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Guideline recommendations on the assessment and management of awake airway intubation: a systematic review

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Abstract

Objectives To systematically appraise the quality of clinical practice guidelines (CPGs) regarding awake tracheal intubation (ATI) and to compare the consistency of common recommendations.

Design Systematic review, critical appraisal and narrative synthesis of CPG recommendations for ATI.

Methods A systematic search of the PubMed, EMBASE, Cochrane, Web of Science, and Scopus databases was conducted up to July 1, 2024, to identify up-to-date CPGs. The AGREE II (Appraisal of Guidelines for Research and Evaluation) checklist was used to critically appraise the CPGs. Interrater agreement was determined via intraclass correlation coefficients (ICCs) with a two-way random effects model for each domain and overall rating score. All the suggestions extracted from the included guidelines were sorted and analyzed and summarized via the GRADE (Grading of Recommendations Assessment, Development and Evaluation) system.

Results Our study resulted in 939 records and ultimately 7 CPGs were appraised. The content of these CPGs covered six themes of ATI: indications, airway local anesthesia, the intubation procedure, checking the tube position, management after ATI failure, and the extubation process. When the AGREE II tool was used to appraise CPGs, only 3 CPGs were rated as "high" quality. With the exception of domain 1, we observed good agreement in all five other domains (ICCs over 0.7). These CPGs provided relatively consistent recommendations and evidence on intubation procedures and checking tube position. In terms of indications and airway local anesthesia, there was controversy. Twenty-nine recommendations regarding ATI were summarized through the GRADE system, among which 16 were considered relatively reliable.

Conclusion Through the AGREE II tool and the GRADE system, the strengths and weaknesses of each CPG were comprehensively analyzed on the basis of its scientific validity and practicability. Moreover, the limitations of the current CPGs in terms of indications, airway local anesthesia and complex clinical situations are presented, and clinicians are encouraged to apply the guidelines more scientifically and to update and improve the guidelines.

Systematic review registration CRD4202458548 (PROSPERO).

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Keywords Awake tracheal intubation (ATI), Clinical practice guidelines (CPGs), Systematic review, AGREE II (Appraisal of guidelines for research and evaluation), Intraclass correlation coefficient (ICC), GRADE (grading of recommendations assessment development and evaluation)

Introduction

The assessment and management of difficult airways remains one of the greatest challenges for anesthesiologists. The American Society of Anesthesiology estimated that nearly 34% of anesthesia-related deaths or brain injuries are related to hypoxia, which is often caused by failure, difficulty, or delay in intubation, and the safest method of intubation is awake tracheal intubation(ATI) [1]. ATI is an important medical means for awake, spontaneously-breathing patients during the intubation process, and can reduce the risk of reflux aspiration and ensure safe anesthesia management and patient life support [2]. Although ATI has a high success rate and is recommended as the gold standard for managing patients with anticipated difficult airways [3–6], ATI is currently used in < 1% of general anesthesia [7] for several possible reasons. Awake airway intubation is a complex medical procedure that requires a high degree of skill and expertise to ensure patient safety, and involves placing a tracheal tube most commonly with flexible bronchoscopy (FB) or video laryngoscopy (VL) [8, 9]. Incorrect intubation can lead to severe complications such as airway damage, misplacement of esophageal catheters, and hypoxemia.

The continuous development in the medical field and technological advancements have led to the emergence of new technologies and drugs to improve the effectiveness and safety of ATI. For example, the Shikani Optical Stylet (SOS) may be a potential alternative to awake nasal intubation for fiberoptic bronchoscope (FOB) [10]. Therefore, the practices and guidelines for awake airway intubation may need to be constantly updated and improved to ensure that physicians can provide optimal care to their patients. High-quality guidelines are essential for ATI, as they help enhance patient safety, reduce the risk of complications, and ensure that medical professionals follow best practices when performing this procedure. These guidelines also help ensure that healthcare providers across the globe adopt appropriate standards, thereby improving the quality and safety of healthcare.

Currently, there are variations in the levels of ATI training and practice across different regions and healthcare institutions [11]. Optimizing the quality of guidelines and improving their scientificity, applicability and operability can provide standards for the training of medical workers and enhance operational techniques.

A systematic review aimed to assess the quality, feasibility, applicability, and effectiveness of clinical practice guidelines (CPGs) [12]. The evaluation of CPGs can help develop more consensual best practice guidelines, reduce variation in medical practices, improve training and education programs, and ultimately improve patient safety and treatment outcomes.

Therefore, we conducted this study to assess the quality and differences of the CPGs for awake airway intubation issued by different institutions and organizations. This will help determine the optimal timing of awake airway intubation, the selection of techniques and equipment, and best practices for the intubation process. This will help improve clinicians' effectiveness in responding to airway problems and provide safer medical care.

Materials

Data sources and search strategy

We conducted systematic literature searches according to the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidance [13]. The International Prospective Register of Systematic Reviews (PROSERO) registration number is CRD4202458548. The PubMed, EMBASE, Cochrane, Web of Science, and Scopus databases were searched from inception to July 1, 2024. We manually searched the Google Scholar database to retrieve related articles. We used the following search terms: ('awake tracheal intubation' or 'awake airway intubation' or 'awake intubation' or 'endotracheal intubation in awake patients') and ('guideline' or 'clinical practice guideline' or 'consensus' or 'recommendation' or 'standard'). The detailed search strategies are provided in Supplementary Table 1. During the process of manuscript revision and peer review, we found that the 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) released the latest guidelines for difficult airway management in November 2024, and we deliberately included these guidelines in the study [14–16].

Selection criteria

All CPGs and the consensus published in English on the management of awake airway intubation were included in our analysis. The exclusion criteria were as follows: (1) systematic reviews, original studies, retrospective reviews, textbook chapters, study protocols, comments on existing guidelines or consensus, and conference abstracts or posters; (2) draft documents that are under development or not finalized; (3) previous documents replaced by updated versions from the same

organization; and (4) reports unrelated to the diagnosis or management of awake airway intubation.

An investigator (F.C.) performed the electronic database and manual reference list searches. Two investigators (F.C. and Z.T.) independently scrutinized the titles and abstracts for eligibility for inclusion in the current study. Discrepancies of opinion on the eligibility of a particular study were resolved through discussion with a third reviewer (Q.H.). Two investigators (F.C. and Z.T.) independently collected and documented the data of interest for each included study. Disagreements in the data collected were reconciled by Q.H., similar to the process defined above for article selection.

Data extraction

The items retrieved from each CPG included the following: characteristics of the CPGs (such as title, year of publication, primary development group, intended users, target patients and the main research scope of the guideline), indications for awake difficult airway intubation, airway local anesthesia, management strategies, and recommendations related to the intubation and extubation process. Data were extracted by one investigator (F.C.) and examined by another investigator (Z.T.).

Assessment of guideline quality and analysis

All included guidelines were independently evaluated by three investigators by AGREE II (Appraisal of Guidelines for Research and Evaluation) reporting checklist [17–20]. The AGREE II is an internationally developed and validated tool, which is validated and recommended by the Cochrane group [17]. It is widely used to assess the quality of CPGs and consensus, and has good construct validity and reliability. The instrument focuses on guideline development and reporting and includes 23 items addressing 6 domains (1.Scope and purpose; 2.Stakeholder involvement; 3.Rigor of development; 4.Clarity of presentation; 5.Applicability and 6.Editorial independence). Each item is scored on a 7-point Likert scale from 1 (Strongly disagree) to 7 (Strongly agree). In addition, there are two final items that require appraisers to give an overall judgment on basis of the ratings of the 23 items.

For each of the 6 AGREE II domains a quality score is calculated independently. Each domain score is calculated by summing all the scores of the items included in each domain and by representing the total score as a percentage of the maximum score for that domain. The specific evaluation items and details for guideline appraisal via the AGREE II are shown in Supplementary Table 2.

When the scoring of all included CPGs was completed, F.C. convened and chaired the meeting to discuss each item with a score difference of more than one point. After the session, F.C. had the opportunity to revise their scores or keep their original scores.

Using AGREE PLUS on the AGREE II website individual item scores, domain scores and overall AGREE II scores were calculated for each CPG [21]. AGREE PLUS calculates domain and overall scores as a percentage of the maximum possible score. The data were entered and analyzed via SPSS (IBM SPSS Statistics V.24.0). Means and SDs for each of the 23 items and six domain scores (percentages) were calculated. We used the intraclass correlation coefficient (ICC) with a two-way random effects model for each domain and overall rating score. The ICC was calculated via the irr package, and ICC ≥ 0.7 was considered acceptable [22].

Synthesis of guidelines and identification of consistent recommendations

We manually extracted recommendations for key clinical questions from all included guidelines and summarized them into six themes: (1) indications for awake difficult airway intubation, (2) airway local anesthesia before awake difficult airway intubation, (3) awake difficult airway intubation procedure, (4) checking the tube position after awake difficult airway intubation, (5) management after failure of ATI, and (6) extubation procedure for ATI. We further visualized these guidelines in a five-color grid to illustrate inconsistencies. Currently widely recommended content will serve as a reference. We colored guidance documents that provide consistent recommendations with reference content in green, those that provide inconsistent recommendations in red, and those that provide partially consistent recommendations in yellow. Partially consistent recommendations are defined as those containing recommendations that differ from the reference content. If no recommendation is given or if the recommendation is not applicable, the cells are colored blue and gray, respectively.

All the recommendations extracted from the included guidelines were collated and then grouped according to themes. The GRADE [23, 24] (Grading of Recommendations Assessment, Development and Evaluation) system was used for analysis and summary. The GRADE is an evaluation system for grading the evidence of systematic reviews and clinical guidelines and evaluating the strength of guideline recommendations. It provides a transparent and structured way to summarize clinical evidence and guideline recommendations. Three investigators (F.C., Z.T. and Q.H.) met to discuss each recommendation and finally reached consensus on the grade of evidence and strength of the recommendation.

The grade of evidence (GOE) is determined by many factors, including the number and type of research studies. The GRADE system classifies the GOE for recommendations for each outcome of interest into four categories (Table 1) [25, 26]. For each outcome, downgrading was carried out by evaluating the extent of risk of

Table 1 Grades of evidence [a]

Level	Definitions of evidence
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

[a] This table was adapted from Balshem et al. [26].

Table 2 Strength of recommendation

Level	Strength of recommendation
Strong	Refers to a recommendation according to which the expected effects of the intervention outweigh the adverse effects.
Weak	Refers to a recommendation according to which the expected effects of the intervention are likely to outweigh the undesirable effects, but with significant uncertainty

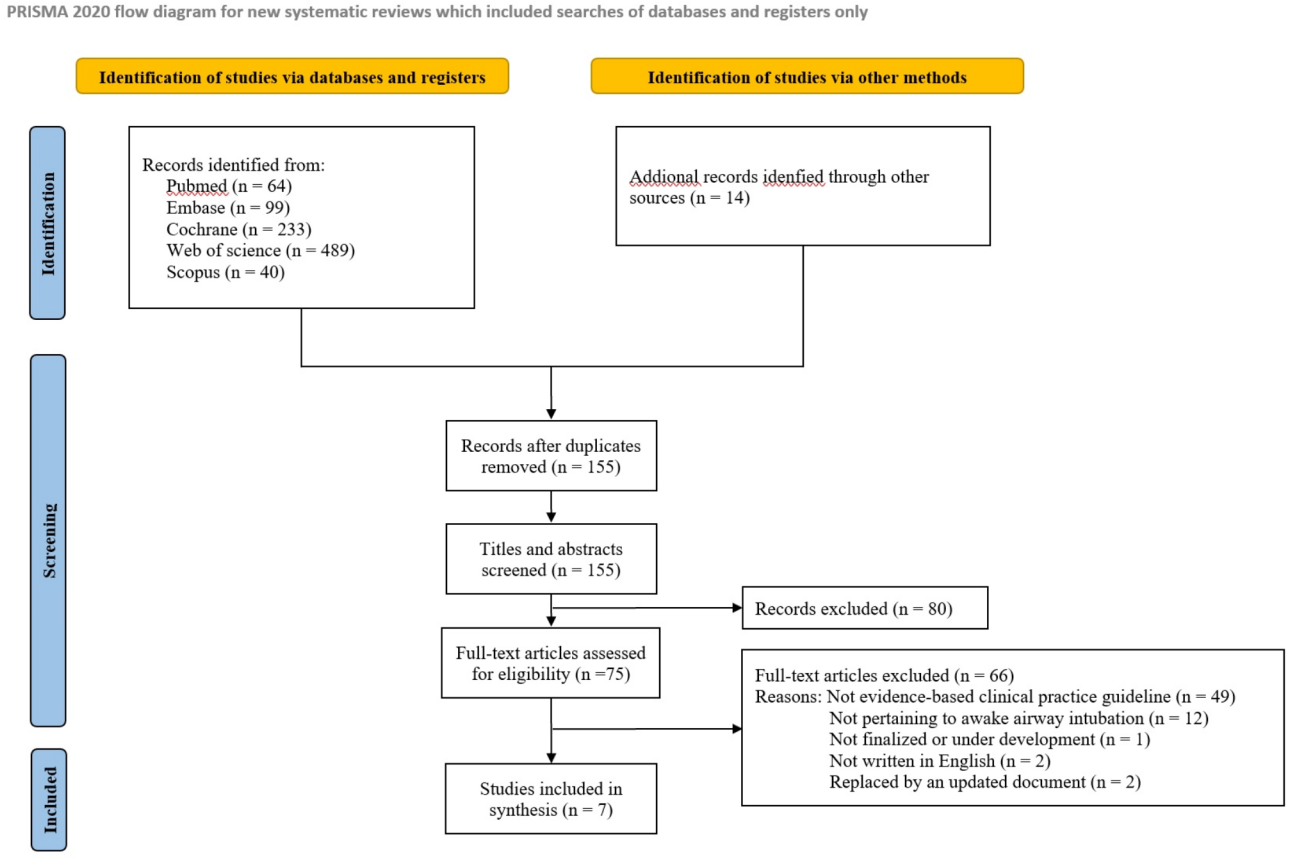

Fig. 1 Flow diagram of guideline selection

bias, inconsistency, indirectness, imprecision, and publication bias.

The strength of the recommendation is based on consensus discussion and reflects the degree of certainty of the expected effects of the recommended intervention and the adverse effects on the relevant population. The GRADE system divides the strength of the recommendation into two categories (Table 2).

Results

Search results

As shown in the flow diagram of guideline selection (Fig. 1), 939 records were initially retrieved. After screening their titles and abstracts, we examined 75 full-text articles to determine if they were relevant for this study. Ultimately, after removing duplicates and irrelevant articles, 7 CPGs were included in our review [2, 15, 16, 27–32]. Each guideline comes from a unique series. A

methodological quality assessment and evidence synthesis analysis of the included CPGs were conducted.

Characteristics of the included guidelines

Among of the seven included CPGs, 6 (85.7%) were published within the last 5 years. The Difficult Airway Society (DAS) institution participated in most of the guideline publications, followed by the American Society of Anesthesiologists (ASA). A large majority of CPGs are usually developed by multidisciplinary teams, usually consisting of anesthesiologists, otolaryngologists, emergency physicians, and respiratory physicians. The content of these guidelines covered several different topics: anticipated difficult airways in routine practice ($n=6$) [2, 15, 16, 27–31], perioperative management ($n=1$) [32], and practice in patients with COVID-19 ($n=2$) [2, 31]. Only four CPGs [2, 15, 16, 27, 30](57.1%) assessed the quality of evidence, three of which used the AGREE tool, and the rest of the guidelines did not. Moreover, only one CPG [15, 16] (26%) rated the strength of the recommendations via the Grade system. An overview of the characteristics of the included CPGs is presented in Table 3.

Appraisal of guidelines

The average scores of the three independent evaluators were used to score the six quality domains (Table 4), which are detailed in (Supplementary Table 2), and a radar plot was drawn to show the score of each domain (Fig. 2). Domain 5 (mean ± SD 51.6 ± 4.6%) was received the lowest scores. Domain 1 (mean ± SD 84.4 ± 8.5%) was received the highest score. In the single domain score, domain 1 of Ahmad 2020 and domain 4 of Gómez-Ríos 2024 had the maximum score (94.4%). At the same time, in Ahmad 2020, domain 5 received the minimum score (45.8%). No guideline achieved a perfect score of 100% in any AGREE II quality domain. As mentioned above, there were variations in the domain scores between the seven assessed guidelines.

On the basis of the AGREE II tool criteria, guidelines with five or more domains scoring > 60% are classified as "high" quality, those four or three domains scoring > 60% are classified as "average" quality, and the rest are classified as "low" quality. Only three CPGs met the criteria for "high" quality. The other CPGs did not achieve "high" quality mainly because the views and preferences of patients and their families were not taken into account; the definition of target users was unclear; or the implementation tools were not provided.

Assessment of the ICC

We calculated the ICCs for each of the six domains (Table 5). Domain 1 had the lowest ICC score (OR 0.65, 95%CI [0.38 to 0.81]) and was considered to be moderately consistent, suggesting that there might be some

Table 3 Characteristics of the included clinical practice guidelines

First author, Year of publication	Primary Development group	Intended users	Target patients	Evidence base	Methods	Guideline contents
Ahmad, 2020[27]	DAS	Multidisciplinary	Adults	Systematic literature	AGREE and Delphi	Support for decision-making, preparation, and practice of awake tracheal intubation
J.A.Law, 2021[28, 29]	CAFG	Multidisciplinary	Patient with an anticipated difficult airway	Expert consensus	Expert review and comment	Planning and implementing safe management of patients with anticipated difficult airways
Foley, 2021[2]	SAM	Medical staff in the COVID-19	Adult patients with COVID-19	Systematic literature, Consensus panel	AGREE	Difficult Airway Management in Adult Coronavirus Disease 2019 Patients
Apfelbaum, 2022[30]	ASA	Anesthesiologists	All patients	Systematic literature	Expert survey	Management of the Difficult Airway
Cook, 2020[31]	DAS, ICS, FICM, RCoA	Staff involved in airway management	Patients with COVID-19	Expert consensus	Expert review and comment	Managing the airway in patients with COVID-19
Japanese Society of Anesthesiologists, 2014 (JSA, 2014)[32]	JSA	Anesthesiologists	All patients	Expert consensus	Expert review and comment	To improve the safety of induction of anesthesia
Gómez-Ríos, 2024[15, 16]	SEDAR, SEMES, SEORL-CCC	Staff involved in airway management	Adults	Systematic literature	AGREE II, GRADE and Delphi	Management of the Difficult Airway in the adult patient.

DAS = Difficult Airway Society; CAFG = Canadian Airway Focus Group; SAM = Society of Airway Management; ASA = American Society of Anesthesiologists; ICS = Association of Anaesthetists the Intensive Care Society; FICM = Faculty of Intensive Care Medicine; RCoA = Royal College of Anaesthetists; JSA = Japanese Society of Anesthesiologists; SEDAR = Spanish Society of Anesthesiology, Reanimation and Pain Therapy; SEMES = Spanish Society of Emergency and Emergency Medicine; SEORL-CCC = Spanish Society of Otolaryngology, Head and Neck Surgery; AGREE = Appraisal of Guidelines Research and Evaluation; AGREE (Appraisal of Guidelines for Research and Evaluation); GRADE = Grading of Recommendations Assessment, Development, and Evaluation

Table 4 Quality appraisal of guidelines: AGREE II domain scores (%) and quality assessment

Guideline	Domain 1 Scope and purpose (%)	Domain 2 Stakeholder involvement (%)	Domain 3 Rigor of development (%)	Domain 4 Clarity of presentation (%)	Domain 5 Applicability (%)	Domain 6 Editorial independence (%)	Overall assessment (%)	Quality
Ahmad, 2020	94.4*	62.5*	67.5*	83.9*	45.8	75*	67.7*	High
J.A. Law, 2021	79.6*	59.7	59.5	85.2*	48.6	61.1*	50	Average
Foley, 2021	88.9*	68.1*	62.7*	51.9	56.9	58.3	50	Average
Apfelbaum, 2022	87*	79.2*	82.5*	75.9*	48.6	75*	67.7*	High
Cook, 2020	72.2*	62.5*	46.8	63*	58.3	69.4*	33.3	Average
JSA, 2014	75.9*	62.5*	56.3	87*	52.8	55.6	67.7*	Average
Gómez-Ríos, 2024	92.6*	90.1*	84.7*	94.4*	50	46.7	67.7*	High
Mean ± SD	84.4 ± 5	69.2 ± 1.3	65.7 ± 3.8	77.3 ± 5.0	51.6 ± 6	63.0 ± 0.6	57.7 ± 3.6	

Cells with * indicate domain attained 'High' rating

divergence between investigators in Domain 1. Good agreement was observed in the other five domains (ICC>0.7), and the ICC values of domains 5, 3 and 6 were all above 0.8. This indicated that the quality scores of the three investigators in the three domains were similar, so there was good agreement.

Synthesis of evidence

We compared the evidence and recommendations from all the guidelines in terms of indications for awake difficult airway intubation, airway local anesthesia, intubation procedures, checking the tube position after ATI, management after failure of ATI, and extubation. A detailed summary of these recommendations is provided in Fig. 3.

In terms of indications, there is a small amount of controversy, such as difficulty in mask ventilation, inability to ventilate and the appropriateness of awake tracheal intubation in patients with difficult intubation. There is no consensus on the use of CPGs for airway local anesthesia. Apfelbaum 2022, Cook 2020, and JSA 2014 did not provide detailed recommendations in this regard. In terms of the intubation process, all CPGs except Foley 2021 provided relatively complete and consistent recommendations. This might be because Foley 2021 is a CPG related to COVID-19 and is more focused on the handling of different aspects for special patients, such as adherence to personal protective equipment (PPE) protocols, while the routine intubation process has not been described in detail. Most CPGs achieved good consistency in terms of checking the tube position after ATI, and Foley 2021 also does not cover this aspect much. Regarding the management after failed ATI and extubation, most CPGs provided descriptions and suggestions, but they were not comprehensive. Meanwhile, Cook 2020 hardly covered these two aspects, and JSA 2014 did not cover extubation at all. Gómez-Ríos 2024 was the most exhaustive of all the CPGs, which might be related to its publication time.

In summary, the current guidelines provided relatively consistent recommendations and evidence on intubation procedures and checking the tube position after ATI.

Recommendations of CPGs

We identified twenty-nine recommendations for ATI from seven CPGs. Only the recommendations that were suggested by more than two CPGs and not suggested by any CPG were presented. Each recommendation in Table 6 includes an accompanying GRADE score, which reflects the strength of the recommendation and the quality of the evidence. For details of the evaluation of each recommendation, please refer to Supplementary Table 4.

Sixteen recommendations (55.2%) were derived from moderate to high quality evidence, with strong recommendations in most CPGs, and relatively reliable

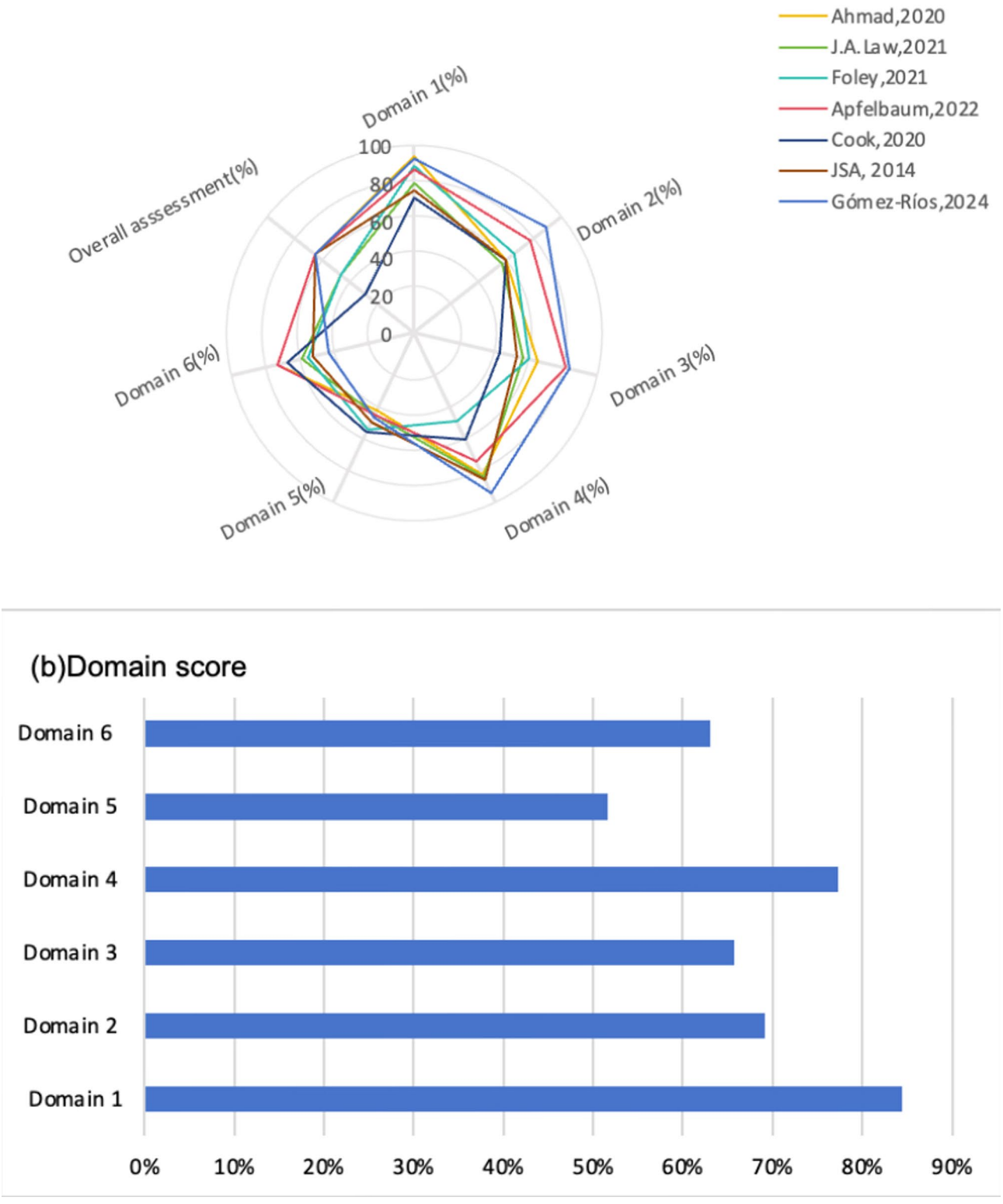

Fig. 2 Domain scores for the assessed guidelines. (**a**) Radar plot showing each domain score of each CPG. (**b**) Box plot showing the mean scores of each domain

Table 5 Interrater agreement for the AGREE II domains and overall scores

Domain	ICC (95%CI)
1:Scope and purpose	0.65 [0.38, 0.81]
2:Stakeholder involvement	0.72 [0.48, 0.85]
3:Rigor of development	0.84 [0.68, 0.92]
4:Clarity of presentation	0.75 [0.54, 0.87]
5:Applicability	0.86 [0.71, 0.93]
6:Editorial independence	0.84 [0.68, 0.92]

ICC = intraclass correlation coefficient; AGREE II = Appraisal of Guidelines for Research and Evaluation

evidence was found through literature retrieval. We can consider that these 16 recommendations were the ones with the most sufficient evidence among the 29 recommendations identified.

Thirteen recommendations were based on low-quality evidence. They focused on several key areas, including the intubation process, management after failed ATI, and extubation. The main reason is that most of them were solely based on expert opinions or consensus rather than evidence.

Discussion

Main findings

A total of seven CPGs related to ATI were included in our review. These CPGs were developed by systematic reviews or expert consensus, and were mostly jointly authored by multidisciplinary teams including anesthesiology, respiratory medicine, otolaryngology, and emergency department. The DAS institution was involved in the publication of several guidelines [27, 31, 33, 34]. The majority of CPGs were related to anticipated difficult tracheal intubation ($n = 6$) and were published after 2020 ($n = 6$). Notably, Foley 2021 and Cook 2020 were primarily aimed at ATI practice in COVID-19 patients.

The scores of the AGREE II tool revealed that domains 1, 2 and 4 were highly rated in the six domains it contains, most guidelines were over 60%. Ahmad 2020, Apfelbaum 2022 and Gómez-Ríos 2024 scored more than 60% in five or more domains, and the overall score ranked in the top three of all guidelines, which were regarded as having a high level of evidence and had a strong degree of recommendation. The 5-color grid plot shows that different CPGs are relatively consistent in two parts of

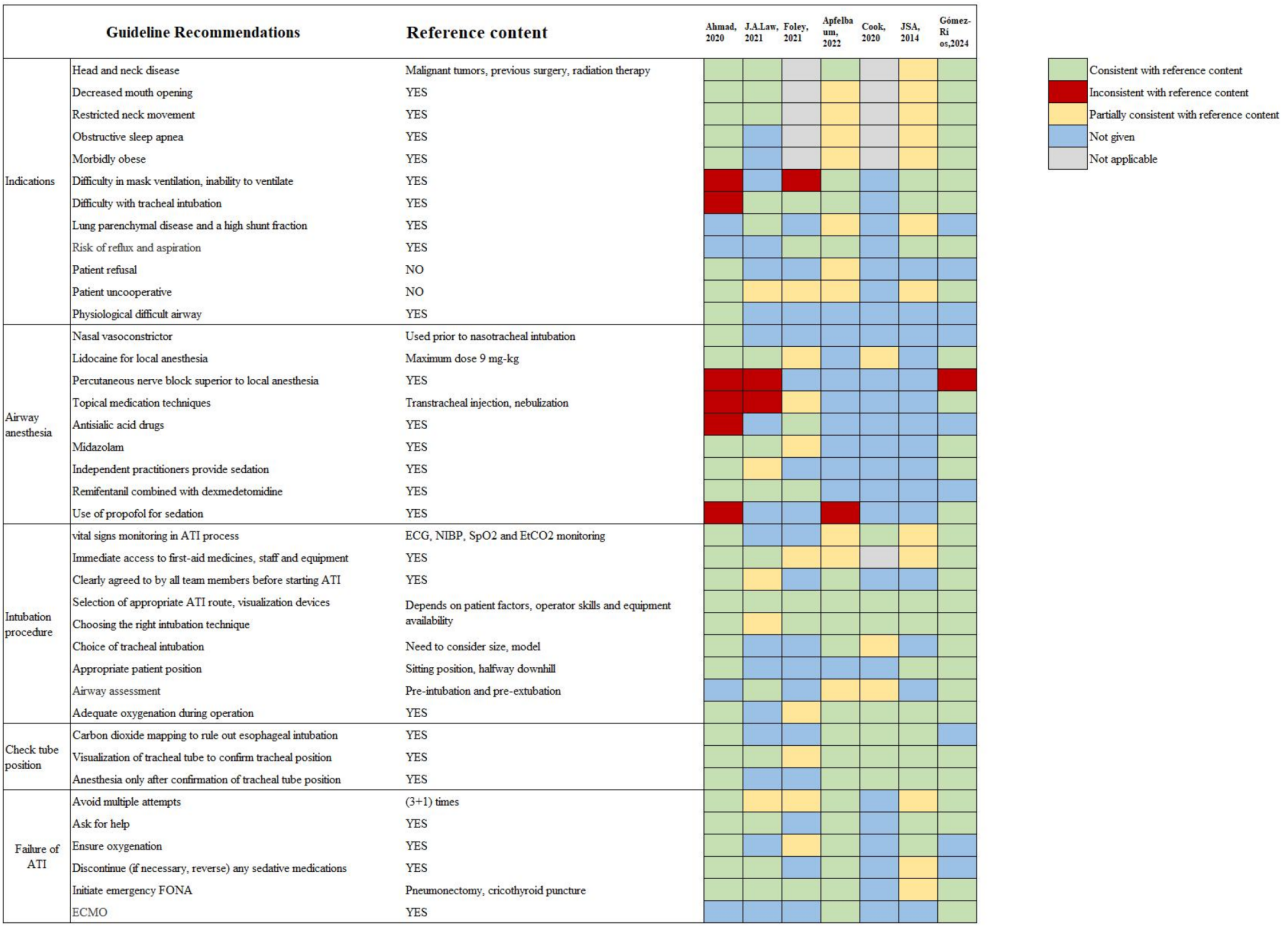

Fig. 3 Consistency of recommendations across guidelines for ATI

Table 6 Summary of recommendations derived from the CPGs

	Recommendations	Quality of evidence	Strength of recommendation
Indications			
1	Patients with head and neck pathology may have difficult airways.	High	Strong
2	Patients with decrease in mouth opening may have difficult airways.	High	Strong
3	Limitation of head or neck extension is a predictor of difficult airway.	High	Strong
4	The diagnosis of SAHS is a predictor of difficult airway.	Moderate	Strong
5	Morbidly obese patients are at high risk of difficult airway.	Moderate	Strong
6	Initiation of management of difficult airway is recommended when tracheal intubation is not expected to be rapidly and efficiently achieved, and the patient is at significant risk of aspiration of gastric contents.	High	Strong
Airway anesthesia			
7	Topically applied lidocaine creates good conditions for ATI. The maximum dose of topical lidocaine should not exceed 9 mg/kg (lean body weight).	Moderate	Strong
8	The use of sedation during awake endotracheal intubation can reduce patient anxiety and discomfort, and midazolam is commonly used as a drug.	Moderate	Strong
9	Sedation by an independent practitioner is strongly recommended.	Low	Strong
10	Remifentanil and dexmedetomidine are often used for sedation in ATI.	Moderate	Strong
Intubation procedure			
11	Vital signs monitoring in ATI process is extraordinary essential, including ECG, NIBP, SpO_2 and $EtCO_2$ monitoring.	High	Strong
12	Healthcare facilities should ensure that first-aid medicines, staff and equipment of ATI are immediately available.	Low	Strong
13	All team members explicitly agreed before starting ATI.	Low	Strong
14	Selection of appropriate ATI route, including visualization devices, intubation technique and tracheal tube, depends on patient factors, operator skills and equipment availability.	High	Strong
15	Appropriate patient position is recommended to improve tracheal intubation conditions.	Low	Strong
16	Airway assessment should be performed both pre-intubation and pre-extubation	Low	Strong
17	A variety of techniques should be used throughout the ATI process to ensure adequate oxygenation of patients, and high-flow nasal oxygen (HFNO) can be used if possible.	Moderate	Strong
Check tube position			
18	Carbon dioxide mapping can rule out esophageal intubation.	High	Strong
19	Using visualization of tracheal tube to confirm tracheal position.	High	Strong
20	Anesthesia should only be induced after confirmation of correct tracheal tube position.	Low	Strong
Failure of ATI			
21	The number of attempts should be limited to three, with one further attempt by a more experienced operator (3 + 1).	Low	Strong
22	Immediate actions should include a call for help when successful tracheal intubation has not been achieved.	Low	Strong
23	When ATI fails, any sedative medications should be discontinued (if necessary, reverse) and oxygenation be ensured.	Low	Strong
24	Given the high possibility of ATI failure, it is suggested to prepare the plan for emergency front of neck airway (eFONA).	Moderate	Strong
25	If the selected approach fails or is not feasible, initiate ECMO when/if appropriate and available.	Low	Strong
Tracheal extubation			
26	Before tracheal extubation, laryngoscopy can provide useful information.	Low	Strong
27	Leak test may facilitate decision making before tracheal extubation.	Low	Strong
28	Awake extubation is recommended for DA.	Moderate	Strong
29	Extubate only with a plan for reintubation prepared.	Low	Strong

CPG = clinical practice guideline; ATI = awake tracheal intubation; SAHS = sleep apnoea-hypopnoea syndrome; ECG:=electrocardiogram; NIBP = non-invasive blood pressure; SpO_2: peripheral oxygen saturation; $EtCO_2$ = end-tidal carbon dioxide; HFNO = front of neck airway; DA = difficult airway; ECMO = extracorporeal membrane oxygenation

ATI (intubation procedure and checking the tube position after ATI). Regarding management after the failure of ATI and extubation, most of the CPGs covered these aspects but the coverage was incomplete. However, there was notable heterogeneity between different guidelines for the indications for ATI, the choice of local anesthesia before intubation.

By using the GRADE system, we identified a total of 31 recommendations, among which 19 were based on evidence of moderate to high quality. These

recommendations focus on three aspects, namely, the indications for ATI, airway local anesthesia, and post-intubation examinations, providing powerful guidance for clinicians in the management of DA.

Previous findings

Airway management difficulties are the single most important cause of major anesthesia-related morbidity and mortality [35]. Difficult airways occur in up to 10% of the general population [36–39], and most of them can be detected in advance during preanesthetic airway examination and anesthesia risk assessment. Previous studies have shown that for anticipated difficult airways, tracheal intubation should be performed under conscious sedation and topical anesthesia. Theoretically, awake tracheal intubation for anticipated difficult airways can preserve the patient's spontaneous breathing and the intrinsic airway tone before endotracheal intubation, ensuring airway safety. In certain special circumstances, it can quickly ensure airway patency and reduce the risk of serious adverse effects associated with general anesthesia, such as aspiration and asphyxia [6].

Although studies have confirmed that ATI has a high success rate and low risk profile, making it the gold standard for managing anticipated difficult airways, it is underutilized in clinical practice. This is obviously related to the limited technical skills of the operator, outdated approaches to handling difficult airways, unfamiliarity with the awake intubation process, and the need for necessary tools for awake intubation. In recent years, various ATI guidelines related to ATI have been published, but due to differences in issuing organizations and target audiences, their contents vary. To date, there has been a lack of quality assessments of ATI-related guidelines.

Clinical significance

Consistency analysis of ATI-related guidelines

Guidelines related to ATI have been published in recent years, reflecting the increasing emphasis on difficult airway management. These patients have suffered from Since the COVID-19 pandemic, and many patients have COVID-19 combined with ARDS (Acute Respiratory Distress Syndrome) [40, 41]. These patients suffer from alveolar and capillary damage, leading to a sharp decline in respiratory function and the need for mechanical ventilation to maintain breathing. In these patients, the disease tends to progress rapidly, and the viral-induced systemic inflammatory response can lead to local edema and inflammatory exudation of airway tissues, causing airway narrowing and increasing the complexity of airway access. As a result, ATI often becomes the only viable option for COVID-19 patients whose airways are anticipated to be difficult [2, 31]. However, ATI should also be avoided unless absolutely necessary due to the extremely high degree of transmission of COVID-19 [42]. In addition, maintaining the prone position and noninvasive ventilation (NIV) are also recommended for awake patients with COVID-19-related pneumonia requiring oxygen supplementation [43, 44].

The results of AGREE II reflected that most of the CPGs included in this study have a clear explanation of their scope and purpose (domain 1), clarity of the presentation of recommendations (domain 4), and high stakeholder engagement (domain 2). The low scores in the rigor of development (domain 3) and applicability (domain 5) may be related to the fact that most CPGs do not adequately consider the potential risks of applying recommendations, costs, and lack of necessary resources. Due to the fact that the funding agencies and competing interests of guideline development group members were not recorded in detail, the guidelines scored relatively low in terms of editorial independence (domain 6).

The high degree of consistency among different guidelines in the 5-color grid diagram for the intubation procedure and post-intubation checks embodies the mature characteristics of ATI's long-established technology itself.

Differences in indications in ATI-related guidelines

In the discussion of the indications for ATI, the main controversy has focused on whether difficult mask ventilation (DMV) and difficult intubation can be regarded as its indications. A meta-analysis [45] based on a large sample revealed that there are 13 main risk factors for DMV and difficult intubation, namely neck radiotherapy, increased neck circumference, obstructive sleep apnea (OSA), presence of a beard, a history of snoring, obesity, male gender, Mallampati score of III-IV, limited mouth opening, temporomandibular disorder (short TMD), an edentulous jaw, limited neck movement, and advanced age. Upon careful comparison, it is not difficult to find that there are both similarities and differences between these risk factors and the other existing indications of ATI. This undoubtedly serves as a wake-up call for clinical practice, meaning that medical staff need to use diverse assessment methods to conduct comprehensive and meticulous assessments of patients. After all, it is simply impossible to definitively determine whether a patient has a difficult airway on the basis solely of a single sign or symptom. In view of this, when evaluating ATI, we must adopt a more prudent and rigorous attitude and allow no slightest negligence.

It is worth noting that Gómez-Ríos, 2024, proposed that physiological difficult airway (PDA) should also be considered an indication for ATI, while other guidelines do not mention it. PDA refers to the increased risk of complications during intubation due to pathophysiological changes, such as short apnoea tolerance, haemodynamic instability, severe metabolic acidosis or full

stomach. Most patients with physiological difficult airway are at a risk of major adverse events during intubation (such as death or brain damage), and this risk is further heightened when multiple intubation attempts are required. Therefore, the first successful of the intubation attempt is crucial for the patient. For this reason, we believed that PDA should be considered an indication for ATI, and sufficient airway assessment should be performed when time permits to reduce the risk of intubation-related complications.

Differences in the choice of airway local anesthesia in ATI-related guidelines

Among the seven CPGs, the greatest divergence among the guidelines lies in the choice of airway local anesthesia. The key to successfully performing awake tracheal intubation lies in effective airway local anesthesia. This not only affects the comfort of the patient, but also directly affects smooth operation. However, the choice of airway local anesthesia prior to ATI varies markedly between guidelines, and some lack clear advice, resulting in a lack of consistent criteria for clinicians in protocol selection.

There are a variety of techniques currently used for airway anesthesia, including the topical use of local anesthetics or airway nerve blocks (ANBs) [46]. The topical use of local anesthetics is commonly employed because of its simplicity in operation and can be achieved in multiple ways, including sprays (such as the "spray-as-you-go" technique), transtracheal injection, and nebulization, which may cause less trauma to the oropharyngeal and laryngeal tissues [47, 48]. Lidocaine is the most widely-used local anesthetic. However, the systemic toxicity risk should be taken into account. CPGs recommended a maximum dose of 9 mg/kg (lean body weight) for topical lidocaine [49].

ANBs include superior laryngeal nerve blocks (SLNBs), glossopharyngeal nerve blocks (GPNBs), and recurrent laryngeal nerve blocks (RLNBs). A recent meta-analysis showed that ANB for ATI improved airway anesthesia quality and patient satisfaction, and reduced cough, the gag reflex and intubation time compared without airway nerve block [6]. In addition, several RCTs(Randomized Controlled Trial) comparing the topical administration of local anesthetics and ANB reported that ANB provided excellent quality of airway anesthesia (better intubation conditions, shorter intubation time and better patient comfort) [50–52]. However, up to now, all the above studies mentioned above have small sample sizes (less than 100). Notably, ANB is considered to be more technically difficult to perform and usually carries the risk of complications, such as bleeding, nerve damage or intravascular injection [53]. Therefore, it is not entirely certain whether ANB can provide better airway anesthesia.

In conclusion, we believe that for patients with DA, the topical lidocaine technique can be the first choice for airway local anesthesia. Moreover, the lowest appropriate dose of lidocaine should be used, and a suitable topicalization method should be selected according to the current conditions. As for ANB, its use can be considered appropriate when experienced anesthesiologists, equipment such as ultrasound devices are available, and resuscitation equipment is fully equipped.

Disparities in the quality of ATI-related guidelines

Our study evaluated seven clinical practice guidelines related to awake airway intubation, and only three were rated as high quality, reflecting significant gaps in the consistency and scientificity of current clinical guidelines. This not only exposes insufficient evidence and inconsistent standards in the development of guidelines, but also shows that there are great challenges in the application of different clinical scenarios. The lack of high-quality guidelines directly influences clinician decision-making in complex airway management and may increase medical risk.

Due to issues such as the clinical practice environment, experience, and equipment, it is impossible for CPGs formulated by different countries and organizations to be completely identical. All CPGs can only be required to reach agreement in terms of standard procedures and consensus, but there may be differences in details.

In the future, it is urgent to integrate global evidence-based data and practical experience, pay attention to multidisciplinary cooperation and global consensus, and develop high quality guidelines to improve their scientific value and applicability. These guidelines should be dynamically updated and continuously integrated with the latest research findings and technological advances to ensure that they are up-to-date and responsive to changing clinical needs.

Through more rigorous, evidence-based research and multidisciplinary collaboration, physicians are able to provide safe and effective treatment on the basis of standards. Moreover, the international society of anesthesiology and related professional organizations should strengthen the standardized application of guidelines through training and education, and establish clear directions for clinical training and practice, so as to ultimately improve patient safety and quality of care.

Complications of ATI

Although ATI has already become the recognized best approach, namely the so-called "gold standard", for managing patients with anticipated difficult airways, it is not without drawbacks and has complications, which can be roughly divided into two categories: procedural injuries and the failure of ATI.

In terms of procedural injuries, since ATI inevitably involves invasive and traumatic operational steps during its implementation, the airway itself and its surrounding tissues and organs are highly vulnerable, leading to adverse consequences such as hoarseness [9].

Once faced with the situation of ATI failure, if the oxygenation status of the patient cannot be quickly guaranteed, it is very likely to cause serious consequences and endanger the patient's life and health. For this reason, when it is perceived that there is a risk of ATI failure, it is necessary to immediately initiate emergency front of neck access (FONA), such as performing cricothyroidotomy or tracheotomy and other emergency operations, so as to ensure the patient's life safety and avoid life-threatening risks caused by ventilation disorders [54].

Strengths and limitations

We used the AGREE II tool and the GRADE system to evaluate the seven recent CPGs, which helps provide credibility and usability references for the intended users of these guidelines. At the same time, it provides an idea for optimizing the quality of the guide and improving the scientificity, applicability and operability of the guidelines.

There are also limitations to this study. Although the AGREE II is currently the tool most commonly used to assess the quality of guidelines, its scoring process is subjective. Therefore, we used the ICC to verify the consistency of the AGREE II scores of the three reviewers. Additionally, AGREE II assigned equal weight to its six domains, without considering their relative importance in specific contexts. Correspondingly, we visualized the recommendations or choices of the included ATI guidelines in different aspects through a 5-color chart. For readers, the scores derived from the AGREE II assessment need to be interpreted with caution, especially when used to guide clinical practice.

Conclusions

The scientificity and operability of guidelines directly affect the treatment outcomes and life safety of patients. This study emphasized the importance of a systematic review of guidelines, which provides a reference for clinicians to choose appropriate guidelines and an idea for guideline developers. Through the AGREE II tool and the GRADE system, the strengths and weaknesses of each CPG were comprehensively analyzed on the basis of scientificity and practicability. Moreover, limitations of the current CPGs in aspects of indications, local airway anesthesia and complex clinical situations are presented, and clinicians are encouraged to apply the guidelines more scientifically and to update and improve the guidelines.

Abbreviations

CPGs	Clinical practice guidelines
ATI	Awake tracheal intubation
AGREE	Appraisal of Guidelines for Research and Evaluation
ICCs	Intraclass correlation coefficients
GRADE	Grading of Recommendations Assessment, Development and Evaluation
FB	Flexible bronchoscopy
VL	Video laryngoscopy
SOS	Shikani Optical Stylet
FOB	Fiberoptic bronchoscope
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta Analyses
PROSERO	Prospective Register of Systematic Reviews
SEDAR	Spanish Society of Anesthesiology, Reanimation and Pain Therapy
SEMES	Spanish Society of Emergency and Emergency Medicine
SEORL-CCC	Spanish Society of Otolaryngology, Head and Neck Surgery
GOE	Grade of evidence
ASA	American Society of Anesthesiologists
DAS	Difficult Airway Society
CAFG	Canadian Airway Focus Group
SAM	Society of Airway Management
ICS	Association of Anaesthetists the Intensive Care Society
FICM	Faculty of Intensive Care Medicine
RCoA	Royal College of Anaesthetists
JSA	Japanese Society of Anesthesiologists
PPE	Personal protective equipment
SAHS	Sleep apnoea-hypopnoea syndrome
ECG	Electrocardiogram
NIBP	Non-invasive blood pressure
SpO_2	Peripheral oxygen saturation
$EtCO_2$	End-tidal carbon dioxide
HFNO	Front of neck airway
DA	Difficult airway
ECMO	Extracorporeal membrane oxygenation
ARDS	Acute Respiratory Distress Syndrome
NIV	Non-invasive ventilation
DMV	Difficult mask ventilation
OSA	Obstructive sleep apnea
short TMD	Temporomandibular disorder
PDA	Physiological difficult airway
ANBs	Airway nerve blocks
SLNBs	Superior laryngeal nerve blocks
RLNBs	Recurrent laryngeal nerve blocks
RCTs	Randomized Controlled Trial

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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Author contributions

F.C., Z.T. and Q.L. drafted the protocol for the study. The literature review was carried out by F.C. and Z.T. with supervision from Q.L. The first draft of the manuscript was written by F.C. and Q.H. All authors revised the manuscript critically and approved the final version.

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Data availability
Data sharing is not applicable to this article as no new data were created or analyzed in this study. The data used to support the findings of this study are included within the article.

Declarations

Ethics approval and consent to participate
Not Applicable.

Consent for publication
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Competing interests
The authors declare no competing interests.

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