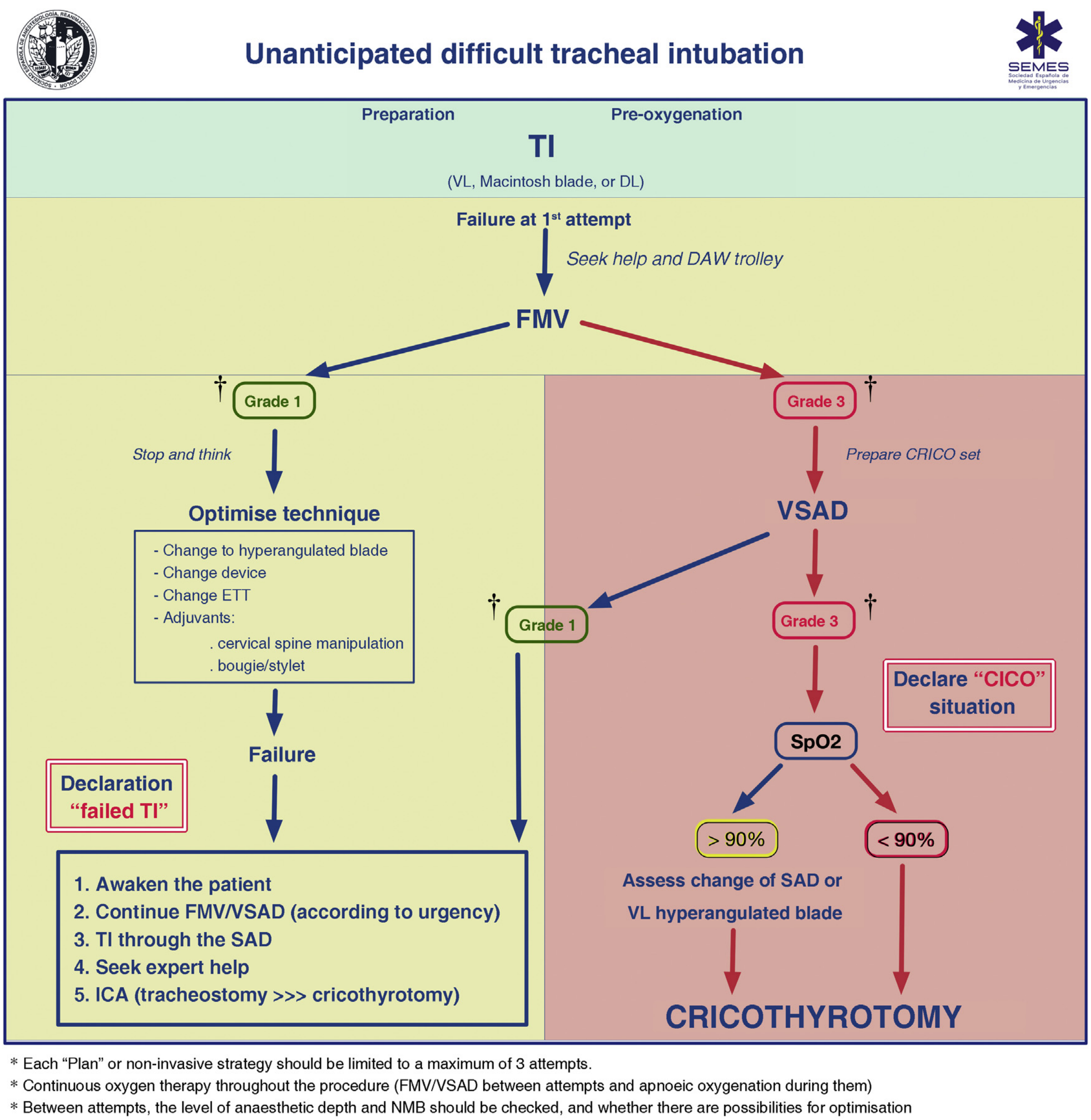


Figure 3 Treatment algorithm for unanticipated tracheal intubation.
† Ventilation grades according to capnography waveform; CRICO: cricothyrotomy; DAW: difficult airway; DL: direct laryngoscopy; FONA: front-of-neck access; ETT: endotracheal tube; FMV: face mask ventilation; SAD: supraglottic airway device; SpO2: peripheral oxygen saturation; TI: tracheal intubation; VSAD: ventilation with supraglottic airway device; VL: videolaryngoscopy.
*Each ''Plan'' or non-invasive strategy should be limited to a maximum of 3 attempts.
*Continuous oxygen therapy throughout the procedure (FMV/VSAD between attempts and apnoeic oxygenation during them).
*Between attempts, the level of anaesthetic depth and NMB should be checked, and whether there are possibilities for optimization.

to be overcome.[171] The recommended manoeuvres to overcome this difficulty are shown in Table 3.[182–186]

Bougies are associated with higher first-attempt success rates in elective and emergency TI, especially in patients with predictors of DAW or poor view of the glottis.[187–190] It is recommended that a bougie be available in every location with AW management (**E.S.** 97.1%)[191] and its use should be assessed from the first attempt.[120,185,188,192] SEDAR SEMES SEORL-CCC recommend the use of a dynamic or articulated bougie versus a conventional stylet for TI in patients with DAW (**1 C**) because it improves the first-attempt TI rate and time to successful intubation, thus reducing instrumentation and the use of alternative adjuvants.[60,69,186,193,194]

Recommendation

Flexible fibrobronchoscopy

FOB-guided TI in the patient, unconscious or under GA can be very effective in skilled hands,[195–198] but is technically more difficult than in the awake patient, and it may fail and be associated with episodes of desaturation or complete obstruction of the AW.[105] The presence of blood, emesis, or secretions in emergency TI further reduces the likelihood of success.

Table 3 Manoeuvres to overcome difficult tracheal intubation with video laryngoscopy.

Relating to the relationship of the device to the glottis to optimise view
◦ Selection of an appropriate device size, especially those with a guide channel. The internal size of the guide channel determines the orientation of the ETT exit.
◦ Adjust the distal position of the device with partial elevation and retraction to enlarge the field of view and align the blade to the glottis. In the case of devices with a guide channel, this allows centring the view of the glottis and thus optimising the TI, as the ETT advances towards the glottis under a predetermined angle defined by the channel configuration and the angulation of the distal end of the ETT.
◦ External laryngeal manipulation (BURP)
◦ Increase head elevation
◦ Clamp the epiglottis with the blade in case of large hanging epiglottis obstructing the view of the glottic structures and passage of the ETT
Relative to the use of adjuvants
◦ Semi-rigid stylet, either malleable, which can be pre-formed as a ḧockey stick̈to adapt the ETT to the same angulation as the blade of the device, or the manufacturer's own stylet designed for use with a specific VL. Their use is indispensable in the case of VLs with a hyper-angulated blade without a guide channel. As soon as the vocal cords are passed, it is recommended to remove the stylet to avoid injury to the AW.
◦ Static bougie with angled distal end. Limited usefulness if they are not malleable as they do not maintain curvature similar to that of the blade and for devices with a guide channel, more useful for video laryngoscopes with Macintosh-type blade.
◦ Dynamic bougie or combined use with flexible FOB to n̈egotiateẗhe acute angle between the glottis and the distal end of the ETT.
Relative to the endotracheal tube
◦ Type of ETT. Flexible tubes with silicone distal end and conical tip
◦ Appropriate size of ETT. In general, a smaller size than usual is recommended to facilitate passage through the glottis, although excessively small ETTs in devices with a guide channel can hinder TI to the extent that by widening the difference between the internal calibre of the channel and the external calibre of the ETT, the exit of the distal end of the ETT is separated from the distal end of the blade, and takes an excessively posterior position.
◦ Modify the curvature of the ETT
◦ ETT with flexible articulating distal end that allows articulation at a variety of angles.
◦ Rotating the ETT 90◦ clockwise so that the bevel faces forward reduces the angle of incidence of the ETT when intubation adjuvants are not used, or the stylet is removed prior to advancing the ETT into the trachea. When using a dynamic bougie or combined flexible FOB, rotating the ETT 90◦ is recommended so that the bevel is posterior facing to overcome the difficulty in advancing it.

BURP: backward, upward, right lateral position; FOB: fibrobronchoscopy; TI: tracheal intubation; ETT: endotracheal tube; AW: airway; VL: videolaryngoscopy.

Routine use of VL is recommended over DL as the primary device for TI.

Strong recommendation; moderate level of evidence (⊕⊕⊕⊖)

Aa dynamic or articulated bougie (flex-tip or FOB type) is recommended over a conventional stylet for TI in patients with DAW.

Strong recommendation; low level of evidence (⊕⊕⊖⊖)

Manoeuvres such as lingual traction and jaw-thrust allow opening of the pharynx and larynx respectively, improving view and the success of the technique.[197,199] Oral cannulae, anterior displacement of the base of the tongue with the laryngoscope or patient in the left semilateral position rotating their head to the left facilitate passage of the FOB and improve view.[200] If there is resistance to ETT advancement, jaw-thrust and anticlockwise rotation of the ETT can facilitate its passage through the glottis.[198]

All the patients included in the 4th National Audit Project (NAP4) registry in whom FOB-guided TI was attempted after induction of GA as the primary technique or after failure of DL, failed and emergency FONA was required.

FOB is highly salvageable after failure of most devices, either alone or as a multimodal approach.[6] In an emergency, its availability, preparation, and execution is more laborious and time-consuming than VL,[43,47] and therefore it is less widely used as a rescue device.[201]

Confirmation of tracheal intubation

Once TI has been achieved, it is recommended to immediately rule out oesophageal intubation as this is a common complication with devastating consequences.[167,202–204]

No confirmatory technique is 100% reliable in all circumstances, and therefore a combination of methods is recommended.[205,206]

The capnography waveform is the gold standard for confirming TI (**1 B)** because it is the most accurate (sensitivity 98%–100% and specificity 100%) and rapid method.[4,120,205,207–212] Therefore, despite persistent deficits in standardisation,[204] capnography is mandatory to confirm ETT placement and should be present in all locations where AW management may be required.[167,203,211,213–216] An absent trace (grade 3 ventilation) indicates failed TI until proven otherwise (**E.D.** 80%)[211,217] and oesophageal intubation should be actively excluded.[218] The capnography trace is present but attenuated (not flat) even in cardiac arrest.[211,212,217–219] The positive predictive value of end-tidal carbon dioxide (EtCO2) is lower during cases of low or no perfusion[212] and false positive readings are possible when the ETT tip is in the hypopharynx.[205] In these cases, confirmation by ultrasound is a valid alternative as it has a sensitivity of 99% and specificity of 97%, is independent of pulmonary blood flow, is quick to perform (mean time of 13 seconds), and even allows real-time visualisation of the introduction of the ETT into the trachea or oesophagus.[220,221] Presence of the ̈double tract signällows detection of oesophageal intubation before initiation of ventilation.[216,222]

Colorimetric capnometry should be limited to situations where a capnography waveform is not available, such as in pre-hospital or emergency settings.[205]

Clinical examination alone has too high a false positive rate,[223] especially in an emergency setting,[224] and confirmation bias can lead to seeing and hearing what one wants,[225] although in combination with capnography it is useful. Ultrasound or fibrobronchoscopy examination via the ETT are alternative methods of confirming a TI. Other methods are oesophageal detector devices, transtracheal illumination, pulse oximetry, and chest radiography.[205]

Capnography waveform monitoring during maintenance of mechanical ventilation is highly recommended in all settings (**E.S.** 100%)[207,209,211,226–230] because it allows continuous monitoring of the position of the ETT, confirmation of AW patency, and early diagnosis of inadvertent extubation or partial displacement of an artificial AW.[211,218,227,229,231–233] The NAP4 registry found that lack of monitoring may have contributed to more than 70% of AW-related ICU deaths, [234] and therefore widespread use of capnography in critical care units and education of medical and nursing staff[211,217,218] may be the single change with the greatest potential to prevent morbidity and mortality associated with TI or other artificial AW outside the operating theatre.[211,234]

Recommendation

Capnography waveform is recommended as the gold standard to confirm alveolar ventilation.

Strong recommendation; moderate level of evidence (⊕⊕⊕⊖)

Ventilation with supraglottic airway device

In addition to their use as a primary technique in elective surgical procedures or cardiopulmonary resuscitation,[235–237] SADS play an indispensable role in the rescue of difficult or failed TI as they allow ventilation and oxygenation, provide a patent AW with some degree of protection against aspiration, and act as conduits to facilitate FOB-guided TI.[238–243] Anatomical and/or technical factors hindering FMV and IT usually do not influence the insertion and function of the SAD.[239] Therefore, an SAD should be inserted without delay to preserve alveolar oxygenation in the event of difficult or failed TI (**E.S.** 85.7%).

2 G SADs have most of the ideal characteristics: easy insertion, high oropharyngeal sealing pressures, and they allow TI and gastric decompression.[49,239,244] They have thus shown superior performance to first generation devices and are more suitable for advanced use and as rescue devices.[244–246] Therefore, the immediate availability of an 2 G SAD is recommended, and to have the necessary competence to use it in all AW management sites (**E.S.** 100%).

The SAD to rescue a DAW should be selected prior to the procedure. Those with high first-attempt ventilation success and that allow IT through them[238,247] are of first choice: i-gel™ (Intersurgical Ltd., Wokingham, UK), Ambu® AuraGain™ (Ambu A/S, Ballerup, Denmark), LMA® Protector™ (The Laryngeal Mask Company Limited, Mahé, Seychelles), and iLTS-D (VBM Medizintechnik GmbH, Sulz, Germany).

One optimal attempt or a maximum of three attempts before declaring plan failure is recommended as the success rate decreases significantly with successive attempts[248,249] and these attempts increase trauma and delay transition between plans. During insertion of an SAD, cricoid pressure should be released if it is being used (**E.S.** 80%). Each attempt should include a change to improve the chances of success. Between and during attempts it is recommended to continue with peri-procedural oxygenation methods.

Rapid insertion and correct placement of the SAD are important to ensure the AW.[250] Rotation of 90°, jaw-thrust and the use of DL or VL (of choice) with the ̈insert-detect-correct-as-you-gö technique increase the efficacy and safety of the SAD by facilitating insertion, increase the first- attempt success rate and reduce pharyngeal trauma (**E.S.** 82.9%),[246,250–257] and can prevent malpositioning.[257,258] In contrast, ̈blindïnsertion results in 50%–80% malpositioning[246,256,257] associated with suboptimal AW control, leakage or obstruction, increased risk of further displacement and increased morbidity.[251,255,259] Malpositioned SADs are 26 times more likely to cause gastric insufflation and subsequent aspiration.[255] Table 4 shows the requirements for ideal positioning of an SAD, causes of malpositioning, and treatment options.[246,255] The recent videolaryngeal masks (VLM)[259] allow placement under direct view and immediate corrective manoeuvres without the aid of an additional device,[66] although there is still insufficient evidence.[259–264]

Correct placement of an SAD is clinically confirmed by a normal capnography waveform (ventilation grade 1) and maintenance of adequate alveolar oxygenation with peak inspiratory pressures of 20 cmH_2O, oropharyngeal leak pressure >25 cmH_2O, pulmonary auscultation, and passage of a tube through the gastric channel as complementary signs.[259]

Achieving effective ventilation and oxygenation provides time to stop and decide how to proceed according to the degree of urgency and type of procedure:

Table 4 Requirements for ideal position of a supraglottic airway device, causes of malpositioning, and options for AW management.

Correctly placed SAD (good seal and no leak)
Requirements for ideal position
1. Tip of distal cuff in oesophagus
2. Epiglottis resting on the outside of the cuff
3. Epiglottic tip aligned with proximal cuff
4. Cuff adequately inflated to produce a seal (pressure 40—60 cm H_2O)
5. No crease in the cuff (silicone is better than PVC)
Avoid:
• Hyperinflating the cuff (displacement of the SAD)
• Hyperinflating the cuff (risk of aspiration)
• SAD too deep/too small
• SAD too superficial/too large
Malpositioned SAD confirmed with videolaryngoscopy[255] (leak and AW obstruction)
Causes
1. Tip of distal cuff
a. Bending upwards
b. Bent backwards
c. Located between the vocal cords
2. Epiglottis in the bowl of the SAD
a. Without folding upwards
b. Folded downwards
c. Folded epiglottis
Treatment options:
• Jaw thrust to open the oropharyngeal space (increase the distance between the epiglottis and the posterior wall of the oropharynx) with the aim of repositioning the SAD[268]
• Different size or type of SAD (PVC cuff to silicone or reinforced tip)
• Guided technique with a bougie or orogastric tube[269]
•Magill forceps[270]

SAD: supraglottic airway device.
Adapted from Van Zundert AA, et al.[246]

1 If the situation is non-urgent (e.g. elective surgical procedure), the safest option is to awaken the patient and perform surgery under regional anaesthesia or postpone the intervention to perform an ATI.
2 If the situation is an emergency in (a) urgent surgery: it may be decided to continue the procedure while maintaining the second-generation SAD, but this is a high-risk option because the AW patency may be compromised in the course of the surgery; (b) the critically ill patient: a definitive AW is likely to be required, and therefore a FONA (tracheostomy) may be performed in anticipation of life-threatening hypoxaemia.
3 In intermediate cases, FOB-guided TI via the SAD may be chosen if the situation is stable, under adequate NMB and if the operator is competent (**E.S.** 97.1%, success rates close to 100%[238]). Blind TI is not recommended as the success rate is low (10%−20%), repeated attempts are required, and may result in increased trauma and impaired oxygenation.[265,266] The use of VLM allows TI without the help of FOB,[66] and many therefore shorten the technique and be especially advantageous in settings where FOB is not available, such as pre-hospital care and emergency care.[267]

Grade 2−3 ventilation or ineffective oxygenation after exhausting attempts requires immediate progression to a new plan.

Face mask ventilation

FMV is an essential transitional technique during induction and treatment of an emergency AW and an indispensable rescue plan when other techniques fail.[271]

The presence of predictors of difficult FMV, and its use during emergency AW or as rescue from failed plans, make it especially advisable to use the optimal technique for FMV (triple manoeuvre of full neck extension, anterior jaw thrust, and mouth opening) from the outset, oropharyngeal or nasopharyngeal cannula placement,[272] and two-handed V-E technique,[271,273] either with two operators or with pressure-controlled ventilation with ventilator or other device,[274,275] in a patient with optimal positioning and intense NMB[271,276–280]) (**E.S.** 80%) in order to limit AW obstruction and optimise sealing to achieve grade 1 alveolar ventilation without causing gastric insufflation.[126,275,281] This also speeds up the transition between plans and reduces peak ventilation pressure.[282] Face mask ventilation with modified triple manoeuvre is recommended over the E-C technique for the general population (**1 C**).

An effective attempt should be defined, in addition to a stable or improved normal SpO_2, an acceptable tidal volume and AW pressure (4—5 mL/kg^{-1} and <15—20 cmH_2O, respectively[273,275,283]) and clinical criteria, by the presence of plateau phase on the capnography trace.[284] The use of scales to stratify the difficulty of FMV objectively, such as that proposed by the Japanese Society of Anaesthesiologists (Fig. 2, Part I), is recommended. This allows early declaration of failed FMV before desaturation (late sign) occurs.[275]

FMV is a dynamic procedure that requires continuous assessment until the AW is assured.[285] Declaration of failed FMV implies immediate transition to ventilation with SAD (**E.S.** 85.7%). Clinical deterioration and worsening oxygenation should prompt declaration of a CICO situation and immediate transition to FONA if ventilation with SAD has also failed.

A CICO situation should be declared using clear language that is easily understood by the entire team to create a shared model that facilitates an effective transition to FONA.[119,286]

Recommendation

> Face mask ventilation is recommended with modified triple manoeuvre over the C–E technique for the general population.
> ***Strong recommendation; low level of evidence*** (⊕⊕⊖⊖)

Front-of-neck access techniques

Failure of the three non-invasive supraglottic plans (primary and rescue) in the apnoeic patient requires declaration of a CICO situation and prompt FONA regardless of the SpO_2 value (**E.S.** 90.6%) because, in these circumstances, deterioration will be imminent if it is not already apparent. In the hospital setting, SEDAR SEMES SEORL-CCC recommends requesting the presence of an ENT specialist (or surgeon trained in performing tracheostomy) as soon as a CICO situation has been declared, although no procedure should be delayed until such time.

Delay in FONA is a major cause of morbidity and mortality.[99,234,247,287,288] Situational awareness and shared decision making, as well as good technical and HF training, can remove these psychological barriers to abandoning further attempts at non-invasive techniques.[99,119,287,289–291] The use of cognitive aids speeds up the transition to FONA by mitigating stress[292] (Fig. 1, Part I).

Psychological and technical preparation is recommended before declaring a CICO situation. A ̈double set-up ̈may be useful[293]: one team manages the AW conventionally while a second team is prepared and ready to perform a potential FONA. The multidisciplinary approach is associated with better first-attempt success rates and faster time to securing the DAW.[104]

It is recommended to continue 100% supraglottic oxygen delivery, ensure intense NMB[127,294] and full neck extension for better laryngeal exposure.[295]

Emergency FONA encompasses three techniques: percutaneous cricothyrotomy, surgical cricothyrotomy, and surgical tracheostomy.

Cricothyrotomy is the technique of choice in a CICO situation (**S.D.** 91.4%) due to its relative simplicity, rapidity, high success rate, and low complication rate,[100,296] although the presence of an experienced ENT specialist or surgeon ensures that tracheostomy is performed as effectively and safely as a scalpel cricothyrotomy,[297,298] and therefore if the ENT specialist is present, they will lead the FONA using the technique they consider most appropriate.

The approach to a cricothyrotomy can be surgical or percutaneous. The evidence is limited as to which FONA approach is more appropriate in this setting. The few comparisons that have been made were in a simulation model and an animal model,[99] and therefore no one technique can be identified as superior to the others.[99,101,299–302] However, surgical access is successful in virtually 100% of cases.[234,287,303]

SEDAR SEMES SEORL-CCC recommend the scalpel-bougie-tube surgical cricothyrotomy method (**E.S.** 91.4%) for the following reasons[98,234,247,287,291,294,301,304,305]: (1) universality of the material, (2) it can be performed by a single operator, (3) technical competence is easy to acquire, (4) its execution, despite involving a greater psychological challenge,[300,306,307] it is characterised by its simplicity and speed, (5) it allows insertion into the trachea of an ETT or cannula with balloon and sufficient internal diameter to definitively secure the AW, protect it against aspiration, and allow effective gas exchange by means of PPV with conventional equipment and confirmation with capnography, and (6) its safety and efficacy profile. The required equipment includes a scalpel with blade no. 10, 20, or 21, ETT, or cannula with an internal diameter of no more than 6 mm and a bougie.

Other cricothyrotomy methods are considered valid, provided the appropriate expertise and equipment are available. Percutaneous cricothyrotomy approaches that achieve re-establishment of oxygenation with adequate ventilation are those that allow the introduction of a tube or cannula with an internal diameter $\geq$ 4 mm and 15 mm connector, or wide cannula techniques.[247,291,294,301,305,308] SEDAR SEMES SEORL-CCC leaves its use to the operator's discretion as first choice or as rescue due to failure of another method,[309] and therefore recommends acquiring skills in more than one technique.[300,302,310] Experience, availability of the equipment, and patient characteristics play a relevant role in the selection of technique.[99,101,294,297,309,311] The percutaneous technique, because it is more familiar and less intimidating, could be initiated earlier.[300]

It is essential to identify the CTM for the success of the technique. Detection by palpation has a high error rate. The use of ultrasonography over palpation is recommended to identify the cricothyroid membrane (**1 C**), and therefore SEDAR SEMES SEORL-CCC recommends acquiring the necessary skills. The laryngeal handshake technique, although slightly more time-consuming than conventional techniques, has a higher success rate.[312,313] For cervical spine anatomies with anatomical landmarks that are difficult to identify by palpation, a vertical skin incision of more than 4 cm in the midline of the neck in a distal-proximal direction above the sternal notch is suggested to find the relevant anatomy.[98,247,314] Ultrasonography is superior to palpation in identifying the CTM and its immediate availability improves success.[315–319] However, it can be time-consuming, and therefore in a CICO situation it is only recommended if there is immediate availability and sufficient training.

After ensuring FONA, correct ventilation and alveolar oxygenation should be verified by capnography waveform, clinical assessment, pulse oximetry, and arterial blood gases when indicated.[294] A fibrobronchoscopy and radiological examination can complete the examination. Emergency cricothyrotomy should be converted to an ETT or tracheostomy as there is insufficient evidence as long-term treatment (**E.S.** 85.7%).[296,320] Conversion within 72 h is recommended to avoid the development of subglottic stenosis.[301,321]

Failure of a cricothyrotomy makes tracheostomy by a skilled operator advisable (**E.S.** 94.3%).[100]

CICO situations accounted for 39% of critical events and 25% of all anaesthesia-related deaths in the NAP4.[287] FONA is the last resort when non-invasive strategies have failed and is therefore of vital importance.[322] It is recommended that every institution standardise the technique and have a commercial or pre-assembled cricothyrotomy kit[99,247,311,323] with transparent packaging, which allows familiarisation with its contents and mental rehearsal of its use, and easy access, ideally located on the DAW trolley, available in every AW management site. All AW management professionals must acquire and maintain the necessary competence to perform a surgical or percutaneous cricothyrotomy with Seldinger's technique (**E.S.** 100%).[99,101,119,247,291,298,301] FONA should be feasible in any AW management site (**E.S.** 100%).[324]

Recommendation

Ultrasonography is recommended over palpation to identify the cricothyroid membrane.

Strong recommendation; low level of evidence (⊕⊕⊖⊖)

Pre-hospital setting

AW management in the pre-hospital setting is critical to patient survival and represents a real challenge for the emergency medical services (EMS).[325,326] In each scenario, different combinations of factors and constraints come together to create a high level of uncertainty that can turn any ordinary AW into a DAW.[327] Also, patient and operator positions may not always conform to those described in the manuals (subject trapped, confined, crushed, buried or in a place with simply no space). Survival depends on the correct interlocking of the entire chain of care. Table 5 shows the differential characteristics of AW management in the pre-hospital setting.[328,329]

Human and ergonomic factors

A standardised rapid sequence induction (RSI) procedure is recommended to optimise outcomes, alleviate cognitive load in high-pressure situations, and improve technical and non-technical performance. Therefore, it is desirable to standardise the AW bag, have an ergonomic layout, and a checklist.[330] Fig. 4 shows the bag and ergonomic layout suggested by SEDAR SEMES SEORL-CCC for the pre-hospital setting.

AW case/bag

Its objective is to store AW material in a standardised way, with a modular design, to keep it visible, accessible in less than a minute and organised in specific compartments for each of the four treatment plans, separated by Velcro® or zips, and marked with easily recognisable pictograms.[331] There should be at least one device for each plan (Fig. 4)

For outdoor work, it shall be a transportable, non-rigid case, bag, or rucksack, of reasonable size and weight, labelled, and manufactured in a different colour with approved material that is waterproof, resistant to corrosive agents, and easy to wash and sterilise. It shall have both handles and shoulder straps to free the hands and allow unimpeded access to the patient. Equipment should preferably be checked daily and at shift changes against a checklist.

Ergonomics of positions during DAW management

Critical patient care in the pre-hospital environment is based on teamwork, the team usually consisting of a physician, a nurse, and one or more technicians. Therefore, there is usually only one operator.

The multiple scenarios, risks, patients, positions, and obstacles make it necessary to adapt to the setting. Each intervention is unique and unrepeatable. The situation requires accessing and controlling the scene and identifying the most serious subject, determining priorities, and establishing more than one approach plan. Most often the patient is found lying on the ground and a safety roll is possible, although not always. TI on the floor is a predictor of DAW.[332] Abnormal positions generate varying degrees of difficult-to-access DAW/AW, necessitating awareness of the anatomical changes and pathophysiology involved (Fig. 5). However, in an ideal scenario, SEDAR SEMES SEORL-CCC suggests the arrangement of team members as shown in Fig. 4. The physician controls ventilation and AW at the patient's head with a technician on their right to support AW management (Sellick, backward, upward, right lateral position [BURP], AW enlargement hook, traction support, supply of material, etc.). The nurse and second technician are positioned next to the individual's left shoulder/arm; while the AW case is opened to

Table 5 Differential characteristics of AW management in the prehospital setting.

Body of doctrine	• Lack of a specific body of doctrine and a unified training model
Operational procedures	• Research presents complex methodological challenges • Highly complex clinical safety, quality control, and evaluation procedures
Safety	• Limited level of evidence • Protocols incomplete or with ostensible limitations (lack of cognitive aids and poor updating)
Setting	Usual setting of particular complexity (contextual DAW) • Patient's home, public thoroughfare, or inside an ambulance • Confined and/or inaccessible spaces • Adverse context (infinite combinations): adverse weather conditions, excessive or poor lighting, noise level, social pressure • Difficult access. Sometimes it will be necessary to manage the AW in abnormal positions • High stress level
Patient and pathology	• Highly complex clinical context • Emergency indication: imminent AW compromise, absence of spontaneous ventilation, impaired level of consciousness, or agitation • Physiological DAW: haemodynamic compromise, shunt, $\dot{V}/\dot{Q}$ mismatch, ↓ FRC, full stomach • Anatomical DAW • Unknown history and clinical history
Operator	• Single, less experienced operator due to multidisciplinary training • Only one opportunity to control the AW (oedema, haemorrhage in AW...)
Material and devices	• Devices not adapted to the pre-hospital setting (extreme temperatures, lighting) • Lower solvency (e.g., portable aspirators with lower power) • Limited availability
Airway maintenance	• Medical transport carries added risks that require specific anticipation and planning: - Accidental extubation in uncontrolled environment - Clinical and haemodynamic deterioration: early, delayed, and late • To avoid complications, specific checklists are recommended for initiation of medical transport • Contingency plans are required considering special circumstances (non-stop itineraries, air transport, limited space, or difficult access) • Capnography is the guiding element

AW: airway; DAW: difficult airway; FRC: functional residual capacity; $\dot{V}/\dot{Q}$ mismatch: ventilation/perfusion mismatch.

the right, and the monitor at the feet for proper visualisation. In case of cardiorespiratory arrest (CRA) the monitor should be placed on the subject's left shoulder for better handling.

Pre-procedural assessment and planning

DAW is by definition not anticipated in the pre-hospital setting. However, pre-procedural assessment remains essential to anticipate potential difficulties and plan treatment.[331] Predictive tests can be difficult to perform, and, in many cases, there is no time for more than öne second look. This rapid assessment can be useful but, where possible, should be combined with other tests.[333]

Different series have described as independent predictors of DAW: (1) AW obstruction, intubation, on the floor, and hyoid-mental distance less than three fingers,[332] (2) limited space at the scene, short neck, obesity, face and neck injuries, mouth opening less than 3 cm and ankylosing spondylitis,[334] and (3) Glasgow scale > 3, limited cervical spine movement, trismus/jaw tension, inability to palpate landmarks in the neck, presence of blood or vomit in the airway.[335]

For anticipated DAW, it is also recommended that teams have experience in awake TI, although the indications are narrower in emergency TI.[336,337]

Peri-procedural oxygenation

Apnoeic oxygenation significantly reduces hypoxaemia during emergency TI,[338,339] making it, together with pre-oxygenation, essential for TI in the pre-hospital setting.[340] Standard nasal cannulae at 15 L/min should be included from the pre-induction period until TI in daily clinical practice except in patients with epistaxis, severe head trauma with possible skull base fracture, or complex facial fractures because it could worsen TI conditions and cause pneumocephalus.[331]

Any factors that may influence the success of TI should be optimised prior to the first attempt to achieve the best outcome.

Rapid sequence induction

RSI is the most commonly used method in the pre-hospital setting. However, alternative techniques are of interest.[95] It is advisable to follow a standardised RSI procedure using

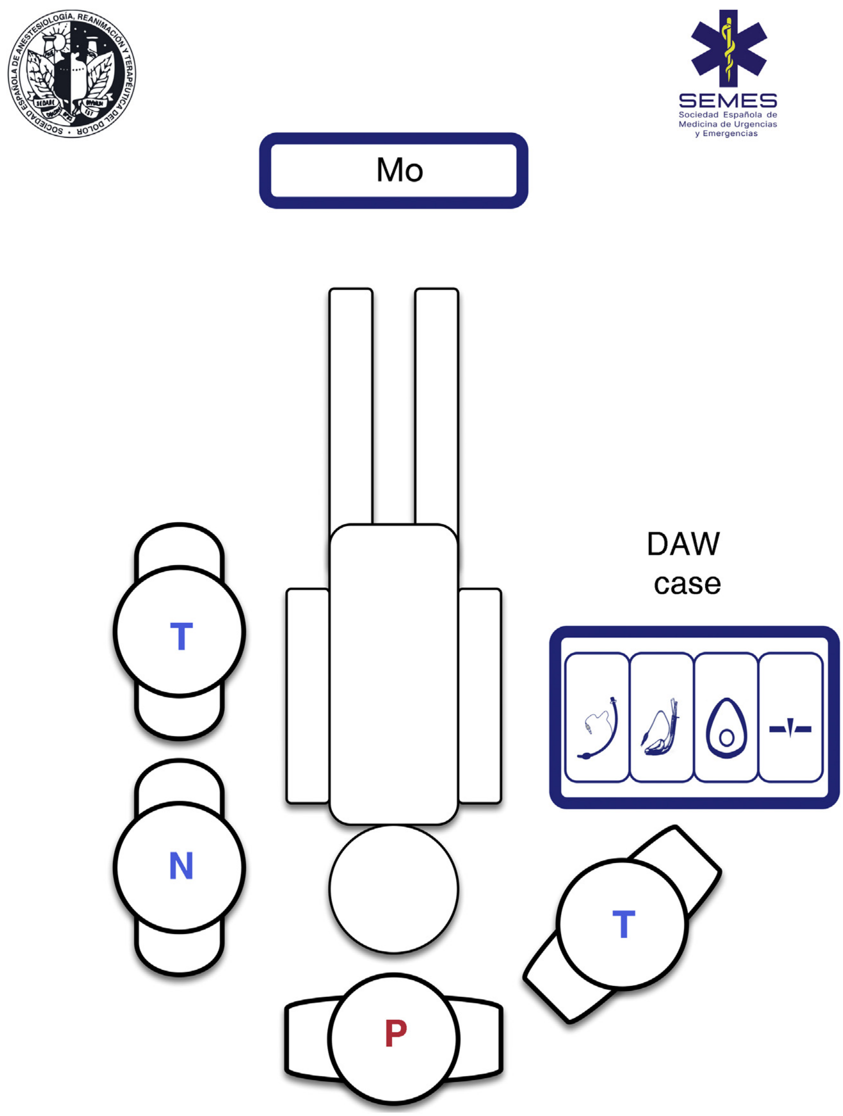


Figure 4 Location of equipment and material in an ideal pre-hospital scenario. N: nurse; P: physician, Mo: monitor; T: technician; DAW: difficult airway.

a checklist including drugs, calculation of dose and all available elements.[341]

Cardiopulmonary resuscitation

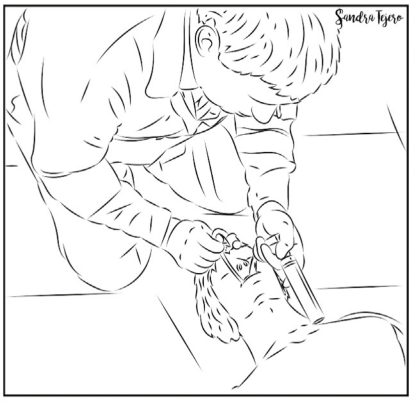
Any abnormal situation increases the delay in ventilation and alveolar oxygenation, interrupts chest compressions, and delays recovery of spontaneous circulation (ROSC).[342]

The available evidence does not show strong differences between different non-invasive AW management plans.[343–345] Outcomes are conditioned by TI success rates. Therefore, if the desired level of TI efficacy is not achieved, ventilation and alveolar oxygenation should be given preference over the specific treatment plan, taking care not to interfere with other techniques (chest compressions, defibrillation, and treatment of potentially reversible causes of cardiac arrest).[328]

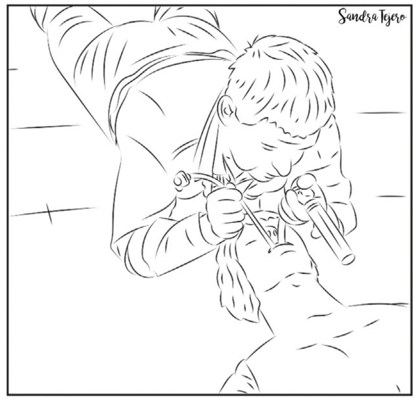
Severe trauma

Severe head trauma carries a high risk of AW obstruction, pulmonary aspiration, hypoxia, brain injury and death.[346] Severe head trauma carries a high risk of AW obstruction, pulmonary aspiration, hypoxia, brain injury, and death. Pre-hospital TI is beneficial when performed by experienced physicians following standardised protocols.[346,347] Pre-hospital TI together with air transport could reduce overall mortality by 47%.[326]

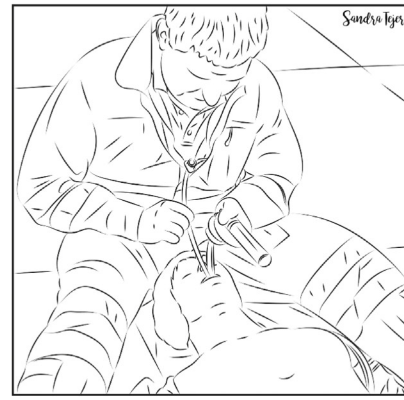
Several factors may hinder AW management such as, (1) the possible presence of an unstable cervical spine injury necessitating bimanual alignment, (2) contaminated AW, flooded or pooled by tissue, vomitus, secretions, blood (bloody airway), etc., these conditions require aggressive management with manual release of fragments and radical aspiration of secretions using the suction assisted laryngoscopy airway decontamination (SALAD) manoeuvre,[349] (3) uncooperative or agitated patient, (4) fractures of



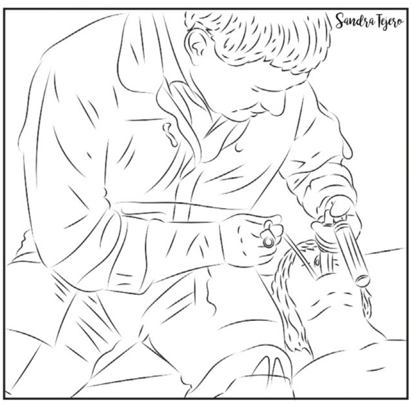
Position 1. Operator kneeling.
Allows good application of force by the left hand, although requires the operator to have dorsal flexibility. However, poor axis alignment may make laryngoscopy and oesophageal intubation difficult.



Position 2. Operator in prone position.
The axes are much more favourable. The left arm reduces its lever arm and, therefore, the axial traction force.

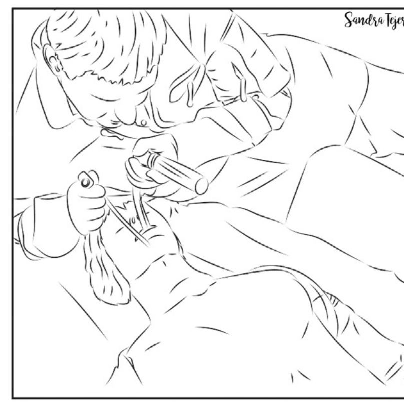


Position 3. Operator seated at the patient's head.
Good application of force. Poor axis alignment. Useful for narrow spaces.

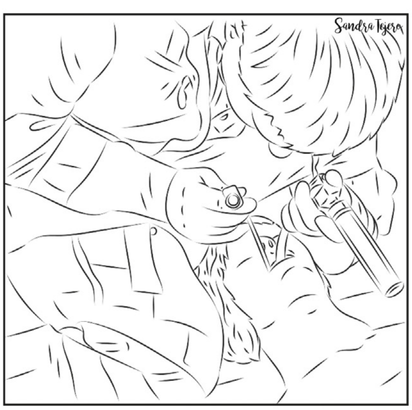


Position 4. Operator seated at the patient's side.
Very complex.

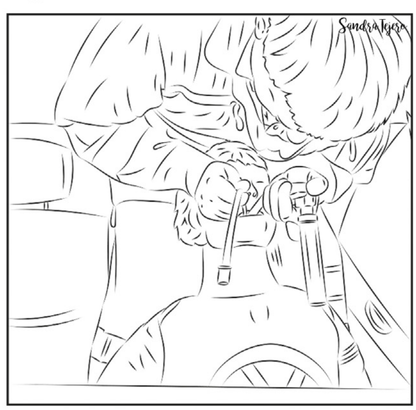
Position 5. Operator straddling the patient's chest (reverse frontal).
Requires change of hands. Allows good application of force. Axis alignment is not good. Usually requires support to maintain balance.



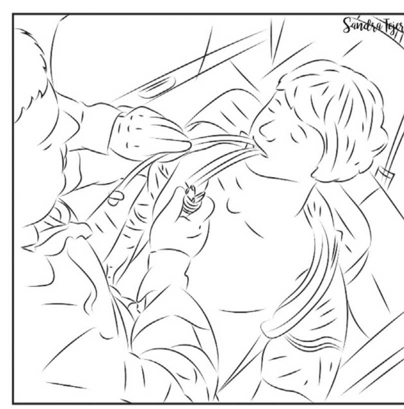
Position 6. Operator in right lateral decubitus.
Very complex. While the position reduces the power of the left arm, supporting the right arm reduces its level of precision. Useful for left-handers, with left-handed blades



Position 7. Operator in left lateral decubitus. Paris SAMU position.
Very interesting. Increases the traction power of the left arm, which also has a lateral traction component due to the position, and further opens the airway. The right hand retains its precision.



Position 8. Operator above and behind the patient.
Requires flexibility. Laryngoscopy is simple. Axis are good. Support is often required.
With the patient upright, the need for gravity traction is reduced



Position 9. Operator facing the patient.
Requires a change of hands. Enables application of force and laryngoscopy

Figure 5 Main models of the approach to the difficult-to-access AW.

the facial mass, and (5) direct trauma to the AW, both penetrating and blunt (AW burn and/or inhalation syndrome). The presence of penetrating cervical trauma is the most frequent indication for awake TI while those with maxillofacial trauma have the highest incidence of FONA.[348,350]

In these conditions, TI with RSI and VL with hyperangulated blade and preconfigured stylet is recommended.[348,351]

The impact of sunlight on the screen or the presence of blood or vomitus in the AW may condition the procedure.[352] If VL is not available, an SAD or DL with traction reduction can be used.[329] The use of DL may increase the risk of cervical spine injury.[348,350]

Trapped, buried, crushed, or inaccessible patient

This is the paradigm of the difficult-to-access AW. This new field forces teams to expand their knowledge so as to take part in life support manoeuvres for rescue (8 methods) and in hostile environments.[353]

Cuff pressure monitoring

Much laryngotracheal morbidity is related to inadequate cuff pressure.[354] Underinflation may cause hypoventilation or an increased risk of aspiration, while excessive pressure, even for short periods, may cause hoarseness, sore throat, impaired ciliary motility, and injuries such as mucosal swelling and ischaemia, laryngeal oedema, ulceration, stenosis, tracheoesophageal fistula, tracheomalacia, tracheal rupture, vocal cord paralysis, or nerve injury.[241,355–357] The incidence of these complications has reduced since the introduction of low-pressure, high-volume cuffs [358]; however, the devices used still cause avoidable harm.[94,359]

Intermittent cuff pressure monitoring by manometry is desirable after cuff pressure is established and periodically during maintenance[360–364] (not applicable in crisis situations). The use of continuous monitoring devices to constantly maintain the cuff pressure in range in the critically ill patient may decrease the risk of ventilator-associated pneumonia.[365–367] Continuous monitoring with cuff pressure manometry is suggested (**1 C**).

Cuff pressure should be set at the minimum pressure necessary to ensure an effective and safe seal. The pressure should remain between 20 and 30 cmH_2O (ideally less than 25 cmH_2O) for ETT and tracheostomy and cricothyrotomy tubes, and < 60 cmH_2O for SADs (**E.S.** 94,3%),[241,354,358,368–371] from insertion to removal. If within these limits the seal is inadequate, it may be necessary to reposition the device or resize it.[372]

Nitrous oxide diffuses into the cuff,[359] requiring further measurements after 20 min, when the pressure stabilises, and again if its concentration increases.[373]

Recommendation

Continuous cuff pressure monitoring with manometry is suggested.

Strong recommendation; low level of evidence (⊕⊕⊖⊖)

Extubation

Tracheal extubation is a high-risk procedure with major physiological implications.[374] It may evoke a haemodynamic response to stress, cough, laryngospasm, or agitation and, secondarily, an increase in intracranial or intraocular pressure.[375–378] Protective laryngotracheal reflexes remain impaired for several hours after extubation, facilitating aspiration. Failure of extubation occurs when a patient is unable to maintain oxygenation, adequate ventilation, clearance of secretions, or AW patency and can have catastrophic consequences, particularly in those with DAW.[376] AW obstruction is its main cause and is often associated with post-obstructive pulmonary oedema with severe hypoxia.[378] Failed extubation, generally defined as the need for reintubation within 24—72 h, occurs in approximately .1%–.45% of general anaesthesia[379] and is 10 times more prevalent in patients with sleep apnoea-hypopnoea syndrome (SAHS), or those undergoing AW procedures, and its prevalence is 10-fold higher in critical care areas.[380] This is an event with potentially severe outcomes.[381–383] Thus, secondary cases of death or permanent brain damage constitute one third of all anaesthesia-related cases.[288,384] Poor anticipation and planning for ät-riskëxtubation are key issues.[288,384] Extubation is an elective procedure that must be prepared for, followed by a stepwise strategy and meticulous follow-up.[375,376,378,385] Fig. 6 shows a cognitive aid for planning extubation based on risk.

The primary goal in tracheal extubation is to preserve alveolar oxygenation in addition to avoiding reintubation. Any reintubation can be considered potentially difficult as it involves additional complexity (**E.S.** 97.1%, distorted anatomy with restricted access, secretions, blood or oedema, limited time, and in a high-stress environment).[375,376,385] Risk stratification based at anatomical, physiological, and contextual level[376,383,386,387] can determine the chances of success conditioned by extubation tolerance and reintubation feasibility, establishing an individualised strategy and optimising AW-related factors and physiological status such as hypoxaemia, hypercapnia, residual NMB, hypothermia, or oedema in the AW.[355,383,387] Leak testing,[388] preferably quantitative (leak volumes <110 mL or <12%–24% of tidal volume determine reduced AW patency and risk of post-extubation stridor due to laryngeal oedema[387,389]), ultrasound assessment,[390,391] and visualisation of the larynx with VL or FOB can help in decision making (**E.S.** 97.1%) because they enable assessment of AW patency and determining the presence of periglottic oedema or bleeding prior to extubation,[355] although they are not a specific predictive test for successful extubation.[392]

Once the decision has been made to proceed with extubation, the first step is to review the original TI and update the AW assessment, and general risk factors.[383] Careful preparation beforehand, conveying potential problems and early warnings, and establishing appropriate rescue plans for oxygenation and reintubation in case of failure of the primary plan are conducive to safe and successful extubation.[378,383] Important prior to intervention[378] are (1) pre-oxygenation until extubation, (2) oropharyngeal suctioning of secretions or blood under direct visualisation, ideally with laryn-

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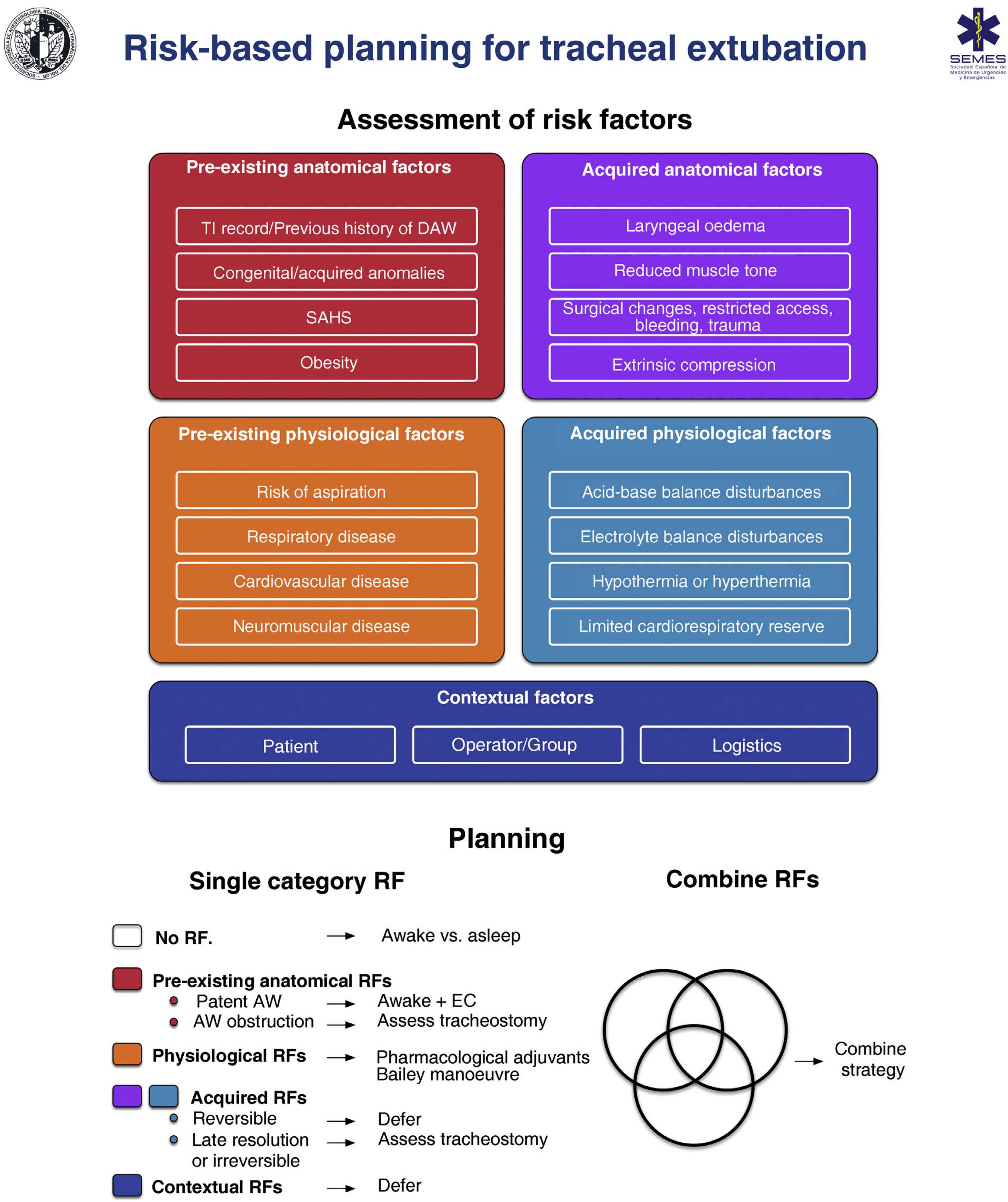

Figure 6 Cognitive aid for planning, risk stratification, and decision making for AW extubation.
Adjts: adjuvants; AW: airway; DAW: difficult airway; EC: exchange catheter; RF: risk factors; SAHS: sleep apnoea-hypopnea syndrome; TI: tracheal intubation.

goscopy, to avoid soft tissue trauma, (3) placement of a bite block,[386] (4) correct positioning of the patient, (5) reversal of NMB, neuromuscular monitoring in combination with reversal agents aiming for a train-of-four ratio ≥.90 is essential to avoid residual NMB,[393–396] (6) minimisation of head and neck movements and reduction of noxious stimuli to avoid laryngospasm, (7) emergence to state of wakefulness,[377,378,385–387] deep extubationis an inappropriate technique for DAW or when there is risk of aspiration,[377,386] (8) apply positive pressure, deflate the cuff and remove the ETT, (9) administer 100% oxygen, confirm AW patency and adequate spontaneous ventilation, and (10) continuous oxygen therapy until full recovery, surveillance, monitoring, and skilled assistance to cope with potential emergency tracheal reintubation.[385] The DAW team must be prepared and remain immediately accessible.

Prophylactic administration of corticosteroids prior to elective extubation is associated with a significant decrease in the incidence of post-extubation adverse events in the AW and reintubation, therefore patients at high risk of obstruction may benefit.[397–399] In those with absent or reduced leak, administration of a corticosteroid at least four hours prior to extubation is recommended.[376,387,389] Prophylactic administration of corticosteroids prior to extubation is suggested in patients at high risk of obstruction (**1 B**).

There are several advanced methods for at-risk extubation that should only be performed by experienced personnel.[378] The administration of pharmacological adjuvants[400–405] such as a remifentanil infusion[406] or the Bailey manoeuvre, which involves placing a SAD over the ETT and then removing it,[407] may be considered when gentle emergence and attenuation of undesirable cardiovascular or respiratory responses is required.[408–410] The use of VLMs for TI may have a role to play in safer and simplified TI because they allow the switch to be performed by simply pulling back the ETT through its ventilation channel, vision-guided, and reversing it instantaneously.[66] Both techniques require a deep level to perform, and may therefore be inappropriate in patients in whom reintubation may be difficult or there is a risk of aspiration.[1,378]

Awake extubation using advanced techniques is the most appropriate method for DAW (**E.S.** 94.3%), because it maintains upper AW patency with re-established muscle tone, protective reflexes, and spontaneous ventilation.[410] Airway exchange catheters are the most commonly used adjuvant to salvage extubation in potential or known DAW.[1] These devices allow tracheal reintubation by acting as a guide over which the ETT can be reinserted under direct view[185] and insufflation of oxygen at low flows or jet ventilation through them in potentially life-threatening hypoxaemia, although this should be avoided as even low flows have caused barotrauma.[411] They should be maintained until reintubation is unlikely.[376] Their use has been associated with high overall (92%) and first-attempt (87 vs. 14%) success rates, fewer oesophageal intubations, and fewer episodes of desaturation, bradycardia, or hypotension.[412] The main risks of the technique are AW stimulation, trauma with subcarinal insertions, and accidental catheter dislodgement. In adults, they should never be inserted deeper than 25 cm from the lips.[378] Staged extubation kits consisting of guidewire and reintubation catheter[413,414] are associated with an overall success rate of 93%,[415] and appear to improve tolerance at the cost of increased accidental dislodgement.[416] If reintubation over an intubation catheter is necessary, limiting the difference between the internal diameter of the ETT and the external diameter of the catheter, establishing an appropriate NMB, viewing advancement of the ETT by VL facilitate the procedure by avoiding impingement of the epiglottis and arytenoids.[383,417] The remaining recommendations for facilitating FOB-guided TI are equally applicable to exchange catheter-guided TI. Failure of the technique means referring to the unanticipated DAW algorithm.

Capnography should be available in recovery units and used in high-risk cases (**E.D.** 97.1%). Oxygen therapy with nasal goggles and masks with capnography line after extubation facilitates early detection of respiratory depression, hypoventilation, hypercapnia, or post-extubation AW obstruction.[379,387]

Strategies to prevent extubation failure include head tilt and supplemental oxygen administration. A good oxygenation strategy with NIV or HFNO may prevent reintubation in at-risk populations.[374,418–421]

Recommendation

Prophylactic administration of corticosteroids prior to extubation is recommended in patients at high risk of AW obstruction.

Strong recommendation; moderate level of evidence (⊕⊕⊖⊖)

Documentation

Documentation of AW management is necessary to guide future management. In addition to the collection of consent and pre-procedural assessment it should include methods of peri-procedural oxygenation, topicalisation, awake sedation, induction, device, adjuvants and ETT used, approach (right nasal, left nasal, or oral), number of attempts, extubation, and any difficulties or complications. Appendix A, supplementary material 5 shows a template for recording relevant AW-related information.

A history of failure of previous procedures is the most accurate predictor of failure of subsequent treatments (**E.S.** 97.1%).[422] Documenting the difficulty is one of the most important actions to prevent complications as it facilitates decision-making and allows for a targeted structured approach and efficient transition with less instrumentation by avoiding persevering with plans that have failed in previous procedures.[422,423] Therefore, it is appropriate to diversify the means of documenting a DAW as this increases the chances of successful transmission of this critical information.[423,424] Thus, the following are recommended[11,294,424]: (1) recording in the electronic history with detailed description and visual record, images and/or video, of the anatomy and the successful technique employed,[425] (2) verbal communication to the conscious patient and the family member, guardian, or caregiver, (3) written report to the patient, Appendix A, supplementary material 6 includes the DAW notification template proposed by SEDAR SEMES SEORL-CCC, (4) notification bracelet or necklace or ID card with QR code for access to clinical information, Appendix A, supplementary material 7 shows the means of identifying a DAW suggested by SEDAR SEMES SEORL-CCC, (5) alert each time the electronic patient record is accessed, and (6) entry in national or international databases.[426] It is recommended to standardise records with mandatory fields and free text sections to include the characteristics of the AW, the nature of the difficulty, failed and successful techniques.[294,424] Structured notes in the electronic record have shown an improvement with reduction of adverse events.[427,428]

Management in the field of the airway

In addition to individual commitment, a proactive state, and institutional and departmental involvement are required to implement strategies.[429,430] The action plan to improve safety, cost-effectiveness, and quality of care in AW management includes (1) standardisation of practice and equipment in all locations, effective adherence to guidelines, a standardised DAW trolley,[431] removal of barriers and application of facilitators,[432–434] (2) coordination of departments that manage the AW (anaesthetics, intensive care, ED, ENT, and pre-hospital care), (3) procurement and availability of appropriate equipment, (4) continuous staff training and education, (5) regular audits and error limitation programme: (a) incident analysis, (b) identifying and addressing departmental and institutional factors that may have contributed to the event for learning and implementation of improvements, (c) case review and discussion of alternative plans, (6) incident documentation and notification plans,[435] (7) DAW coding, recording, identification and alerting systems, and (8) organisational resource guidelines and continuous process improvement.[436,437]

Appointing an AW lead in each institution is recommended (**E.S.** 100%);[11,429,430,438] a professional with experience in the field, who liaises with management to assume the actions and organisational aspects indicated. Their primary objective is to provide each professional with the necessary tools.[429,439] Some hospitals have set up multidisciplinary teams of specialised staff with defined roles to increase safety.[440–442] The creation of a national network of AW leads and teams can enable the field to develop.[438,439]

Decisions on the procurement of AW devices should be supported by formal evaluation based on scientific evidence.[24,443,444]

Teaching and training

AW management is an essential competence in anaesthesiology, critical care, pre-hospital, and emergency medicine.[445,446] Poor training is a common causal or contributing factor to complications[234,384] and impacts on the confidence operators have in the use of devices and performing essential techniques such as FOB and cricothyrotomy.[447–449] Optimising teaching and training is key to increasing safety.[322]

There is limited evidence and lack of standardisation in AW management teaching,[324,450] and therefore strategies are extrapolated from other fields. Good training should include cognitive skills based on theoretical principles and technical and non-technical skills.[322,451] Competency acquisition should be gradual, through a cognitive phase, simulation, and clinical training with problem solving until the learning curve is complete, with assessment and feedback from the instructor at each phase (**E.S.** 100%).[437,452,453] Competency-based education requires individualised instruction.[454] Training should follow a learning approach consisting of reaching a predefined standard goal of mastery of a skill to escalating levels of difficulty and stress.[455] It is a learner-centred, evidence-based method,[456] potentially associated with better outcomes.[457,458]

Education and training should cover all sections of the guidelines in a structured way,[37,322,445,455] with special priority given to core, versatile, and time-critical skills.[445] Standardisation of a teaching and training programme is highly recommended. Simulation plays a relevant role, mainly in the acquisition of non-technical skills such as teamwork, the incorporation of guidelines and cognitive aids in clinical practice, and the rehearsal of tasks and resolution of rare life-threatening events.[437,448,455,459–464] Guidelines and algorithms are training tools for gaining knowledge and learning strategies and act as a resource during debriefing,[322,465,466] while cognitive aids are a good implementation tool for rehearsal during simulation.[127,322] Structured debriefing improves clinical knowledge, skill acquisition, and implementation of skills in practice.[455,467]

Operators with greater professional experience may be at risk of providing lower quality care,[446,468] and therefore require ongoing education and regular training to develop the new skills needed with the addition of new devices or techniques, and to maintain competencies,[322,445,455,469,470] preferably on an annual basis (**E.S.** 97.1%).[471] A proactive organisational and individual attitude is necessary. It is highly recommended that each service designate a local AW lead to promote quality interprofessional and multidisciplinary training programmes, with defined objectives, evaluation and supervision, and to ensure dissemination and adherence to the guidelines and cognitive aids.[322,324,439,445,448,472] Training should be diversified to provide the operator with alternatives.[43] Appendix A, supplementary material 8 shows the skills recommended by SEDAR SEMES SEORL-CCC that should be included in any AW training programme and the training methods needed to achieve objectives.

Summary of recommendations from the systematic literature search

Search strategies and GRADE tables are shown in the supplementary material.

No.	Recommendation	Level of evidence	Grade of recommendation
Pre-procedural assessment and planning			
1.	A diagnosis of SAHS is a predictor of difficult face mask ventilation	**Low**	**Strong**
2.	A diagnosis of SAHS is a predictor of difficult tracheal intubation	**Moderate**	**Strong**
3.	Gastric ultrasound examination is recommended to assess the risk of aspiration in at-risk situations	**Low**	**Strong**
Preparation			
4.	Capnography waveform is recommended as gold standard to confirm alveolar ventilation	**Moderate**	**Strong**
5.	Ramped position or elevated head to 30° in the obese population is recommended to improve tracheal intubation conditions	**Low**	**Strong**
6.	Ramped position prolongs safe apnoea time in obese populations	**Moderate**	**Strong**
Peri-procedural oxygenation			
7.	HFNO is recommended as first-line pre-oxygenation technique for patients with mild hypoxaemia	**Low**	**Strong**
8.	NIV is recommended over conventional oxygen therapy for anaesthetic induction in the obese patient	**Moderate**	**Strong**
9.	Oxygenation during apnoea with high-flow nasal goggles (NOT DESAT/HFNO) is recommended	**Low**	**Strong**
Rapid sequence induction			
10.	Neuromuscular block is recommended to improve TI conditions and the incidence of AW-related adverse events in the general population	**Moderate**	**Strong**
11.	The rocuronium + sugammadex combination is not inferior to succinylcholine for RSI	**Moderate**	**Strong**
Unanticipated difficult airway			
Tracheal intubation			
12.	The routine use of VL is recommended over DL as the primary device for TI	**Moderate**	**Strong**
13.	The use of a dynamic or articulated bougie (flex-tip or FOB type) versus a conventional stylet is recommended for TI in patients with difficult airway	**Low**	**Strong**
14.	Parker Flex ETT is recommended over conventional ETT for FOB-guided TI in the general population	**Moderate**	**Strong**
15.	Parker Flex ETT over conventional ETT for TI guided by FOB and laryngoscopy in the general population is suggested to reduce complications	**Low**	**Strong**
Face mask ventilation			
16.	Face mask ventilation is recommended with modified triple manoeuvre over the C-E technique for the general population	**Low**	**Strong**
Front-of-neck access			
17.	Use of ultrasonography over palpation to identify the cricothyroid membrane is recommended	**Low**	**Strong**
Pressure cuff monitoring			
18.	Continuous pressure cuff monitoring with manometry is suggested	**Low**	**Strong**
Extubation			
19.	Prophylactic administration of corticosteroids prior to extubation in recommended in patients at high risk of AW obstruction	**Moderate**	**Strong**

AW: airway; DL: direct laryngoscopy; ETT: endotracheal tube; FOB: fibrobronchoscopy; HFNO: high-flow nasal oxygen; NIV: non-invasive ventilation; NO DESAT: nasal oxygen therapy during efforts to secure an ETT; RSI: rapid sequence induction; SAHS: sleep apnoea-hypopnoea syndrome; TI: tracheal intubation; VL: videolaryngoscopy.

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Expert statement from the results of the Delphi questionnaire

No.	Question	% in favour [in favour; neutral; against]
Human factors		
1.	The number of attempts for each non-invasive treatment plan should be limited to three	88,6 [31; 2; 2]
2.	The first attempt should be made under optimal conditions	100 [35; 0; 0]
3.	The most appropriate primary technique should be the one that offers the best guarantee of first-attempt success	94,3 [33; 1; 1]
4.	Visual cognitive aids are recommended for the management of emergency crises	97,1 [34; 1; 0]
5.	A standardised difficult airway trolley is recommended in areas with AW management	100 [35; 0; 0]
6.	Use of checklists is recommended to reduce the incidence of human error, improve task completion time, and reinforce a culture of safety in the AW management	100 [35; 0; 0]
7.	The use of ergonomic and communication models is recommended	91,4 [32; 3; 0]
Pre-procedural assessment and planning		
8.	Pre-procedural assessment is recommended for all patients requiring AW management	100 [35; 0; 0]
9.	Pre-procedural assessment of AW should be multifactorial, structured and aimed at detecting anatomical, physiological, and contextual DAW	97,1 [34; 1; 0]
10.	AW exploration can start by detecting predictors of difficulty or failure for the primary plan and subsequently for the 3 alternative plans	97,1 [34; 1; 0]
11.	Multivariate models may have a higher predictive power	97,1 [34; 1; 0]
12.	Decision-making should be individualised according to patient, operator, context, and time	97,1 [34; 1; 0]
13.	Restriction of food and fluid intake following preoperative fasting guidelines is necessary	97,1 [34; 1; 0]
14.	The presence of a full stomach indicates that the AW should be protected with TI	88,6 [31; 2; 2]
Preparation		
15.	Capnography waveform should be available in all AW management sites to assess the success of any of the 4 plans used	97,1 [34; 1; 0]
Basic options for difficult airway management		
16.	Before each procedure, the appropriateness of the treatment should be assessed, and a risk-benefit analysis performed	97,1 [34; 1; 0]
17.	Awake management is recommended when there is a high degree of difficulty or impossibility of TI, combined predictors of difficulty, or physiological disturbances, and negative contextual conditions	82,9 [29; 5; 1]
18.	Induction of general anaesthesia with preservation of spontaneous ventilation is suggested in situations where awake management is recommended but general anaesthesia is unavoidable due to uncooperativeness or urgency, and there are no physiological or contextual predictors of difficulty or obstructive pathology	91,4 [32; 2; 1]
19.	When physiological or contextual predictors of difficult AW exist, the benefit of deferral may be assessed if it outweighs the risk of proceeding to airway management, or alternative anaesthetic strategies may be considered	85,7 [30; 5; 0]
Known or anticipated difficult airway		
20.	Awake management is the option of choice to ensure a known or anticipated DAW	85,7 [30; 4; 1]
21.	High-flow nasal oxygen therapy is recommended over conventional low-flow cannulae	91,4 [32; 3; 0]
22.	NIV with endoscopic mask may have a role in TI in the critically ill patient with hypoxaemia	82,9 [29; 6; 0]
23.	Premedication with an antisialogogue is recommended to optimise the efficacy of local anaesthetic efficacy and field of view, glycopyrrolate being the preferred option	80 [28; 5; 2]

24.	Sedation is an optional adjunct to adequate topical anaesthesia in awake airway management	88,6 [31; 2; 2]
25.	The goals of conscious sedation for awake AW management are effective amnesia, patient satisfaction, and analgesia to reduce cough, gag, and haemodynamic reflexes, while preserving AW patency, spontaneous ventilation, and protective laryngeal reflexes	94,3 [33; 2; 0]
26.	If the selected primary technique (FOB or VL) fails, the alternative technique should be used	80 [28; 6; 1]
27.	A third attempt may benefit from a multimodal approach (VL + FOB)	100 [35; 0; 0]
28.	The combination of a TI SAD and FOB may be useful as a rescue technique to maintain oxygenation, maintain AW patency and to perform a TI through it	100 [35; 0; 0]
29.	A smaller than usual ETT is recommended with VL and FOB	85,7 [30; 4; 1]
30.	Decreasing the difference between the outer diameter of the FOB and the inner diameter of the ETT is recommended to facilitate FOB-guided TI	85,7 [30; 3; 2]
31.	Standard PVC ETTs are not recommended for FOB-guided TI as they are more likely to impact glottic structures	71,9 [23; 4; 5]
32.	After visual confirmation of TI, it is recommended to induce general anaesthesia after establishing cuff pressure and capnographic confirmation of TI	94,3 [33; 2; 0]
33.	Alternative techniques and approaches should be planned in advance and implemented without delay after failure of the primary approaches	100 [35; 0; 0]
34.	With a high probability of awake TI failure, it is recommended to prepare a FONA in parallel to the invasive treatment plan in case of total obstruction	88,6 [31; 4; 0]
35.	Awake tracheostomy under local anaesthesia is recommended in the presence of pre-existing critical AW compromise	82,9 [29; 6; 0]
36.	Awake cricothyrotomy would be the most indicated technique in the presence of emergent critical compromise	91,4 [32; 3; 0]
37.	Awake ECMO under local anaesthesia may be the safest option when all 4 conventional plans are expected to be impossible, unsuccessful, or ineffective, with risk of full AW obstruction	90,6 [29; 1; 2]
Unanticipated difficult airway		
Peri-procedural oxygenation		
38.	HFNO should be considered as the first-line pre-oxygenation technique for patients with mild hypoxaemia (PaO_2/FiO_2 > 200 mmHg), while NIV is the technique of choice in those with severe hypoxaemia ($PaO_2/FiO_2 \leq 200$ mmHg)	87,5 [28; 3; 1]
39.	Pre-oxygenation with NIV + HFNO and apnoeic oxygenation with HFNO should be a priority option for critically ill patients during TI	85,7 [30; 4; 1]
Rapid sequence induction		
40.	RSI is the recommended technique when there is a significant risk of aspiration in an AW without predictors of difficulty	97,1 [34; 1; 0]
41.	RSI with or without Sellick manoeuvre is recommended for all emergency TIs	84,4 [27; 1; 4]
42.	The use of checklists is suggested for safe preparation of RSI	97,1 [34; 1; 0]
43.	Premedication with non-particulate antacid immediately before induction and an H_2 -receptor antagonist 40—60 min before, or a proton pump inhibitor to increase pH and reduce the volume of gastric contents is suggested in patients at high risk of aspiration	82,9 [29; 5; 1]
44.	Nasogastric tube treatment should be individualised	88,6 [31; 4; 0]
45.	Highly efficient suction devices with large multi-hole suction tubes should be available in case of potential regurgitation	100 [35; 0; 0]
46.	An elevated head position to 20°-30° is recommended to prevent passive regurgitation and, if regurgitation occurs, the Trendelenburg position, turning the head to one side and suctioning the oropharynx and trachea before initiating positive pressure ventilation	94,3 [33; 2; 0]
47.	The choice of hypnotic as well as the dose and speed of administration should be individualised	91,4 [32; 3; 0]
48.	Delayed sequence induction is suggested in agitated and uncooperative patients for adequate pre-oxygenation	71,9 [23; 3; 6]
49.	Routine use of cricothyroid pressure cannot be recommended	81,3 [26; 2; 4]

50.	A "modified RSI" can be applied in patients at high risk of hypoxia who are not candidates for ATI	85,7 [30; 5; 0]
Tracheal intubation		
51.	Devices with a standard Macintosh-type blade (allows direct and indirect laryngoscopy) are appropriate for AW management without predictors of difficulty, while those with a hyperangulated blade (without or with a guide channel) are indicated for known or anticipated DAW	94,3 [33; 1; 1]
52.	It is recommended that a bougie be available in all AW management sites	97,1 [34; 1; 0]
53.	Absence of capnography trace (ventilation grade 3) indicates failed TI until proven otherwise	80 [28; 6; 1]
54.	Capnography waveform monitoring during maintenance of mechanical ventilation is highly recommended in all sites	100 [35; 0; 0]
Ventilation with supraglottic airway device		
55.	A SAD should be inserted without delay to preserve alveolar oxygenation in the event of difficult or failed TI	85,7 [30; 3; 2]
56.	Immediate availability of a second-generation SAD is recommended, as well as competency in its use in all AW management sites	100 [35; 0; 0]
57.	Cricoid pressure should be released during insertion of an SAD if it is being used	80 [28; 5; 2]
58.	90° rotation, jaw-thrust, and DL or VL (of choice) with the "insert-detect-correct-as-you-go" technique increase the efficacy and safety of the SAD by facilitating insertion, increase first-attempt success rate, and reduce pharyngeal trauma	82,9 [29; 4; 2]
59.	FOB-guided TI through the SAD may be chosen if the situation is stable, under adequate NMB and if the operator is competent in the technique	97,1 [34; 1; 0]
Face mask ventilation		
60.	For FMV it is recommended at the beginning to use the optimal technique (triple manoeuvre of full neck extension, anterior jaw thrust, and mouth opening, placement of oropharyngeal or nasopharyngeal cannula and two-handed V-E technique, in a patient with optimal positioning and strong NMB	80 [28; 3; 4]
61.	Declaration of failed FMV implies immediate transition to VSAD	85,7 [30; 2; 3]
Front-of-neck access		
62.	Failure of all 3 non-invasive plans (primary and rescue), regardless of SpO_2 value, requires verbalisation of the need for and subsequent FONA	90,6 [29; 0; 3]
63.	Cricothyrotomy is the technique of choice in a CICO situation	91,4 [32; 2; 1]
64.	The scalpel-bougie-tube surgical technique is recommended for cricothyrotomy	91,4 [32; 2; 1]
65.	A FONA should be feasible wherever AW is managed	100 [35; 0; 0]
66.	Emergency cricothyrotomy should be converted to ETT or tracheostomy because there is insufficient evidence for it as long-term management	85,7 [30; 3; 2]
67.	Failure of a cricothyrotomy to secure the AW makes it advisable for tracheostomy to be performed by a skilled operator	94,3 [33; 1; 1]
68.	Any AW management practitioner must acquire and maintain the necessary competency to perform a surgical or percutaneous cricothyrotomy with Seldinger's technique	100 [35; 0; 0]
Cuff pressure monitoring		
69.	Cuff pressure should be established at the minimum pressure necessary to ensure an effective and safe seal. Pressure should remain between 20 and 30 cm H_2O for ETT and tracheostomy and cricothyrotomy tubes, and < 60 cm H_2O for SADs	94,3 [33; 1; 1]
Extubation		
70.	Any reintubation can be considered potentially difficult as its management involves additional complexity	97,1 [34; 1; 0]
71.	Leak testing, preferably quantitative, ultrasound assessment, and laryngeal visualisation with VL or FOB may facilitate decision making	97,1 [34; 1; 0]
72.	Awake extubation with use of advanced techniques is the most appropriate method for DAW	94,3 [33; 2; 0]
73.	Capnography should be available in recovery units and used in high-risk cases	97,1 [34; 1; 0]

Documentation		
74.	A history of failure of previous procedures is the most accurate predictor of failure of subsequent management	97,1 [34; 1; 0]
Management in the field of the airway		
75.	Allocation of an AW lead in each institution is recommended	100 [35; 0; 0]
Teaching and training		
76.	Competency acquisition should be gradual, through a cognitive phase, simulation, and clinical training with problem-solving until the learning curve is complete, with assessment and feedback from the instructor at each phase	100 [35; 0; 0]
77.	Ongoing teaching and regular training are required for the development of new skills or techniques and the maintenance of competencies, preferably on an annual basis	97,1 [34; 1; 0]

AW: airway; CICO: can't-intubate-can't oxygenate situation; DAW: difficult airway; DL: direct laryngoscopy; ECMO: extracorporeal membrane oxygenation; ETT: endotracheal tube; FOB: fibrobronchoscopy; FiO_2: fraction of inspired oxygen; FONA: Front-of-neck access; HFNO: high-flow nasal oxygen therapy; FMV: face mask ventilation; NIV: non-invasive ventilation; NMB: neuromuscular block; PaO_2: partial arterial pressure of oxygen; PVC: polyvinyl chloride; RSI: rapid sequence induction; SAD: supraglottic airway device; 2 GSAD: second generation supraglottic airway device; SpO_2: peripheral oxygen saturation; TI: tracheal intubation; VSAD: Ventilation with supraglottic airway device; VL: videolaryngoscopy.

Authors' contribution

- Manuel Á. Gómez-Ríos: drafting of the manuscript, preparation of all cognitive aids and graphic material, tables and annexes, literature review, critical reading, levels of evidence, final revision of the document.
- José Alfonso Sastre: Draft of RSI sections, SAD, and checklist, risk factor tables, information document models, literature review, critical reading, levels of evidence, final revision of the document.
- Xavier Onrubia-Fuertes: FONA contribution, unanticipated difficult tracheal intubation, literature review, final revision of the document.
- Teresa López: Draft of SAD and ECMO sections, literature review, critical reading, levels of evidence, final revision of the document.
- Alfredo Abad-Gurumeta: literature review, critical reading, levels of evidence, final revision of the document.
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- José Carlos Garzón: literature review, critical reading, final revision of the document.
- Vicente Martínez-Pons: Algorithm for unanticipated difficult tracheal intubation, literature review, final revision of the document.
- Marta Casalderrey-Rivas: literature review, critical reading, final revision of the document.
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- Javier García-Fernández: critical reading, final revision of the document.
- Alfredo Serrano Moraza: prehospital setting section, literature review, critical reading, final revision of the document.
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- Miguel Mayo-Yáñez: FONA contribution, final revision of the document.
- Pablo Parente-Arias: FONA contribution, final revision of the document.
- Jon Alexander Sistiaga-Suárez: critical reading, final revision of the document.
- Manuel Bernal-Sprekelsen: critical reading, final revision of the document.
- Pedro Charco-Mora: Coordination, Algorithm for unanticipated difficult tracheal intubation, draft ergonomic options, draft teaching and training, literature review, critical reading, final revision of the document

Conflict of interests

MAGR received lecture honoraria from Medtronic.

XOF received honoraria for lecture and practical workshop on neuromuscular block from Merck Sharp & Dohme.

RCF received honoraria for lectures from Fresenius Kabi.

AAG received honoraria for lectures from Merck Sharp & Dohme and 3 M Edwards.

Delphi expert panel

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