Expert Consensus

Expert consensus on difficult airway assessment

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Background: Identifying a potentially difficult airway is crucial both in anaesthesia in the operating room (OR) and non-operation room sites. There are no guidelines or expert consensus focused on the assessment of the difficult airway before, so this expert consensus is developed to provide guidance for airway assessment, making this process more standardized and accurate to reduce airway-related complications and improve safety.

Methods: Seven members from the Airway Management Group of the Chinese Society of Anaesthesiology (CSA) met to discuss the first draft and then this was sent to 15 international experts for review, comment, and approval. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) is used to determine the level of evidence and grade the strength of recommendations. The recommendations were revised through a three-round Delphi survey from experts.

Results: This expert consensus provides a comprehensive approach to airway assessment based on the medical history, physical examination, comprehensive scores, imaging, and new developments including transnasal endoscopy, virtual laryngoscopy, and 3D printing. In addition, this consensus also reviews some new technologies currently under development such as prediction from facial images and voice information with the aim of proposing new research directions for the assessment of difficult airway.

Conclusions: This consensus applies to anesthesiologists, critical care, and emergency physicians refining the preoperative airway assessment and preparing an appropriate intubation strategy for patients with a potentially difficult airway.

Keywords: Expert consensus; difficult airway; airway management

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Introduction

A "difficult airway" is a situation in which a healthcare provider who is appropriately skilled in airway management has or expects to have difficulty in laryngoscopy and tracheal intubation, and, more importantly, ventilation/oxygenation of the lungs. It may be anticipated from a patient's anatomical or pathological features or unanticipated, occurring during the procedure. Some patients may also have difficulty in extubation (1).

Airway management is a key feature in the safety and quality of anaesthesia. During the period from 2008 to 2009, the Fourth National Audit Project (NAP4) of the Royal College of Anaesthetists of the UK and Ireland and the Difficult Airway Society recorded 133 serious adverse airway events (or one per 22,000 interventions) and 16 airway management-related deaths (one per 180,000) in the UK and Ireland during anesthesia; where major airway management complications included death, brain damage, and emergency surgical airway. NAP4 emphasized that the actual prevalence might be over 4 times higher. NAP4 also found that the top two factors leading to the above airway complications were the patient characteristics (77% of cases) and misjudgment by medical staff (59%) (2).

It was reported that the prevalence of a difficult airway ranged from 11% to 50% for tracheal intubations performed outside of the operating room (OR) (3-5). Identifying a potentially difficult airway is also important in non-operation room sites such as the intensive care unit (ICU) and emergency room (ER).

An unpredicted difficult airway can result in failed intubation and, if ventilation is difficult, can evolve to a "cannot ventilate, cannot intubate" (CVCO) scenario, with risk of hypoxic-ischemic brain injury, and death. While unanticipated difficult airways have always been a challenge for anesthesiologists, critical care, and emergency physicians, appropriate preoperative assessment can enable detection of most difficult airways allowing appropriate preparation and management.

Focusing on a balance between precise assessment and medical resource utilization, this consensus aims to present an effective solution for airway assessment in anesthetic and critical care emergency settings, to standardize the evaluation algorithm, reduce airway-related complications, and improve safety. We present this article in accordance with the CREDES reporting checklist (available at https://hbsn.amegroups.com/article/view/10.21037/hbsn-23-46/rc).

Highlight box

Key recommendations

- Airway assessment is of utmost importance, primarily relying on medical history and comprehensive physical examination.

What was recommended and what is new?

- Airway imaging is recommended for select patients with anatomical abnormalities.
- Transnasal endoscopy is recommended for assessing patients with periglottic lesions or atypical airway structures.

What is the implication, and what should change now?

- In the future, we need to develop more accurate and perfect tools on difficult airway assessment.

Methods

Selection of the expert panel

This consensus was conceived and produced by 7 members from the Airway Management Group of the Chinese Society of Anaesthesiology (CSA) as well as 15 international experts. The panel included anesthesiologists, critical care, and emergency physicians. Each member was involved in at

Table 1 Certainty of the evidence according to the GRADE profile (6)

Certainty	Definition	Type of study
High	High or very high confidence that the actual effect lies close to that of the estimate of the effect	RCT or double-upgraded observational studies
Moderate	Moderate confidence on the estimate effect. The true effect is likely to be close to the estimate effect, but there is a possibility that it is substantially different	Downgraded RCT or upgraded observational studies
Low	The confidence on the effect estimate is limited: the true effect may be substantially different from the estimate effect	Double-downgraded RCT or observational studies
Very low	There is very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate effect	Triple-downgraded RCT, downgraded observational studies, case series, or case reports

GRADE, Grading of Recommendations, Assessment, Development and Evaluation; RCT, randomized controlled trial.

least 5 topics, each assigned to more than one member.

Literature search and appraisal

A literature search was performed on four databases (Medline, EMBASE, Cochrane, and CINAHL) and reviewed by members. No language restriction was applied. Animal, manikin, and cadaver studies were excluded. Commentaries, letters, and editorials were not included for review. Randomized, controlled trials, non-randomized, comparative studies, retrospective studies, observational studies, meta-analyses, and case series were considered for review.

Consensus development

The panel met every month from May, 2022 to October, 2022 via videoconference to revise the findings and provide recommendations. Upon reaching consensus, the first draft recommendations were sent to 15 international experts in airway management for review, comment, and approval. Using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach, the currently available evidence was classified into high, moderate, low and very low levels (*Table 1*) (6).

In addition, all the international experts were invited to participate in the Delphi survey by emails. The Delphi panel used a 5-point Likert scale (1= not important, 5 =very important) (7) to score the initial items, propose new items, and offer comments and suggestions for each item. The items were revised through a three-round Delphi survey. Survey questions in all three rounds of surveys can be found in the website: https://cdn.amegroups.cn/static/public/hbsn-23-46-1.zip. Each member disclosed any conflicts of interest before participating in the generation of initial items. Data obtained from each round of the Delphi survey were analyzed and discussed by the working group. Blinding was achieved by MX replacing the experts' names with random numbers and then by two other group members entering the Delphi survey data independently. The data were subsequently verified by MX. After that, a consensus on each item was determined according to the following rule "Consensus on any item is conditional to at least 66% of the Delphi survey responses having agreed on the rating". Items for which a consensus was not reached were moved to the next round. After the three-round Delphi survey, the items for which a consensus was not reached were discussed by the 7 members from the Airway Management Group of the CSA via videoconference and sent to international experts for approval by email. It is important to note that, within the Delphi methodology, the number of participating experts was relatively limited, potentially introducing bias in topic selection and statement formation. Nevertheless, members from the Airway Management Group of the CSA thoroughly discussed all topics, and the resulting statements were derived from a comprehensive review of the available literature.

Statistical analysis

Throughout each round of the Delphi survey, data acquisition was meticulously analyzed for internal consistency by employing Cronbach's alpha. Responses to the items were analyzed as percentage responses. Statistical analysis was executed using SPSS version 25 for Windows (IBM Corp., Armonk, NY, USA).

Table 2 The three rounds of Delphi scores

Item	1st round Delphi survey (12/21), n (%)			2nd round Delphi survey (15/21), n (%)			3rd round Delphi survey (16/21), n (%)		
	Score 1–2	Score 3	Score 4–5	Score 1–2	Score 3	Score 4–5	Score 1–2	Score 3	Score 4–5
1.1	0 (0.0)	0 (0.0)	12 (100.0)	–	–	–	–	–	–
1.2	0 (0.0)	1 (8.3)	11 (91.7)	–	–	–	–	–	–
2.1	0 (0.0)	0 (0.0)	12 (100.0)	–	–	–	–	–	–
3.1	0 (0.0)	2 (16.7)	10 (83.3)	–	–	–	–	–	–
4.1	–	–	–	0 (0.0)	3 (20.0)	12 (80.0)	–	–	–
4.2	3 (25.0)	4 (33.3)	4 (33.3)*	–	–	–	–	–	–
4.2.1	NA	NA	NA	2 (13.3)	5 (33.3)	7 (46.7)*	3 (18.8)	3 (18.8)	9 (56.3)*
4.2.2	NA	NA	NA	3 (20.0)	6 (40.0)	5 (33.3)*	5 (31.3)	5 (31.3)	5 (31.3)*
4.3	2 (16.7)	4 (33.3)	6 (50.0)	5 (33.3)	2 (13.3)	8 (53.3)	4 (25.0)	4 (25.0)	8 (50.0)
4.4	7 (58.3)	3 (25.0)	2 (16.7)	9 (60.0)	3 (20.0)	3 (20.0)	12 (75.0)	2 (12.5)	1 (6.3)*
4.5	1 (8.3)	4 (33.3)	7 (58.3)	4 (26.7)	5 (33.3)	6 (40.0)	4 (25.0)	6 (37.5)	6 (37.5)
5.1	3 (25.0)	4 (33.3)	5 (41.7)	1 (6.7)	1 (6.7)	12 (80.0)*	–	–	–
5.2	10 (83.3)	1 (8.3)	1 (8.3)	–	–	–	–	–	–

Scores range from 1 to 5, corresponding with the lowest to the highest level of importance. Consensus on any item is conditional to ≥66% of the responses having agreed on the rating in one category. *, one of the experts did not score this item. NA, not applicable.

Results of the Delphi survey

Three rounds of Delphi survey

The response rates for the first, second, and third Delphi surveys were 57.1% (12/21), 71.4% (15/21), and 76.2% (16/21), respectively. The original data for all the three rounds of Delphi surveys are available in the website: https://cdn.amegroups.cn/static/public/hbsn-23-46-2.zip, and the survey scores for all the items in three rounds can be found in *Table 2*.

The checklist description

After the three-round Delphi survey, 12 items were determined to be recommended for the airway assessment before airway management. The description can be found in *Table 3*. These items are distributed across 5 sections: 2 items in medical history; 1 item in physical examination; 1 item in comprehensive scores; 6 items in imaging; and 2 items in others.

Definition

There is no standard classification but the American Society of Anesthesiologists have recently defined "difficult facemask ventilation" as not possible to provide adequate ventilation because of one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas (1). "Difficult laryngoscopy" was defined as the inability to visualize any portion of the vocal cords after multiple attempts with laryngoscopy (1). "Difficult or failed tracheal intubation" was defined as tracheal intubation requiring multiple attempts or failure after multiple attempts (1). It's worth noting that difficult laryngoscopy is not always related to difficult intubation and physicians can sometimes can see the vocal cords but cannot pass the endotracheal tube.

Medical history

Recommendation: review the medical records regarding previous airway management before airway management

If available, an evaluation of clinical documentation regarding previous airway management is essential. This should encompass mask ventilation, direct/indirect laryngoscopy, supraglottic airway, what airway management

Table 3 The detailed survey questions

Section/item	Description
Medical history (2 items)	
1	Review the medical records regarding previous airway management before airway management
2	Obtain a medical history of co-morbidities that may affect the airway before airway management
Physical examination (1 item)	
3	Perform comprehensive physical examination prior to airway management
Comprehensive scores (1 item)	
4	Use an airway assessment tool (STOP-Bang questionnaire, El-Ganzouri score, and Wilson score, and in the ICU, the MACOCHA score) before airway management
Imaging (6 items)	
5	Imaging of the airway may be considered in selected patients with anatomical abnormalities
6	Perform cervical X-ray before airway management in patients with suspected cervical trauma
7	Perform cervical X-ray before airway management in patients with congenital disorders (e.g., odontoid hyperplasia), degenerative conditions (e.g., cervical spondylosis, rheumatoid arthritis and ankylosing spondylitis) or syndromes such as Down's, neurofibromatosis, osteogenesis imperfecta and Klippel-Feil)
8	Perform CT scan before airway management in patients with various congenital disorders, infectious pathologies, airway stenosis due to extrinsic or intrinsic tumours
9	Perform MRI to assess a patient's airway before airway management
10	Perform ultrasound for airway assessment before airway management
Others (2 items)	
9	Perform transnasal endoscopy to evaluate patients with periglottic lesions or abnormal airway structures before airway management
10	Perform virtual laryngoscopy and 3D printing for airway assessment

ICU, intensive care unit; CT, computed tomography; MRI, magnetic resonance imaging; 3D, three-dimensional.

equipment was used, whether the procedure was successful, and if difficulty was encountered. The most accurate predictor of difficult intubation is a history of previous difficult or failed intubation (8,9) (evidence level: moderate).

Recommendation: obtain a medical history of co-morbidities that may affect the airway before airway management

Certain chronic diseases [such as rheumatoid arthritis (10), ankylosing spondylitis (11), and diabetes (12)] may reduce joint mobility (evidence level: low).

Airway-related signs such as snoring (13,14) or obstructive sleep apnea syndrome (OSAS) (15-17) are important to ascertain (evidence level: moderate).

Recent acute respiratory tract infection increases the likelihood of laryngospasm and bronchospasm (evidence level: very low).

Pregnancy (18) and obesity (19) increase the risk of difficult mask ventilation, difficult intubation, and reduce functional residual capacity thereby reducing the duration of safe apnea (evidence level: low).

Recent or past traumatic injuries or burns to the head and neck (e.g., facial fractures) and/or infection can affect the airway, usually due to direct injury and consequent airway deformation, haemorrhage, trismus, and oedema (20-22). The extent and timing of the injury should be ascertained, and the degree of swelling, pain, and spasm assessed. Chemical and thermal injuries can rapidly cause airway oedema, and subsequent head and neck scarring can limit neck mobility and inter-incisor gap, making airway management extremely difficult (23,24) (evidence level: low).

Head and neck cancer can pose challenges to the airway management (25-27). Oral cancer can increase the lingual

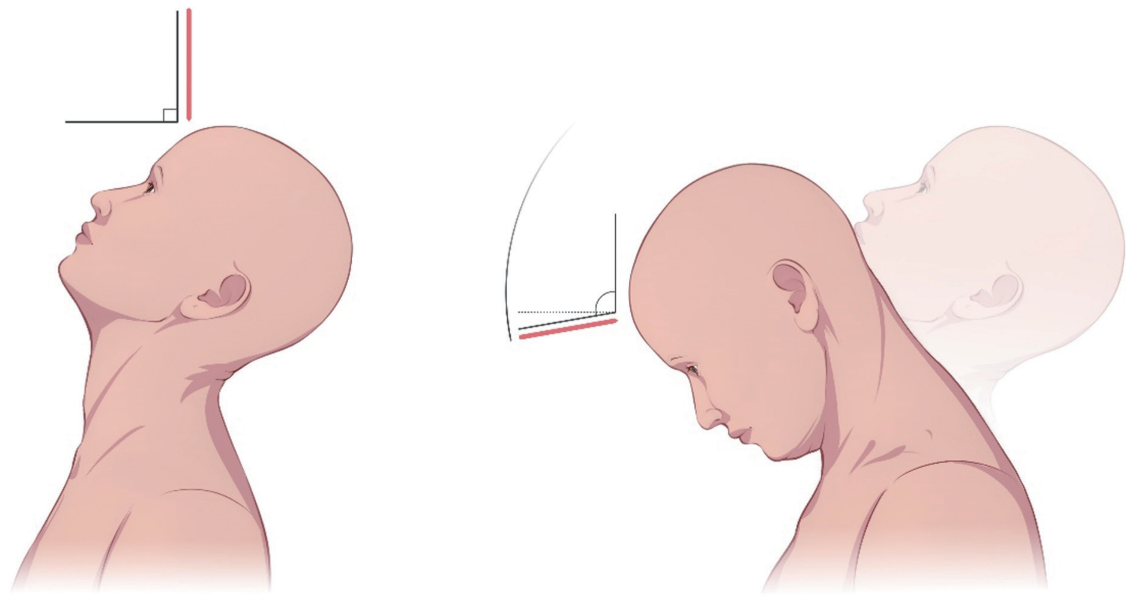

Figure 1 Cervical spine mobility.

volume and/or reduce pharyngeal and submandibular compliance. Throat tumors can easily cause acute airway obstruction and impede the passage of endotracheal tubes. Radiotherapy to the head and neck can result in tissue fibrosis, decreased neck mobility, and osteoradionecrosis, which increase the difficulty of airway management (28) (evidence level: low).

Congenital syndromes such as Pierre-Robin (29), Klippel-Feil (30), Treacher-Collins (31), and Down's (32) can alter facial anatomy (evidence level: low or very low).

Physical examination

Recommendation: comprehensive physical examination is required prior to airway management

Several physical signs which are apparent with bedside examination have been shown to be valuable in predicting difficult airways. These are measurement and assessment of facial and mandibular features (cervical spine mobility, presence of prominent upper incisors, presence of whiskers or beard, and upper lip bite test results) and some anatomical markers (modified Mallampati test score, reduced thyromental distance and sternomental distance, inter-incisor gap, neck circumference, the ratio of neck circumference to thyromental distance, the ratio of height to thyromental distance, the ratio of height to sternomental distance, hyoid-mental distance, and thyromental height).

Patients should be observed for obesity, increased overjet (the horizontal distance between the upper central incisors and the lower central incisors is normally 2–3 mm), edentulousness, retrogenia and head and neck lesions (33,34) (evidence level: low or very low).

The inter-incisor gap refers to the distance between the incisal edges of the upper and lower incisors when a patient's mouth is maximally opened. The width of open mouth is very important in airway management, and a gap <3.5 cm increases the chance of a difficult airway (8,14,34-44) (evidence level: moderate).

During assessment of cervical spine mobility, the patient should be asked to move his/her head forward and downward to bend the neck. The patient is then asked to try and lift the face upwards to evaluate the extension of the lateral atlantoaxial joint (*Figure 1*). Decreased extension of the lateral atlantoaxial joint is related to difficult intubation. A greater degree of lateral atlantoaxial joint extension brings the oral axis towards the pharyngeal and laryngeal axes, and laryngoscopy is easiest to perform in the position with neck flexion and lateral atlantoaxial joint extension (8,14,36,40,45-47) (evidence level: moderate).

The upper lip bite test evaluates mandibular movement

Figure 2 The modified Mallampati test.

by asking the patient to bite the upper lip as much as possible with the lower incisors. The ability of the patient to do so is graded into 3 classes: I, lower incisors can bite the upper lip above the vermilion line; II, lower incisors can bite the upper lip below the vermilion line; and III, lower incisors cannot bite the upper lip. Patients with grades II to III may have difficult airways (37,48-54) (evidence level: moderate). In edentulous patients, it can be observed whether the lower lip can cover the upper lip (55) (evidence level: very low). In 2 meta-analyses, upper lip bite test was proven to be a good predictor of difficult laryngoscopy (8,44) (evidence level: moderate).

Mandibular retrognathia (mandible measuring ≤9 cm) is associated with a difficult airway (8,14,36,45,56) (evidence level: moderate).

The mandibular protrusion is a marker of mandibular mobility and can reflect the relationship between the upper and lower incisors. Limited mandibular protrusion is associated with a difficult airway (8,14,36,40,41,57,58) (evidence level: moderate).

The modified Mallampati test is the most popular technique for assessing tongue and pharyngeal size, and their relationship. The patient is asked to assume a sitting position, with the head in the neutral position, the mouth fully opened, and the tongue maximally protruded without phonation. Based on the pharyngeal structures observed, the view is divided into 4 classes: I, uvula, faucial pillars, and soft palate are visible; II, uvula is covered by the tongue root and faucial pillars and the soft palate is visible; III, only the soft palate is visible; and IV, only the hard palate is visible (*Figure 2*). The modified Mallampati test is a commonly used physical examination for predicting difficult intubation, and grade III or IV is usually associated with difficult intubation (14,36,50,53,59). However, in 2 meta-analyses, it only had moderate ability in predicting difficult airways (8,44) (evidence level: moderate).

Neck circumference is measured using a flexible ruler at the level of the thyroid cartilage around the upper edge of the seventh cervical vertebra when the patient is sitting upright. A neck circumference >40 cm is associated with difficult mask ventilation, laryngoscopy, and endotracheal intubation. While neck circumference may not be able to clearly indicate the distribution of soft tissue in different regions of the neck, the amount of pretracheal soft tissue is more accurate in predicting difficult airways. The ratio of the neck circumference to thyromental distance (60) is a new indicator that may better reflect the distribution of neck soft tissue. Current studies have shown that a ratio greater than five is accurate in predicting difficult airways (60,61) (evidence level: low).

The thyromental distance and sternomental distance are commonly used to measure the distance from the mandibular mental process to the thyroid cartilage notch or the suprasternal fossa when the patient's head is tilted back as far as possible. The hyomental distance is the distance between the tip of the hyoid bone and the mental prominence when the patient's head is in the neutral position. A hyomental distance <3–5 cm (8,39,56,62) and a thyromental distance <4–7 cm (8,36,37,48,49,62-66) are associated with difficult airways (evidence level: moderate).

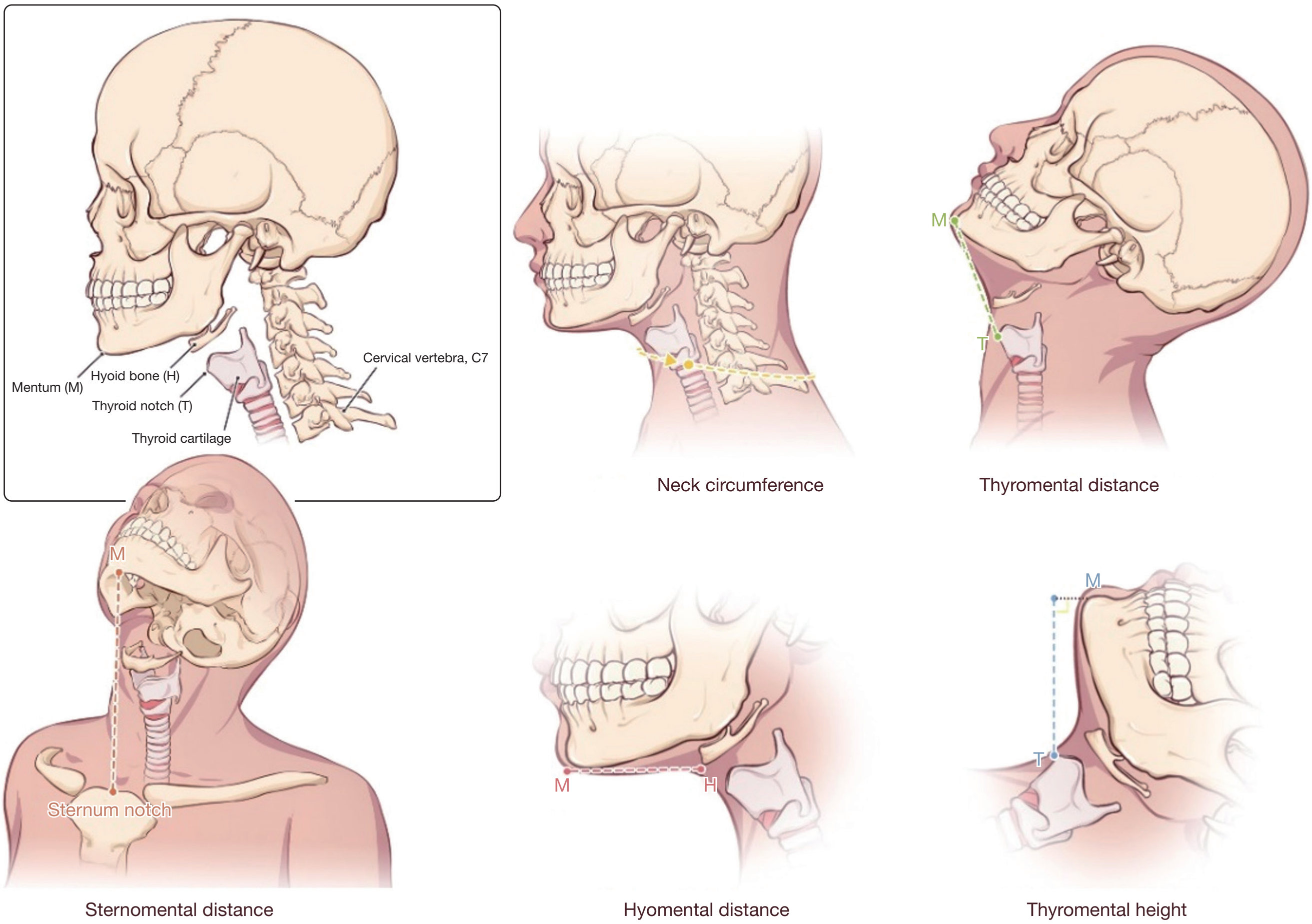

Figure 3 The detailed bedside tests include neck circumference, thyromental distance, sternomental distance, hyomental distance, thyromental height.

These predictors may be more precise after correction for differences in body height. A ratio of height to thyromental distance ≥17–25 is associated with a difficult airway (8,14,49,50,67) (evidence level: moderate). A ratio of height to sternomental distance ≥10.5 is also associated with a difficult airway (67) (evidence level: very low).

Thyromental height is a newly proposed indicator that measures the height between the anterior borders of the mentum and the thyroid cartilage with the patient lying supine. Studies have shown that a distance ≤50 mm has good sensitivity/specificity and predictive accuracy for difficult intubation (65,68-71) (evidence level: low).

Detailed bedside tests are shown in *Figure 3*.

There is, however, considerable heterogeneity on the prediction of difficult airway by bedside physical examination, and no single feature has been identified as more predictive than another. Therefore, it is recommended that clinicians should use multiple approaches to predicting difficult airways.

Comprehensive scores

Recommendation: use an airway assessment tool before airway management

A combination of medical history and physical examination can improve the accuracy of difficult airway prediction. Currently, the most used comprehensive scores and questionnaires include the STOP-Bang questionnaire (72), El-Ganzouri score (73), and Wilson score (74). In the ICU, the MACOCHA score is feasible to predict intubation failure (75).

The STOP-Band questionnaire includes 8 simple questions: (I) loud snoring; (II) daytime tiredness or fatigue;

(III) observed to stop breathing during sleep; (IV) high blood pressure; (V) body mass index (BMI) >35 kg/m^2; (VI) age over 50 years; (VII) neck circumference >40 cm; and (VIII) male gender. Each question scores 1 point for "yes" and 0 for "no". The STOP-Bang questionnaire was designed to screen for OSAS but a score ≥3 has been used as a predictor of airway difficulty (16) (evidence level: low).

An El-Ganzouri Risk Index (EGRI) score (which incorporates the interincisor gap, thyromental distance, modified Mallampati test, neck mobility, mandibular protrusion, body weight and history of difficult intubation) ≥3–4 points is also associated with a difficult airway (73,76-78) (evidence level: low).

The Wilson score evaluates the airway using 5 parameters: body weight, head and neck movement, jaw movement, retrognathia, and prominent incisors. Each parameter scores 0, 1, or 2, and the total risk score, therefore, ranges from 0 to 10. A score more than 2 is associated with difficult airway (8,79-82) (evidence level: moderate).

Tracheal intubation in the ICU may be less optimal and more challenging than for elective surgery in the OR. The recently proposed MACOCHA score ranges from 0 to 12 and is a feasible tool to predict difficult intubation in ICU. It includes patient characteristics (which incorporates the modified Mallampati test, history of OSAS, neck mobility, and the interincisor gap), the general underlying pathology (which incorporates coma and severe hypoxemia) and whether operators are anesthesiologists. Higher scores are associated very closely with complications particularly at the maximum levels (evidence level: moderate).

Imaging

Recommendation: imaging of the airway is recommended in selected patients with anatomical abnormalities before airway management

With advances in biomedical engineering, several visualization techniques have become available for preoperative airway assessment. Diagnostic imaging techniques such as X-rays, computed tomography (CT) scans and magnetic resonance imaging (MRI) can augment the above clinical test/examinations in further improving airway assessment. In addition, ultrasonography, a portable, non-invasive, and repeatable imaging modality, is an increasingly valuable tool in airway assessment (83).

Recommendation: cervical X-ray may be considered before airway management in patients with trauma, congenital disorders (e.g., odontoid hyperplasia), degenerative conditions (e.g., cervical spondylosis, rheumatoid arthritis and ankylosing spondylitis) or syndromes such as Down's, neurofibromatosis, osteogenesis imperfecta and Klippel-Feil)

Abnormal anatomy adjacent to the airway can often be seen on X-ray. Measurements of specific index distances on cervical spine X-rays can be used to predict difficult airways. The atlanto-occipital distance is an important factor limiting head and neck extension (84). A longer atlanto-occipital distance suggests larger head and neck movement. Lateral radiographs of the cervical spine have shown that a gap of <5 mm between the C1 spinous process and the occipital bone is associated with difficult intubation. In addition, a reduced gap between C1 and C2 is associated with a difficult intubation (85). In patients undergoing surgery for cervical spondylosis, an angle >12.1° between C2 and C6 on a lateral cervical radiograph (with the head in the neutral position) was associated with a difficult intubation (86). The contour of the mandible can reflect the internal space of the mandible and the size of the tongue. A larger ratio of the depth of the mandible to its length indicates that the tongue body is larger or positioned more backwards than normal, which impedes laryngoscopy (87). In patients with acromegaly, a distance <48 mm from the dental alveoli of the mandible to the hyoid bone may indicate difficult intubation (88). A maxillo-pharyngeal angle <90° (normal: >100°) is associated with a difficult laryngoscopy (89). In patients with suspected cervical trauma cervical X-ray is considered to be valuable. However, related research has found that about 10% of patients with cervical spine trauma needed emergency intubation within 30 minutes, and the application of cervical X-ray is limited in clinical practice (90).

In general, most of the current research on radiographic prediction of airway difficulty indicates that the sensitivity, specificity, and prediction accuracy of X-ray may be higher than those of the modified Mallampati test (91). However, the number of studies is limited with small sample sizes and much heterogeneity. Radiography, to some extent, can compensate for some of the shortcomings of physical examination; however, its value in predicting difficult airways warrants further exploration (evidence level: low).

Recommendation: CT scan may be considered before airway management in patients with various congenital disorders, infectious pathologies, airway stenosis due to extrinsic or intrinsic tumours

CT is comparable to X-ray in predicting difficult airways (91). CT scan can clearly delineate the airways of patients with oropharyngeal tumors, thyroid masses, lingual tonsil hypertrophy, and tracheal stenosis or deviation. Using three-dimensional (3D) CT reconstruction technology, it is possible to measure, analyze and judge anatomical changes in the upper airway from the sagittal, coronal and transverse views and assess whether a patient has a difficult airway. The appropriate airway tools can be selected, and a treatment protocol developed. CT can be used to measure the area of the tongue which, in turn, can predict airway management difficulty (88). Both the distance from the root of the tongue to the posterior pharyngeal wall and the angle between the epiglottis and the tongue are related to the difficult laryngoscopy (92). CT can also assist in diagnosing abnormalities in the nasal cavity (93).

Due to relatively high radiation dose and cost, CT is only recommended in patients with airway abnormalities (evidence level: low).

Recommendation: routine MRI to assess a patient's airway before airway management is not recommended

MRI can visualize soft tissue more clearly than CT without radiation exposure but is much more expensive and time-consuming, and the patient needs to remain still for a longer period. MRI examination can be easily affected by breathing motion artifacts and has limited resolution; therefore, it has limited value in assessing airway structures (94). The position of the vocal cords, as visualized on MRI, is related to difficulty of laryngoscopy. More specifically, laryngoscopy is more difficult when the vocal cords are located more proximal to the head (95). The thickness of the anterior cervical soft tissue on MRI is not correlated with the difficult laryngoscopy (96). In patients with cervical spine trauma, the thickness of the retropharyngeal space is associated with a difficult intubation (97) (evidence level: low or very low).

Recommendation: ultrasound is recommended as an imaging tool for airway assessment despite a similar diagnostic value to X-ray and CT. Training is required

In addition to real-time imaging, ultrasound can dynamically reflect airway structural changes. Placing the ultrasound probe on the mandible can clearly visualize the tongue, epiglottis, vocal cords, hyoid bone, thyrohyoid periosteum, thyroid cartilage, cricoid cartilage, cricothyroid membrane, tracheal cartilage rings and other airway anatomical tissues. The tissue thickness in the neck and the distance between the different tissue layer can predict difficult airways.

Increased anterior cervical soft tissue thickness is associated with difficult airways (98). The thickness of the anterior cervical soft tissue at the thyrohyoid periosteum plane >2.8 cm correlates with difficulty in laryngoscopy (evidence level: low) (98). A distance from the skin to the epiglottis >2–2.75 cm has the best accuracy in predicting difficult airways (99-109) (evidence level: moderate).

Macroglossia is related to bag and mask ventilation difficulties (33). The cross-sectional area of the tongue can be measured on the midsagittal plane of ultrasound, and the maximum width of the middle of the tongue can be measured on the transverse plane. The product of these 2 measurements is the ultrasound tongue volume. Research has shown that ultrasound assessment of tongue volume has a predictive value for difficult airways (110). An ultrasound tongue volume <100 cm^3 can basically rule out difficult laryngoscopy (99). Ultrasound measurement of the skin-tongue thickness (the maximum vertical distance from the submandibular skin to the back of the tongue) and the ratio of skin-tongue thickness to thyromental distance are important indicators for predicting difficult intubation (111). A skin-tongue thickness >6.1 cm and a ratio of skin-tongue thickness to thyromental distance >0.87 are associated with difficult intubation (111) (evidence level: low).

In recent years, the placement of small and high-frequency curved probes in the sublingual fovea has allowed clear imaging of oropharyngeal and glottic structures, and the examination is well tolerated by awake patients without the use of sedatives (112). Ultrasonographic visibility of the hyoid bone can also be used to predict difficult airways. For this purpose, a specially designed ultrasound probe is placed on the back of the tongue for an ultrasound examination. The visibility of the hyoid bone on the mid-sagittal plane is closely related to difficult tracheal intubation which is very likely if the hyoid bone is not seen on the ultrasound plane (113) (evidence level: low).

Ultrasound also has value in assessing the airways during emergency conditions, e.g., for correct identification of the cricothyroid membrane (114,115) (evidence level: low).

The diagnostic value of ultrasonography is similar to that of CT and X-ray but significantly better than single physical examination such as the modified Mallampati test (91). Furthermore, ultrasound is superior to CT and X-ray because it enables real-time observation of the upper respiratory tract and is cheap, easy to perform, and avoids ionizing radiation. Despite the good sensitivity and specificity of some ultrasound parameters predicting a difficult airway (e.g., the distance from the skin to the epiglottis), their predictive value is strictly related to the prevalence of the condition of interest. For this reason, routine airways assessment tests should be performed in select patients for ultrasound examination. In addition, although ultrasonography has become daily practice for anaesthesiologists and critical care physicians such as in vascular access, cardiac examination and nerve blockade, it is still under-utilized for airway management. As a result, anesthesiologists and critical care physicians are encouraged to train in using ultrasound in this specific area, as it may be very useful in case of doubt or to exclude a potentially difficult airway when routine tests are positive.

Others

Recommendation: consider transnasal endoscopy to evaluate patients with periglottic lesions or abnormal airway structures before airway management

Transnasal flexible endoscopic laryngoscopy (TFEL) can be used to visualize the upper airway and identify abnormalities such as swelling/anatomical distortion and periglottic lesions. In some small studies, TFEL has allowed direct visualization of the anatomy of the airway, which assists in decision-making and improves the precision of difficult airway prediction (116,117). A prospective cohort study demonstrated that TFEL performed during tongue protrusion improved the precision of difficult intubation prediction (117) (evidence level: low).

Recommendation: virtual laryngoscopy and 3D printing is not recommended for airway assessment

Virtual laryngoscopy is a non-invasive diagnostic technique that relies on software to render data from various imaging techniques (e.g., CT and MRI) to reconstruct 3D internal anatomy. This can present internal and external views of the airway and subglottic space in patients with infection, inflammation, and/or tumors, thus improving the precision of airway assessment (118,119) (evidence level: very low).

3D printing, also known as rapid prototyping, is a form of additive manufacturing technology, which produces a 3D solid model that is consistent with the corresponding digital model by adding materials and printing layer by layer. Performing imaging examinations on the airway and using 3D printing technology to reconstruct the model can help the medical staff to learn the internal structures of the airway, identify airway pathology, and learn the relationship between the lesion and its surrounding tissues. This can increase the precision of airway assessment and guide anesthesia induction or intubation (120) (evidence level: very low). However, these 2 reconstruction techniques have only been investigated in small-sample studies, with limited evidence and high cost. Therefore, they cannot be used for routine screening.

New technologies currently under development

The aforementioned airway assessment methods have varying limitations. Traditional physical examination has low precision in predicting difficult airways. Auxiliary examinations have increased precision but are limited by equipment requirements, high expenditure, and radiation risk. Virtual laryngoscopy and 3D printing are even more limited by equipment and cost, and their accuracies need to be further delineated.

Difficult airway prediction from facial images and voice information has high precision and is worthy of further exploration. Cuendet *et al.* (121) used deep learning algorithms to train and analyze facial features (e.g., frontal position, lateral position, mouth opening, and tongue protrusion) and tracheal intubation difficulty. They established a difficult intubation early warning model based on face recognition technology [area under the curve (AUC): 0.81], suggesting that automatic face scanning can better help judge difficult airways. Hayasaka *et al.* (122) used 16 facial images of different body positions to create an evaluation model for the classification of difficult endotracheal intubation by deep learning (convolutional neural network). They found the best artificial intelligence (AI) model for classifying intubation difficulty was generated with the patients' profile in the supine-position with the mouth closed (AUC: 0.864).

Voice signal is a more recent novel and comprehensive indicator that can reflect both anatomical structure and function of the airway. Many acoustic parameters are closely related to the length, inner diameter, shape, and other internal structures of the upper airway. Research has shown that a difficult airway assessment model constructed by phonetic features (5 vowels and 5 formant frequencies) has value in predicting difficult laryngoscopy and difficult mask ventilation with an AUC of 0.761 and 0.74, respectively and the combination with Modified Mallampati test (MMT) can achieve an even better performance (123,124). In Chinese populations, acoustic features including formant frequencies (f1–f4) and bandwidths (bw1–bw4) were predictive of difficult laryngoscopy and difficult mask ventilation with an AUC of 0.709 and 0.779, respectively (125,126).

Facial images and voices can be collected in a simple and non-invasive way and analyzed automatically and objectively, providing an opportunity for digitalized, intelligent, and remote assessment of airways in the future. More large-sample, multi-center studies are expected to clarify the value of image analysis and voice technology in difficult airway assessment.

Conclusions

Airway assessment and examination are essential before airway management. Assessment should rely on 3 key aspects: medical history, physical examination, and additional special assessment tools. Medical history mainly refers to face-to-face interviews and questionnaires, during which information is determined from a patient's prior medical care or medical records. These data include patient's personal/demographic data (age, gender, weight, height, and BMI), history of difficult airway, anatomical distortion, snoring, OSAS, and diabetes, as well as the results of diagnostic examination/tests where appropriate (e.g., X-ray and CT). Physical examination mainly encompasses the assessment of facial features and the measurement of anatomical landmarks. Assessment of facial and mandibular areas includes the inter-incisor gap, extent of mandibular protrusion, cervical spine mobility, presence of prominent upper incisors, beard, and the upper lip bite test results. Anatomical markers include the modified Mallampati test, thyromental distance, sternomental distance, inter-incisor gap, neck circumference, neck circumference/thyromental distance, ratio of height to thyromental distance, hyoid-mental distance, and ratio of height to hyoid-mental distance. Special assessment methods include bedside endoscopy and ultrasound-based measurement and imaging.

Virtual laryngoscopy/bronchoscopy and 3D printing are novel technologies that are not currently suitable for most populations. Predicting difficult airways based on facial image and voice analysis is a new research area that deserves further exploration.

Consequently, medical history, and physical examination/tests remain the mainstay of airway assessment. Preoperative interview is important, and clinicians should use the most comprehensive measures to determine the risk of a difficult airway. More sophisticated assessments can be arranged for more high-risk patients.

Questions to be further discussed and considered

There is considerable heterogeneity in the sensitivity and specificity of bedside physical examinations studied to date. It seems excessive for both patients and clinicians to complete all physical examinations. Is it necessary to perform all examinations on all patients? If not, which physical examinations are most important?

Andrea Carsetti: I think the most useful tests may be the following, as easy to perform and informative: Mallampati, upper lip bite test, thyromental distance and interincisor distance.

Daqing Ma: Width of open mouth and neck movement.

Denise Battaglini: The physician who takes the "first look" to the patient's airways should perform a comprehensive visit, using at least two scores in order to identify potential difficulties. If the physician who is responsible for endotracheal intubation is different from the one who initially visited the patient, airways should be re-assessed in order to plan an appropriate and personalized strategy before the procedure.

Edwin Seet: In my opinion it would be excessive to perform all the examination on all patients. In some instances, because of the urgency of the procedure, limited time is available to perform the assessments. An extensive examination may also be onerous for both the anesthesiologist and patient. A composite evaluation of a few airway assessment measures is more important than any single one physical examination in isolation. STOP-Bang screening is performed on all elective cases in my institution so this will be available. In addition, I find the MMT, inter-incisor gap (IIG), neck mobility and thyromental distance (TMD) to be high yield, quick and simple tests to do by the bedside for all cases. The upper lip bite test (ULBT) has been shown to have good predictive value from the recent *JAMA* paper (7), however it has not been used widely in my country for varying reasons (e.g., edentulous elderly patients, awkward test to do, etc.).

Giustino Varrassi: In my personal opinion, all the physical tests should be performed, safety of patients is extremely important, and it would be useless to reduce the examination time, when safety is in discussion.

Ida Di Giacinto: Multiparametric airway assessment is fundamental to detect a difficult airway. Although several simple clinical findings are useful for predicting a higher likelihood of difficult endotracheal intubation, no clinical finding reliably excludes a difficult intubation (8). In current scoring systems, factors that may complicate airway management are missing. They are non-patient related factors such as human factors, experience, team communication and equipment (127). It is very important document a difficult airway management to assess the future anesthesia.

Martina Rekatsina: Mallampati, TMD, STOP-BANG.

Marvin G. Chang: Multiple examinations should be performed to adequately assess for a difficult airway (particularly those examinations with a moderate level of evidence) such that the anesthesia provider can develop an appropriate airway management plan that also takes into account the ability for one to adequately rescue an airway if it is particularly challenging. For example, a patient with very limited mouth opening, large tongue, and beard may not be particularly amenable to mask ventilation and supraglottic airway (LMA) placement as a rescue maneuver such that the team may decide to perform an awake fiberoptic intubation. While it may be excessive and time consuming for anesthesia providers to complete all physical examinations related to assessing for difficult airway, an anesthesia provider should at least subjectively assess for features that may be relevant and quickly assessed within seconds related to one's ability to predict, manage and rescue a challenging airway such as a patient's body habitus, neck circumference, presence of beard, Mallampati score, neck mobility, mouth opening, tongue size, presence of retrognathia, thyromental distance, absence or presence of teeth, and upper lip bite.

Rita Cataldo: I agree, is excessive to complete as a routine all physical examination; screening test should be chosen according to the patient and to the expected difficulties (e.g., obesity, laryngeal tumor, spondylitis, genetic diseases, etc.) as a routine I suggest: El Ganzouri score, ULBT, IIG, STOP Bang.

Toru Yamamoto: I would consider blood tests, chest X-rays, and electrocardiograms (EKGs) to be minimally necessary.

Vivek Aggarwal: Physical tests are key to successful airway management. In cooperative patients, all possible tests should be performed. Especially, the degree of mouth opening (measured by an inter-incisal edge) along with the extent of head, neck, and jaw movement should be evaluated.

Vladimir Cerny: In my opinion, in term of physical exam of patients airway (I) everyone should have his/her own structured approach to be used in daily clinical practice; (II) everyone should know the limits of those tests.

Alessandro De Cassai: There is high heterogeneity among bedside physical examinations and none of the test taken as single test is superior to others. For this reason, I would recommend to physician to use as many tests as feasible in the clinical setting and encourage the use of comprehensive scores.

Daniel P. Davis: I agree that there is variability in the evidence to support any one of the physical examination strategies. I believe that an airway practitioner should select one of the strategies and become proficient with its application. I also have a bias that the airway assessment for emergent intubation must be different than for elective procedures, if only because the patient is often unable to participate, the examination is limited by circumstances, and additional variables (e.g., the presence of blood in the airway, suspected traumatic brain injury, or immobilization/transport constraints) become more impactful in predicting difficult airways. This was the rationale for developing HEAVEN criteria for difficult airway prediction in emergent circumstances.

Michael G. Irwin: No. Patients should be screened with bedside examination for anatomical features typical of difficult intubation, mouth opening (Mallampati) and range of neck movement. If there is any doubt over intubation difficulty then can move on to other tests. Most likely is bedside ultrasound as X-ray, CT and MRI are expensive, time consuming and will delay surgery. In low resource settings, the emphasis should be bedside and to have a low threshold to consider intubation difficulty and manage accordingly—it is better to assume difficult intubation and proceed with that in mind than have unexpected difficulty following induction of anaesthesia.

An increasing number of studies have used imaging techniques to predict difficult airways. Which imaging modality do you think may be most helpful for difficult airway assessment?

Andrea Carsetti: A cervical X-ray aiming to assess neck movement limitation due to anatomical abnormalities may be probably avoided by careful physical dynamic assessment (neck movement assessment). CT scan may be more useful to investigate soft tissue. However, it uses a relevant dose of radiation and cannot be considered routinely. Ultrasound may have an important role to assess soft tissue and airway in this context in a non-invasive and non-radiant manner. Their role may be more interesting because it is easy to perform at the bedside on the same day of surgery, and the technical skills may be easily acquired by the anesthesiologist. I think ultrasound assessment of airways needs to be further developed and implemented.

Daqing Ma: Ultrasound.

Denise Battaglini: I believe that ultrasound is the most easily available, low cost and feasible at the bedside. However, an appropriate training is required since it is operator dependent and with low sensitivity and specificity. Alternatively, X-ray or fiberoptic awake evaluation would be useful in very difficult situations.

Edwin Seet: The CT scan and the 3D reconstruction has been helpful for Ear, Nose, and Throat (ENT) cases with tumors, infections and abnormal anatomy. The ultrasound airway assessment has a role in difficult airway management.

Giustino Varrassi: Ultrasound examinations are the most important, and useful.

Ida Di Giacinto: Special and different populations require different imaging techniques. A multidisciplinary team (such as ENT and anesthesiologist) should discuss the abnormal anatomical changes of the upper airway.

Martina Rekatsina: The bedside use of ultrasound and trachea endoscopy.

Marvin G. Chang: Ultrasound may be most ideal for assessing for difficult airway given that it can be done on the day of the procedure, it is noninvasive, does not require radiation, and is becoming more readily accessible given more affordable portable ultrasound devices that can fit in the back pocket of anesthesia providers.

Rita Cataldo: It depends of the expected difficulties, of the available facilities and of time. Ultrasounds are the future, they are not so expensive, bedside, easy to perform and to learn; sometimes CT scan is diriment as in case of glottic/sub glottic or tracheal stenosis or tumours (3D reconstructions are sometimes very illuminating!).

Toru Yamamoto: Currently, I believe CT imaging is the most useful.

Vivek Aggarwal: Routine radiographs should be performed. CT scans can provide valuable information. Routine MRI is not indicated.

Vladimir Cerny: If I had just one modality to choose, I would choose ultrasound.

Daniel P. Davis: I believe the imaging strategy should be guided by clinical circumstances and that it is impossible to make a single recommendation in this regard. For example, head/neck trauma warrants plain radiographs or CT scanning, if time allows, prior to intubation. However, the presence of a peri-glottic mass, such as tumor or abscess, may be better characterized by MRI. The availability of bedside ultrasound make this an ideal option for other patients, particularly if time is limited.

Michael G. Irwin: Ultrasound—cheaper, quicker and good.

AI has been widely studied in anesthesiology, and it has also made some progress in the field of difficult airway assessment. Do you think AI (using deep learning to analyze facial images, ultrasound images, voice signals, etc.) can help achieve the smart and precise assessment of difficult airways?

Andrea Carsetti: This is an exciting field that needs future development. I think AI has good potential to help clinicians to predict difficult airways.

Daqing Ma: Not sure.

Denise Battaglini: Yes, I believe it will be. However, it is high cost and not widely available. Thus, I believe that it should be implemented although we are still at the beginning.

Edwin Seet: AI has the potential to be more precise than human assessment. For reasons that it is more objective and more thorough, without the need for practical real-life experience and inter-individual variation.

Giustino Varrassi: Definitely yes. The future will provide incredible surprises, with the technological evolution.

Ida Di Giacinto: AI may be the future of airway assessment but there are difficulties related to the local organization and to the physiologically difficult airway (nonanatomic patient factors that can influence the outcome of airway management).

Martina Rekatsina: Possibly yes, but still too much work to be done and also might be unsafe at the beginning to rely on this.

Marvin G. Chang: AI may play a role in assessing difficult airway in the future however it will likely require a significant more amount of data that we currently have available to be adequately train a machine to predict the difficulty of an airway more reliably than a trained anesthesia provider.

Rita Cataldo: I think big data will be the future in medicine and anesthesia too.

Toru Yamamoto: We believe that advanced AI devices will be useful in the future.

Vivek Aggarwal: AI is still in its early stages. Using new equipment and software may be expensive and not feasible in all clinical setups. However, incorporating AI in taking clinical decisions has a promising future.

Vladimir Cerny: I am quite skeptical in term that AI would replace physician's judgment. I can see its role to identify patients with possible problems with airway based on patients' photo and to preselect those patients that should be seen physically by anesthesiologist in his/her preanesthesia clinic.

Alessandro De Cassai: Physicians gained more and more interest for AI algorithm, while interesting there is still a great gap between the generated algorithm and clinical feasibility. To date proposed generated algorithms by AI are often obscure in their nodes and I believe that use of these instruments is still far from routine clinical use. However, they are a promising tool for physician and further studies are deemed necessary.

Daniel P. Davis: I am not as optimistic that AI will make significant contributions to difficult airway prediction. AI may help with the development of broad screening tools, given that difficulties with airway management are fairly uncommon and require the use of multiple variables from large databases. However, these rules should be oriented towards high sensitivity and negative predictive value as screening tools before application of fiberoptic/video evaluation for a more precise and clinically useful assessment.

Michael G. Irwin: Yes, it has potential but I don't think there is enough supporting data yet.

Daqing Ma: Don't know yet.

Denise Battaglini: Although attractive, I believe that the evidence is too low to date. Additionally, these are really expensive methods that cannot be easily available globally.

Edwin Seet: This is an evolving science and more research is required. Comparative studies and predictive models have to be done to determine the utility of new technologies, in combination with traditional methods or separate from the same.

Giustino Varrassi: Exploration of the new technologies, and their integration into the old methodologies is a natural process, always valid to increase the safety of the patients. The exercise of the anesthesiologist trying to coordinate the old and the new will make the difference.

Ida Di Giacinto: The multidisciplinary team is the cornerstone of patient safety. In different situations, such as trauma, otolaryngology, head and neck surgery, new technologies integrated with traditional methods may be optimize airway assessment.

Martina Rekatsina: Can not comment.

Marvin G. Chang: The most helpful information can often times be obtained by traditional methods such as a thorough history and physical examination (and imaging studies if available), and then using that information to develop a thoughtful airway management plan. New technologies such as virtual laryngoscopy, 3D printing, and analysis based on patient images and speech may be helpful for education and planning purposes, however, it is unclear whether the addition of these technologies will ultimately change the airway management plan that was developed by more traditional methods by a trained anesthesia provider.

How do you think traditional methods (physical examination, imaging studies, etc.) can be integrated with new technologies being explored (e.g., virtual laryngoscopy, 3D printing, and analysis based on patient images and speech) to optimize difficult airway prediction?

Andrea Carsetti: I think that new technologies may help to recognize difficult airways when traditional tests are in doubt or discordant. For example, a model able to integrate different parameters, including some elements that a clinician cannot objectively assess (i.e., the voice), may be diriment.

Rita Cataldo: Just in very selected patients, otherwise they can be time and cost consuming.

Toru Yamamoto: First, evaluate the patient with conventional methods, and when a difficult airway is considered, use newer technologies.

Vivek Aggarwal: Virtual laryngoscopy and 3D printing are great learning tools and can be effectively used in uncooperative patients. However, TFEL would still be a gold standard.

Vladimir Cerny: In my opinion—any new technology or tool should be considered only as a helping tool for clinicians and their clinical judgement. I do not think that any technology would have potential to predict difficult airway with 100% accuracy.

Daniel P. Davis: Physical examination and clinical evaluation should be considered screening tools to identify patients requiring more advanced assessment with fiberoptic/video imaging or 3D printing. With this approach, the physical examination/clinical evaluation should be oriented towards very high sensitivity/negative predictive value. As the urgency of advanced airway management increases, the importance of physical examination/clinical evaluation increases due to the time constraints and impracticality of some of the advanced assessment strategies.

Michael G. Irwin: I think that imaging studies are not necessary specifically for airway assessment—they can be useful if available, e.g., when they have already been performed for surgical planning or other diagnostic reasons but I have never in my whole career ordered them for airway assessment. Analysis based on facial images and speech have great potential because they should be cheap, quick and efficacious. These can be integrated with physical examination.

With the rapid emergence of new airway management equipment, do you think it is still important to optimize pre-anesthesia airway assessment? How will difficult airway assessment develop in the future?

Andrea Carsetti: New tools for airway management allow a very high success rate of tracheal intubation. However, a proper airway assessment is still fundamental to plan the proper strategy for airway management. Different devices have different characteristics and anesthesiologists may face conditions for which general anesthesia is not safe but awake fiberoptic intubation is needed. These situations may be only recognized after a careful examination.

Daqing Ma: Big data analysis.

Denise Battaglini: I believe that pre-induction airway assessment is fundamental for patient-safety and should be always emphasized, also creating dedicated paths and implement training.

Edwin Seet: I believe pre-anesthesia airway assessment is still important. Video laryngoscopy, video stylets, and supraglottic airway devices [including the recent video (supraglottic airways) SGAs] have revolutionized airway management in the last 2 decades. However, the fundamental principles of mask ventilation, laryngoscopy and tracheal intubation, front of neck surgical access still apply and remain relevant.

Giustino Varrassi: Pre-anesthesia assessment is always the basis. Experienced anesthesiologists were not born “experts”. They became “experts” like in any other activities in life: study and new experiences. The future is definitely connected to the technological development, and to the increased skills of the anesthesiologists in the use of the new tools.

Ida Di Giacinto: Pre-anesthesia airway assessment will be still important in the future because it allows to define the most suitable airway management strategies, even with new equipment and technologies.

Martina Rekatsina: Pre-anesthesia airway assessment will always be important. For the future, I could think of a mobile app that would put many different tests into an algorithm and give a final score.

Marvin G. Chang: It is still important to optimize pre-anesthesia airway assessment as difficult airways still leads to significant morbidity and mortality despite the rapid emergency of new airway management equipment. Also, despite the rapid emergence of new airway management equipment, this equipment may not be immediately available at the time. It is important to note that not all airways are managed and assessed by a trained anesthesia provider prior to their procedures as they may be performed without anesthesia such as under conscious sedation. New technologies to appropriately assess for a difficult airway may be invaluable for helping to triage patients for procedures with an anesthesia provider and aid in assisting in having additional airway management equipment immediately available such as for potential in-patient (out of the OR) intubations.

Rita Cataldo: Absolutely yes! The airway assessment guides the use of new technologies and equipment but is not the only element of the airway management: the STRATEGY in the use of devices depends on the prediction. Ultrasounds, big data just few scores will develop in the future.

Toru Yamamoto: I think optimizing pre-anesthesia airway assessment is important for safety. New evaluation algorithms including new technologies need to be established.

Vivek Aggarwal: It is always a good idea to perform an airway assessment using clinical/physical and radiological evaluations.

Vladimir Cerny: Definitely YES, it should be always part of practice of anyone, who is dealing with airway management!!!

Alessandro De Cassai: It will be always important to optimize pre-anesthesia airway assessment. However, airway assessment in the future will move its focus from predicting difficult airways to focus on the choice of the more suitable equipment to obtain airway control.

Daniel P. Davis: New airway management technology often integrate assessment tools, making initial screening with physical examination/clinical evaluation less important. For example, the use of a video laryngoscope (VL) allows an advanced airway assessment simultaneous to the intubation procedure, obviating the need for a detailed clinical evaluation and physical examination.

Michael G. Irwin: Video laryngoscopy has made tracheal intubation much easier and safer. There are not many cases that can't be intubated using VL and a bougie if the patient has adequate mouth opening. There will, however, continue to be cases of failure and airway assessment continues to be a vital part of preoperative assessment.

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Footnote

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